

# Entropy Theory of Wealth: Thermodynamic Analysis of the Economy

Peter Stallinga

Department of Electronic Engineering and Informatics, Faculty of Science and Technology, University of The Algarve, Faro, Portugal  
Email: peter.stallinga@gmail.com

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## Abstract

The economy is analyzed on basis of thermodynamic principles, especially the law of maximum entropy production (LMEP). With thermodynamics self-evident, the reasoning is applied to the entire economy. The idea of Energy Theory of Value (ETV) is worked out and the consequences are presented. The Energy Theory of Value for the macro-economy is then an Entropy Theory of Wealth (ETW). A unit of money, the “boltz” is proposed for economy, which is equivalent to 1 megajoule. This is then applied to organization of society, with two extremes, unfettered capitalism, and communism. Any interference in the economy makes the society less efficient and prone to be taken over, since it does not follow LMEP.

## Keywords

Labor Theory of Value (LTV), Physics, Politics, Energy Theory of Value (ETV), Thermodynamics

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## 1. Introduction

Any scholar tries to understand and correctly describe the world around. One of the big debates that have always been going on is if Economy in effect is an exact science. In a recent publication we worked out the Energy Theory of Value (based on the more famous Labor Theory of Value) and brought the economy back to it being based on biological laws, they, in turn, based on physical laws (Stallinga, 2020). It has as one ingredient that the value of a product is the energy it has cost to produce and bring to the market. In the Labor Theory of Value this was instead the human “toll and labor” that has gone into it.

These then apply to the macro-economy. In this, Marx has reasoned that capital must have profit (or it will stop producing, in a so called crisis of overproduction),

and Piketty has shown that empirically this gain is 5% annually (Piketty, 2013), the energy consumption growth rate was only some 2% since the introduction of fiat-currency (corrected from 3% of (Stallinga, 2020)). In a finite planet, sustainable growth is an oxymoron, and we can thus expect that the system will falter.

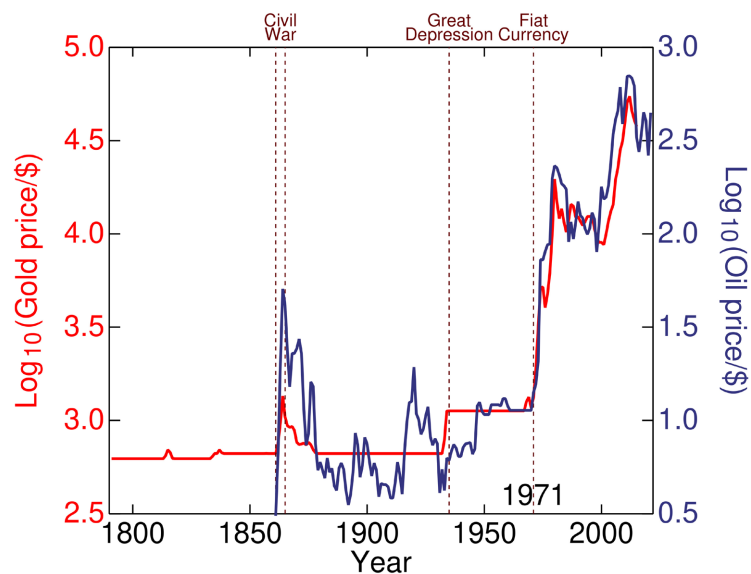
International think tanks like The World Economic Forum, or branches of the United Nations, among others, possibly aware of this economic Armageddon, is planning a restructuring of society, The Great Reset (World Economic Forum, 2020), to stave off this human collapse. In it, they treat themselves—“stakeholders”—as stewards of the planet and the rest—us—as humanity to manage, in a technocratic power grab similar to the energy-based technocracy envisioned in the early years of the 20th century. In this work the framework of these ideas will be analyzed. First arguing how thermodynamic laws are self-evident and then base a reasoning on this. Biological laws are based on these thermodynamic laws and social laws, such as economy, are based on biology laws and thus on thermodynamics. Once we understand that, we can make some relevant observations, which are the second part of this work.

## 2. Energy

The reasoning of energy theory of value (ETV) is that instead of any fiat currency such as euros or dollars (which are meaningless units) to describe the economy, the intrinsic value of products and services is the *energy* it has cost to bring them to the market. This is literally the amount of joules that go into the product. The link with earlier ideas of labor theory of value (LTV) is that LTV uses archaic terms such as “labor” and “workforce”, which are remnants from the earlier times of physics. Work is the force applied times the distance over which it is applied. The SI unit of such work is newton-meter and that is joule. In earlier days prices of products were linked to energy through the monetary system; it was based on gold and an ounce of gold being linked to a certain amount of energy because that was the energy needed to mine and mint it. With fractional-reserve banking this link got diluted and in 1971 even fully abolished with the introduction of fiat-currency, which has zero intrinsic value. It costs nothing to add a number to a computer, but has a *market* value that is equal to what people trust it has. Money is still linked to energy and things like gold, gold for which it can be exchanged on the free market, but this link is not guaranteed (as in a gold-standard), it is merely coincidental. This allows for a market value of fiat currency that can change over time, something we call inflation/deflation and that has happened since the abolition of the gold standard. **Figure 1** demonstrates this perfectly. Here the evolution of gold price and oil price is shown in terms of dollars.

We see that the gold price was fixed in the start of the graph—that is, the dollar was fixed to gold by being convertible into it—apart from some run-on-gold (a bankrun) during the uncertain times of the American Civil War. At the Great Depression the gold price jumped, people lost their faith in the gold-backed promissory dollar-notes and preferred real gold. In 1944 the Bretton Woods system was introduced where international currencies could be converted to dollars that

could, in principle, be converted to gold. After 1971 the exchangeability was fully abandoned, the reason being obvious, because dollars were cheaper in terms of gold than the gold they promised, an untenable situation. The system was replaced by a “petrodollar” that still survived until today. This does not mean that dollars can be exchanged for oil in a guaranteed way, but that petrol (energy) became the de facto reference to the monetary system. This is evidenced by the fact that gold and oil from that moment on went in lockstep. Gold simply costs an amount of energy (or an equivalent amount of oil; 1 kg of oil is 41.868 MJ (Juggler, 2020)) to mine and mint. The dollar itself (and its linked currencies in the Bretton Woods system) became fully floating, disconnected from reality, and could from then on serve as a tool for monetary policy. Read: world management. Those in control of the money system could cause crises (for instance the sub-prime crisis in 2008 based on flimsy research (Reinhart & Rogoff, 2010)), by stopping the money printing. Or create wars (for instance Ukraine in 2014) paying it with increased money printing, not possible with an energy-backed currency. Or stop the entire economy altogether during invented sanitary crises (enabled by, yet again, money printing causing astronomical inflation with a delay) or create religions based on planet-saving agendas (subsidizing energy-inefficiency, thus *inevitably* causing poverty). Those in power of the money machine could thus control the economy and society in general. And they did this because with power comes responsibility and moral obligation to act. Or, as Immanuel Kant wrote,

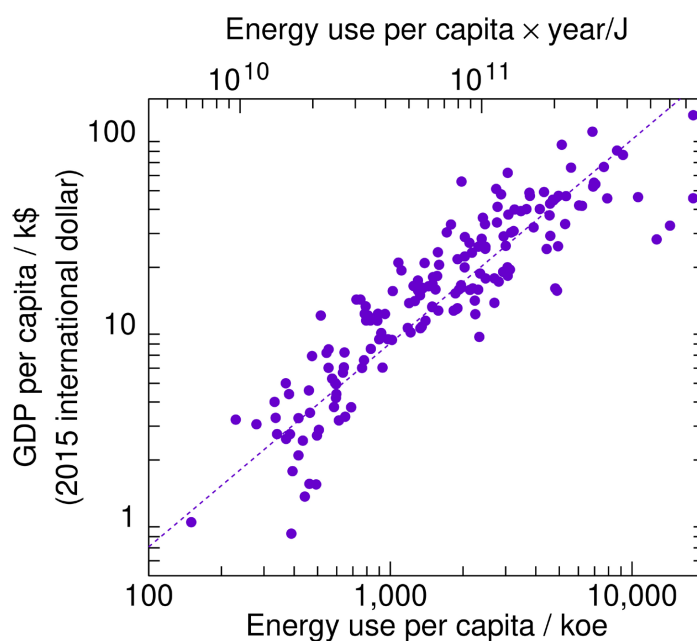


**Figure 1.** Evolution of the gold price (red, left axis) and oil price (blue, right axis). Until the abolition of the gold standard, with a guaranteed convertibility of dollar to gold, the price was stable, barring some catastrophic events where people take their losses in exchange for security, something that is called speculation. Since fiat-currency was introduced in 1971 (indicated by a vertical dashed line labeled “Fiat Currency”), the price of gold is floating and has a general tendency to increase. This represents an increase of the monetary price of a joule. Also plotted in comparison is the oil price and since 1971 the energy-as-money has become the de facto currency; 1 kilo of gold is 100 barrels of oil. Source of data: Our World in Data.

“[Ethics, or ‘the moral system’] defines the domain of morality primarily in terms of unconditionally binding and inescapable form of obligation”.

What person does not think of himself as virtuous? Therefore, those at the helm of the money system started treating humanity as a school-fair science-project ant farm. This is possible—and only possible—when the link between money and energy is severed. In a financial system where money is not linked to a physical quantity this quantity nor money can be created out of nothing. Thus spoke Lavoisier, “Nothing is lost, nothing is created, everything is transformed” (Lavoisier, 1789).

As mentioned, the link between money and energy is coincidental and floating. In 2015 a dollar had a market value of 170 mW per dollar of GDP per year (see Figure 2). In other words, 1 J was worth 186 n\$, or 1\$ was worth 5.36 MJ, and it was established that it is dropping fast (Stallinga, 2020). Interestingly, the link between oil and gold became very solid, see Figure 1. It shows the link between economy and energy (consumption). It is a strong support to the hypothesis of Energy Theory of Value.



**Figure 2.** Correlation between energy consumption and GDP of countries in 2015 (each dot is a country) in a double-logarithmic scale; the slope-1 inclination of the line demonstrates a linear relationship, GDP linearly proportional to energy consumption. And the relation is 170 mW per 2015-dollar of GDP (1\$ is 5.36 MJ). Data source: The World Bank (The World Bank, 2020). 1 kg of oil equivalent (koe) is 41.868 MJ enthalpy (Juggler, 2020). Figure from Stallinga (Stallinga, 2020).

Alternatively, some may say that the only correct indicator of value of a product is the market value and moreover claim that the market is never wrong. However, this would take Economy completely out of the realm of science, since never any theory for the economy can be developed if there is only observation and no reasoning. “What you see is what you get.” We can watch the economy as we watch

an open fire, or a washing machine in action; very relaxing, but not very useful. Continuing the market-oriented reasoning, some may say that the value is determined by “scarcity” of a product, as in the result of supply and demand. This is a somewhat advanced version of the market reasoning. “The price is what it is, that’s it, end of discussion”. Obviously also not very meaningful. Scarcity for a person, and thus the market value, is simply a representation of how a market agent can improve his own energy consumption (entropy production, as we will see) by gaining that product. It has a sort of usage value. We can call this “happiness”. It is a tenet of capitalist free markets that everybody is always happy in free-market trades. Or as Milton Friedman wrote,

“The most important single central fact about a free market is that no exchange takes place unless both parties benefit”.

A “failure” of the free market is not possible. According to Milei ([Post, 2024](#)),

“Talking about ‘[free] market failure’ is an oxymoron. There are no market failures. If transactions are voluntary, the only context in which there can be market failure is if there is coercion [i.e., not free], and the only one that is able to coerce generally is the state, which holds a monopoly on violence”.

Only interference in the market can make a market fail. A free market has benefit for all entering the free market. What this “benefit” means is not clear, but in the ETV framework presented here, as will be argued, it means that if the trade will take place the agent can improve its *entropy production* by the trade. And the link with biology is then also easily made; successful traders somehow have a trading gene that makes them have more chance of surviving in the market.

To say it in another way, in the ETV framework, where energy is the accounting unit, we can define a trade *fair* when products are exchanged with equal energy value. Then obviously not all trades are fair, while they still take place. Even for fair trades the question arises, why would agents exchange things that have equal value in the first place? What is the benefit Friedman talks about? This benefit or gain obviously cannot be energetic for both, at best it can be zero for both, in a fair trade. In an unfair trade, one party even loses energy value. We will defer this question to later, when the full ETV and the Entropy Theory of Wealth (ETW) are presented. Rest to say at this point that trade with modern fiat money is always unfair. Goods or services are exchanged for something that has zero energetic value, namely fiat money. An agent only partakes in such trades because it has an outlook on changing it back to something valuable in the future. As such, money is—and always has been—merely a lubricant in the trade of energetically-valuable things; it is a flow of a commodity like gold circulating in the opposite direction as the flow of goods. Often the money itself was energetically valuable, and often scarce, as in gold, or sea shells (the latter energetically valuable because it took a lot of energy to transport them away from the sea). Or money consisted of promises of these energetic goods (as in banknotes), but only recently we have money that is completely without any value whatsoever, not even a promise of something

of value. They merely serve as intermediary in trades.

Thus, when products are on the market they have a certain intrinsic value that is the energy it has cost to bring them to this market, as already stated by earlier economists,

The [intrinsic] value of a product is the toll and labor it costs to bring it to the market.

If the market is efficient, in the so-called Efficient Market Hypothesis (EMH) (Downey, 2024), the price of exchange reflects all information (all traders have the same information available), but that not necessarily means that trades are fair. In a fair market products are exchanged in an energy-equal way. If one kilo of grain costs 1 kJ to produce and one kilo of rice 2 kJ, then in a fair market they will be exchanged in a 2:1 ratio: two kilos of grain for one kilo of rice. This can then be placed in any local market. In Delhi, for example, a kilo of rice may cost 68 rupiah and a kilo of grain 34 rupiah, so that the local price ratio is 2:1. (One should, of course, also include in the price the energetic cost of transporting it to the market. As such, market prices can be different in different parts of the world, even if these markets are all efficient and fair. What matters is the *total* cost of bringing the goods to the market). It shows that fiat currency is just an intermediate means, an enabler of trade.

We see in **Figure 1** that the gold-oil exchange seems to have become fair after the introduction of fiat currency. Before this, the trade was rather unfair, or oil was not the major source or reference of energy. Notice, however, also that the gold price seems to lag behind the oil price, especially notable after the year 2000. It apparently takes time for the energy price to be reflected in the gold price. Apart from that the market for these products is fair. And the price itself of the products, in dollars or euros or whatever other fiat-currency, irrelevant.

The scarcity of goods is also a factor that influences the markets. However, this can also often directly be reduced to a matter of energy. Scarce products simply cost more energy to bring than abundant products. As an example may serve water. It is very abundant on this planet. However, most of it is salty; fresh water is rather scarce, because it takes a lot of energy to desalinate water. For the moment, however, there are still cheaper sources of fresh water. If that were not the case, water would get a high intrinsic value and in a fair trade could be exchanged for valuable things.

### 3. Entropy

This water example from the previous section nicely highlights an important aspect of ETV, by means of which we can explain the full theory. Nature, and thus real economy, is a zero-sum game by words of Lavoisier. What that means is that no atoms are lost; the planet is a chemically closed box—“ashes to ashes, dust to dust”. Even though some alchemists tried to make gold from other elements, this effect was never achieved (barring some minute transmutation phenomena). The

real world is thus a matrix consisting of atoms that are fully recycled, and what passes through this matrix of atoms is energy. On the one side energy comes in, on the other side of the matrix, heat (entropy) goes out. Economy is the description of the conversion of energy to entropy by humans and their infrastructures.

From Physics we know that such energy concepts are best dealt by Thermodynamics. And this was partly done in the Energy Theory of Value. But it can be linked a little better with Physics and Biology, and even Sociology, something that will be done in the current work. We will describe Thermodynamics in terms of energy and entropy and then apply it to the economy. Once economy has been brought down to physics we can see how society must also obey fundamental laws of physics. To be more precise, it must obey the laws of thermodynamics; everything is Thermodynamics. About which Einstein wrote, “It is the only physical theory of universal content, which I am convinced, that within the framework of applicability of its basic concepts will never be overthrown.”

Since the energy paradigm of ETV is based on Thermodynamics, we have to start here by repeating its standard laws:

- The First Law of Thermodynamics states that energy is conserved. Energy changes form but never vanishes nor is created.
- The Second Law of Thermodynamics states that energy tends to wind up in a form called heat, which represents chaos. We quantify this by “entropy”. The Second Law states that entropy must always increase.
- The Third Law of Thermodynamics states that a crystal at absolute zero kelvin temperature has zero entropy.

To which later a Zeroth Law was added, and to which we add the observation of Lavoisier as the Minus-First Law:

- Zeroth Law: If two systems are in thermodynamic equilibrium with a third one, they are in thermodynamic equilibrium with each other.
- Minus-First Law: The amount of matter is constant. Nothing is lost, nothing is gained, everything is transformed.

We will see that actually the Energy Theory of Value can be combined with an Entropy Theory of Wealth. The reasoning is as follows.

We start with these basic laws of physics. Before all laws comes the law of Lavoisier, the law of conservation of mass and particles mentioned above. The First Law of Thermodynamics then states that energy  $U$  is also conserved. (The concept of energy axiomatically, self-referentially defined as “that used to do work”). The Zeroth Law introduced later states that two systems that are in thermodynamic equilibrium with a third system are in thermodynamic equilibrium with each other. The Second Law states that the world acts spontaneously to minimize potentials or equivalently maximize the entropy. Entropy  $S$  is the amount of disorder in the system. Any real process can only proceed in a direction which results in an entropy increase. It is constant in a reversible process; it increases in an irreversible process. In dissipative systems, locally—i.e., non-closed systems—entropy can decrease, at the expense of the entropy outside these non-closed systems. An

example is an engine that can run and locally decrease entropy at the cost of dissipating heat to the universe. Every process in nature must follow these laws. Also biological entities and thus also human entities and their behavior in society. Or, as Eddington wrote (Eddington, 1928):

“The law that entropy always increases—the second law of thermodynamics—holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell’s equations—then so much the worse for Maxwell’s equations. If it is found to be contradicted by observation—well, these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.”

Swenson states it in another way, more generally as, “(T)he laws of thermodynamics are special laws that sit above the other laws of physics as laws about laws or laws on which the other laws depend” (Swenson, 2000). We can axiomatically assume the laws of Thermodynamics to be correct and unavoidable.

On the other hand, in the thirteenth century Thomas Aquinas wrote (proposition 37), “That nothing should be believed unless it is self-evident or could be asserted from things that are self-evident” (Grant, 1974). We therefore base economy and society on biology and biology is based on chemistry and physics. All, at the end, follow thermodynamics laws, even if it may not be apparent immediately. We coin the term “Entropy Theory of Economy”, or “Boltzmann Economy”, to honor one of the great scientists in the area of statistical physics. So, let’s first take a step back to understand what goes on. All processes in our universe are based on Thermodynamics laws. We will thus consider them from here on as “self-evident” and reason Aquinas-style.

There is a driving “force” to bring the system to equilibrium, which has maximum entropy. “As the applied gradients [to equilibrium] increase, so does the system’s ability to oppose further movement from equilibrium” (Schneider & Kay, 1995). Saying it another way: the force and speed of reaching equilibrium is increasing with distance to equilibrium, or, in other words, the system chooses (if possible) the path with the highest speed towards equilibrium, i.e. the path with the highest entropy production rate. This principle is what is called the Law of Maximum Entropy Production (LMEP), “A system will select the path or assemblage of paths out of available paths that minimizes the potential or maximizes the entropy at the fastest rate given the constraints” (Martínez-Castilla, 2010). We can add this as another law of Thermodynamics:

- Fourth Law: A (pseudo) force exists to drive the system towards maximum entropy production (LMEP).

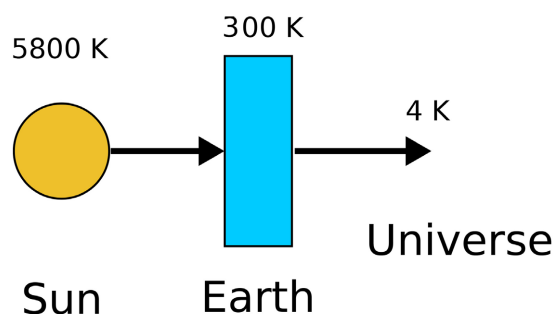
Biological self-organized systems have simply a greater ability to dissipate heat and create disorder and put the system in equilibrium faster. Thermodynamic gradients drive self-organization. It may seem contradictory, that the inevitable

drive towards entropy (chaos) leads to highly-ordered (non-chaotic) structures such as living beings, but that is only a seeming contradiction. Such ordered structures manage to create disorder even faster.

Thus, any process, including those of living things, uses energy and produces entropy. And that can be considered the single goal of the universe. Creating entropy, “chaos”. And LMEP tells us that the entropy production naturally maximizes. It is obvious that a living creature consumes more energy and produces more entropy than, say, a rock. Hence, the theory of evolution is merely rephrasing the LMEP principle in biological terms; survival of the fittest is survival of the entropiest. As Swenson writes, “(E)volution on planet Earth can be seen as an epistemic process by which the global system as a whole learns to degrade the cosmic gradient at the fastest possible rate given the constraints” (Schneider & Kay, 1995). And, “Life can be viewed as a far-from-equilibrium dissipative structure that maintains its local level of organization, at the expense of producing entropy in the environment” (Schneider & Kay, 1995). By the same authors, “We suggest that life exists on Earth as another means of dissipating the solar induced gradient and as such is a manifestation of the restated second law. Living systems are far from equilibrium dissipative systems and have great potential for reducing radiation gradients on Earth” (Schneider & Kay, 1995).

There used to be an enigma, but it was recently solved by Prigogine: While systems close to equilibrium have a *minimum* entropy production and try to be as chaotic as possible, systems far off equilibrium create ordered (non-chaotic) structures (Prigogine, 1978). A classic example is a pot of oil heated from below. When the heat gradient (measure of distance to equilibrium) exceeds a certain value, the heat transport becomes ordered in a way of convection nacles. Our planet is far off equilibrium as evidenced by the fact that we have highly ordered structures such as biological species such as humans.

Planet Earth is a modus in this entropy production. It receives radiation from the Sun at 5800 K and on the other side is a 4-kelvin universe to which the heat has to be dissipated, see **Figure 3**. This is a far-off-equilibrium system (in equilibrium everything would have the same temperature) in which the fastest way to reach equilibrium is through ordered structures, such as humans. Interesting to know, but not coming as a surprise, is that this approach is also well applicable to the climate system of our planet. The climate can be well described by a two-box model with the entropy production maximized (Lorenz, 2010; Lorenz et al., 2001; Paillard & Herbert, 2013). Also, it was observed by Ulanowicz and Hannon that living systems generate more entropy by projecting a lower albedo (whiteness of the planet), absorbing more at shorter electromagnetic wavelengths and generating more emission at longer wavelengths (Ulanowicz & Hannon, 1987). Humans will make the planet black and make it emit more heat radiation by heating it up somehow. (Note: as of yet humans do not have a great impact on the planet, we are still a Type I on the Kardashev scale; some  $10^{12}$  W (Kardashev, 1964)).



**Figure 3.** Planet Earth as a far-off thermodynamic-equilibrium system. It receives energy from a source at 5800 K, is itself only about 300 K and radiates heat to the universe at 4 K. In equilibrium the temperature would be uniform and all processes stop, in what is called a heat death of the universe.

If nature has two options for a path to follow, it will take the path that creates more entropy faster, the path that uses up more energy. We can therefore also say that the species that converts more energy into entropy will be replacing the species that does this to a lesser extent. Once again, there seems to be a contradiction here. Take this example based on words by Swenson: a cabin has people in it and a fire is burning inside. Slowly the heat dissipates into the universe and an equilibrium with maximum entropy will slowly be reached. However, if the people inside the cabin were to decide to open the door, this dissipation of heat would go much faster and the equilibrium faster reached. Why do these “optimized” people not simply open the door?! That is obviously true—they’d instantly produce more entropy. However, they would die, or not reproduce so easily, so the number of people will be less, and less fires will be started, and with less ordered structures around, *less* entropy would be produced. In the end, the species with most entropy production will win.

Since for species we can also substitute society—we can consider it a meta-species—we can state that the society that consumes more energy will conquer or drive out the ones consuming less. Thus, free-market capitalism theory—as we will see, there is no other type of economy—as we can understand it, is a rephrasing of evolution theory in economy terms, and thus a rephrasing of the laws of thermodynamics. However, things can get a little fuzzy at this level, and we no longer seem to recognize the laws of physics that unavoidably govern the laws of economy.

We have, however, on the one hand the absolute solid reasoning that also economy must follow thermodynamics—or else our ideas will “collapse in deepest humiliation”—that it must grow by LMEP since we are not yet at maximum, and on the other hand, we have the empirical law that capital grows by 5% annually (Piketty, 2013) and that capital must grow (Marx, 1867). Since, if capital grows by 5%, the means of production grow by 5% and production grows by 5% - 95% non-capital, i.e., consumer goods, or wealth, that also grows by 5% per year—we recognize an ever-increasing spiral of growing entropy production, exactly as predicted above; consumer goods are converted into entropy. We have no idea why

the percentage must be 5%, but we do understand that it must grow, and will grow, whatever we do. If we don't do it, somebody else will do it and remove us from the genetic pool in the process. This was also pointed out by Garret in his epic comment in *Science*, *The Tragedy of the Commons* (Hardin, 1968), we cannot be “nice” people (read: sustainable, or ecological, or whatever other virtue-signaling buzzword), because if everybody is nice, somebody will be bad and take all.

So far, we have discussed here how economy is merely a description of human activity in terms of biological processes that are based on fundamental physics laws. Everything boils down to thermodynamics, more specifically the production of entropy. Humans inescapably must obey this fundamental law of physics. Trying to find other explanations of observable processes—including the economy!—“will collapse in deepest humiliation”. So, on the one hand we have that the economy *must* follow thermodynamic laws, and we cannot find any reason why it shouldn't be, and on the other hand we have a theory that shows how it *can* be explained by thermodynamics.

As such, the measure of economy cannot be any form of fiat-currency, since that has no links whatsoever to the laws or concepts of thermodynamics. The unit of economy must be some of the parameters of Thermodynamics. We propose the entropy production measured as the consumption of enthalpy, with a unit of joule (J). Enthalpy  $H$  is the sum of internal energy (chemical, gravitational, kinetic, radioactive, etc.) and the “mechanical” energy of pressure  $p$  times volume  $V$ . This is more meaningful for our analysis since work done can involve change of pressure or (mostly) volume, and we thus prefer to speak in terms of enthalpy. In any case the unit is joule.

In honor of the great Boltzmann, a pioneer in Thermodynamics, this unit could be called a “boltz” in economy, and for ease of use, we propose that a boltz is equivalent to 1 MJ. In 2015 a boltz was worth 18.6¢.

Economy consists of converting energy into entropy. In economics terms it means using energy to produce goods and services and then consuming these goods and services. The latter, consumption, is production of entropy (some of it was also already produced during production of goods). The thing that has to be optimized in the LMEP.

Or to put it in classic economy terms, economy consists of adding value to things. This added value is the usage of enthalpy, and its unit is joule. “Adhering to David Ricardo's labour theory of value, Karl Marx held that human labour was the source of economic value.” (Britannica, 2022). Indeed it is, but a less archaic term of labor is “work”. This work  $W$  is the use of energy or enthalpy. For instance the simple mechanical work of lifting a kilo one meter against gravitation, the conversion of chemical energy to gravitational potential energy. This work is the force times distance over which it was applied, which has a unit newton-meter, which is joule. Labor is work, work is energy.

The work done by this energy is the enthalpy lost, and the total value  $v$  of a product is the sum of added intrinsic energetic values at the individual production

steps  $i$ ,

$$v = -\sum_i \Delta H_i = \sum_i W_i. \quad (1)$$

It is all the work put in it. In contrast to what Marx writes, at each step, nature, capital and humans all can contribute. In fact, from a physics point of view, we should not even make a distinction between these concepts; they, as well as the use of words as “confiscate”, etc., are merely social constructs, and depend on the point of view. For instance, in feudalism humans were considered a form of capital. Whether this is immoral or not is not the subject of this work but pertains to the realm of Ethics.

An anthropocentric view was presented by Karl Marx who only identifies human contributions to work and thus the source of value. He then continued the above phrase by, “The capitalist pays his workers less than the value their labour has added to the goods”. The value added by the workers is partly “confiscated” by “the capital” because their wages are less than the created value. Whereas workers produce 10 cars with their wages they can buy only 9. The difference is the surplus value that is confiscated by the capital (Money, 2024).

“Marxian economic concept that professed to explain the instability of the capitalist system. Adhering to David Ricardo’s labour theory of value, Karl Marx held that human labour was the source of economic value. The capitalist pays his workers less than the value their labour has added to the goods, usually only enough to maintain the worker at a subsistence level. Of the total worth of the worker’s labour, however, this compensation, in Marxian theory, accounts for only a mere portion, equivalent to the worker’s means of subsistence. The remainder is ‘surplus labour’, and the value it produces is ‘surplus value’. To make a profit, Marx argued, the capitalist appropriates this surplus value, thereby exploiting the labourer.”

The current energy theory of value (ETV) states that *any* source of energy creates added value. Also, for instance, the burning of coal. And this invalidates the observation of Marx, as we will see.

We have just left one issue dangling, namely the trades at free markets. As was mentioned, a fair trade is one in which things with an equal amount of intrinsic energy are exchanged. However, not all trades are fair, even if both parties are fully informed about the energetic value of the trade and the fairness of the trade. Yet, they take place because both sides benefit from the trade, and on basis of Thermodynamics we can now say that this benefit is entropy or outlook thereon. For a trade to take place between reasonable agents, both parties must gain prospect on increasing their entropy production. Trade, in general, thus increases entropy and is driven by LMEP.

The total entropy production of a set of thermodynamic machines (“agents”, for instance humans of a society) is given by this equation which is the core of the ideas here. The total entropy produced by society is,

$$\Delta S = \sum_i^N \Delta S_i = \sum_i^N \Delta U_i \times \left( \frac{dS}{dU} \right)_i. \quad (2)$$

In this,  $N$  is the number of agents,  $\Delta U_i$  energy used by an individual agent  $i$ , and  $(dS/dU)_i$  the efficiency of producing entropy from the energy. Each agent contributes to optimizing this entropy by striving to optimize its *own* contribution to the sum  $\Delta S$ . This is where humans may differ from other species that manage to optimize it by collective strategies. In any case the species with highest entropy production will prevail. Survival of the entropiest. So far, humans are on top by their individualist strategy. The above equation implies that agents are lazy (decrease  $\Delta U_i$ ), greedy (increase in their personal  $\Delta S_i$ ), inventive (decrease  $\Delta U_i$  and increase  $dS/dU_i$ ) proliferate (increase  $N$ ) machines. With less work  $W$  try to get more entropy, with entropy  $\Delta S_i$  the final goal of an agent and  $\Delta S$  the goal of a society. In psychology jargon, this entropy is called happiness. When agents strive for happiness, for instance by trading, they do so to increase their happiness, which merely means entropy or outlook thereon. We can also call this wealth. We thus arrive at an Entropy Theory of Wealth (ETW). Wealth is entropy or outlook thereon. One way or another.

A trade, therefore, can be energetically neutral, or even lossy, while still taking place, as long as it increases entropy production, either direct or later on. “A kingdom for a horse”, said the king, who thus increased (or maybe managed to keep) his outlook on future entropy production. This selfish entropy production—without knowing it, since that term was coined much later—is what Adam Smith referred to when he wrote (Smith, 1776: p. 26),

“It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.”

It is the recognition that agents in the economy always act in self-interest. Contrast this to the sneering comments of Michael Parenti (Louise, 2012),

“The free market mythology argues that the most ruthless, selfish, opportunistic, greedy, calculating plunderers applying the most heartless measures in cold blooded pursuit of corporate interests will produce the best results for all of us.”

Indeed it does! It is not a myth. It is called the Invisible Hand of Smith. In his own words (Smith, 1776: p. 456):

“But the annual revenue of every society is always precisely equal to the exchangeable value of the whole annual produce of its industry, or rather is precisely the same thing with that exchangeable value. As every individual, therefore, endeavours as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labours to render

the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it. I have never known much good done by those who affected to trade for the public good. It is an affectation, indeed, not very common among merchants, and very few words need be employed in dissuading them from it.”

It does not matter how nice character people have, or how good-looking they are, or what people think or say. Or what reasons they may have for doing things. It does not matter that somebody is a—“bad, very bad, shame on you!”—selfish person. The only thing that matters is what they *do*. Namely what they *produce*. Since on the free market both parties are happy, *in a free market somebody can only get rich by making others wealthy too*. The more ruthless, selfish, opportunistic, greedy, calculating people are in cold blooded pursuit of personal interest, the better it may be. What matters is how much they produce for us. How much they satisfy our needs. It is the essence of capitalism. Those, like Parenti, that appeal to other people’s altruism do that in an egoistic self-interest of getting more goodies for less work. It is merely a strategy to optimize one’s personal  $\Delta S_i$ . In fact, any political ideology is just a group strategy of optimization of entropy production of the group. We should never listen to the words of politicians, but look at their entropy-grabbing actions, which are merely driven by self-interest. By low-energetic talk they can confiscate surplus value created by workers. This is the true class struggle. We’ll come back to this later.

Here we conclude that this self-interest, as we now understand it, is the optimization of an agent’s entropy production, which also governs biology. Boltzmann:

“The general struggle for existence of animate beings is therefore not a struggle for raw materials ... but a struggle for entropy, which becomes available through the transition of energy from the hot Sun to the cold Earth”.

To summarize the Thermodynamic Theory of Economy in the Energy Theory of Value and the Entropy Theory of Wealth, we can say that:

Production is energy use. Work, done by humans or machines alike, consists of converting energy. The unit is joule, [J]. Measured per year, the economy is the sum of all values added by work in a year, and is GDP with unit watt, [J/s]. Wealth is the amount of entropy produced or the outlook thereon. Its unit is [J/K].

Life is nothing more than entropy production. With dust a high-entropy state, this

is beautifully poetically summarized by the classic line of T.S. Eliot in *The Waste Land*, “I will show you fear in a handful of dust.”

#### 4. Economy

We can now look at some ramifications of the above presented theory. Let's pit two extremes of organization of the economy against each other. Communism and capitalism.

First of all, applying thermodynamics to biology means that the species with the highest entropy production will be the one most fit and will thus survive. Each biological agent will try to optimize its own entropy-production machine, that means minimizing energy spent and maximizing consumption (entropy production). The most “bang for buck”, the most entropy for the least energy. In other words, an agent is inherently lazy, greedy and proliferate. On the scale of society it means that an organization of society that is based on these traits will win over one that doesn't make use of them. This without moralizing, since morality anyway has no SI unit and thus should be kept out of a scientific discussion. We can see that a system “From each according to his ability, to each according to his needs” (*Jeder nach seinen Fähigkeiten, jedem nach seinen Bedürfnissen*) (Marx, 1970), as in communism proposed by Karl Marx, is doomed to fail, since agents will demonstrate that their abilities are small (a.k.a. “laziness”) and their needs are large (a.k.a. “greedy”). If consumption (rights) are not in accordance with production, production will be tending to a minimum, since that maximizes the bang for buck, the entropy per joule, which is the main objective of physics and thus the main objective of each biological agent. What communism therefore produces, above all, are its own grave diggers. (A parody on the last sentence of *Manifest* of Karl Marx (Marx & Engels, 1895)). In such systems, production can only be stimulated by threat of elimination of the agents from the genetic pool. For these eliminated elements  $\Delta U_i = 0$  and  $\Delta S_i = 0$  holds, which is below optimum. This we would no longer call communism, but rather feudalism, where people produce by order of a “special agent” (a.k.a. “dictator”).

As long as this stage is not reached and the system is democratic, people will tend to minimize their contribution to work  $W$  and try to optimize their entropy-channels, their consumption rights  $\Delta S_i$ . In a system of “to each according to his needs and from each according to his abilities” people will become unproductive beggars. This is very well described in the book of Ayn Rand, *Atlas Shrugged* (Rand, 1957),

“We're all one big family, they told us, we're all in this together. But you don't all stand working an acetylene torch ten hours a day—together, and you don't all get a bellyache—together. What's whose ability and which of whose needs comes first? When it's all one pot, you can't let any man decide what his own needs are, can you? If you did, he might claim that he needs a yacht—and if his feelings is all you have to go by, he might prove it, too. Why not? If it's not right for me to own a car until I've worked myself into a hospital ward,

earning a car for every loafer and every naked savage on earth—why can't he demand a yacht from me, too, if I still have the ability not to have collapsed? No? He can't? Then why can he demand that I go without cream for my coffee until he's replastered his living room? ... Oh well ... Well, anyway, it was decided that nobody had the right to judge his own need or ability. We voted on it. Yes, ma'am, we voted on it in a public meeting twice a year. How else could it be done? Do you care to think what would happen at such a meeting? It took us just one meeting to discover that we had become beggars—rotten, whining, sniveling beggars, all of us, because no man could claim his pay as his rightful earning, he had no rights and no earnings, his work didn't belong to him, it belonged to “the family”, and they owed him nothing in return, and the only claim he had on them was his “need”—so he had to beg in public for relief from his needs, like any lousy moocher, listing all his troubles and miseries, down to his patched drawers and his wife's head colds, hoping that “the family” would throw him the alms. He had to claim miseries, because it's miseries, not work, that had become the coin of the realm—so it turned into a contest among six thousand panhandlers, each claiming that his need was worse than his brother's. How else could it be done? Do you care to guess what happened, what sort of men kept quiet, feeling shame, and what sort got away with the jackpot?

But that wasn't all. There was something else that we discovered at the same meeting. The factory's production had fallen by forty per cent, in that first half-year, so it was decided that somebody hadn't delivered “according to his ability”. Who? How would you tell it? “The family” voted on that, too. They voted which men were the best, and these men were sentenced to work overtime each night for the next six months. Overtime without pay because you weren't paid by time and you weren't paid by work, only by need.

Do I have to tell you what happened after that—and into what sort of creatures we all started turning, we who had once been human? We began to hide whatever ability we had, to slow down and watch like hawks that we never worked any faster or better than the next fellow. What else could we do, when we knew that if we did our best for “the family”, it's not thanks or rewards that we'd get, but punishment? We knew that for every stinker who'd ruin a batch of motors and cost the company money—either through his sloppiness, because he didn't have to care, or through plain incompetence—it's we who'd have to pay with our nights and our Sundays. So we did our best to be no good.”

Communism is defined as a system in which the workers/consumers take the decisions in production—what to do with the means of production (MoP)—and optimize to satisfy the needs of the workers/consumers. In fact, we can readily state that they *steal* the MoP, since property cannot be defined in physical terms (a legal document of property is meaningless in physics terms) other than that the one owning the property is the one controlling it. Therefore, the workers taking

the decisions in production, controlling the MoP, are *owning* the MoP in communism. They forced transfer of ownership—a.k.a. theft—in a revolution resulting in communism. In a recent publication we presented research that shows how this can be achieved, namely by joining forces (Stallinga, 2024b). In a so-called join-believe-fight (JBF) system, agents join around a core idea of which the veracity is irrelevant, in this case soviet-communism, and with the combined power start stealing wealth of others. Soviet communism is an example of such a JBF system.

This may theoretically, that is mathematically, work. (Mathematics, that is, not pertaining to the real world (Stallinga, 2024a). That is, we can *mathematically* also optimize entropy production. There can never be a wish unfulfilled, a necessity left unanswered, since these entropy-leanness problems will be solved. For instance, a lack of shoes cannot exist, because if there is a lack of shoes, in communism the central committee will decide to give orders to those operating the means of production to produce shoes. Problem solved. However, in the real world it is Darwinistically-optimized agents that take these decisions—if they can. As such, the central committee, composed of such agents, will merely optimize their *own* state. Orders will be given to satisfy the needs of the ones giving the orders, those that self-acclaimed have a lot of needs. No agent is interested in altruism, since that goes against the laws of physics, as described in the previous section. There is no psychical or biological mechanism that can give rise to such altruism, and therefore it does not exist. It is at best a Tit-for-Tat strategy of self-interest; (pseudo) altruism in expectation of reciprocal altruism. This is true even if we might think that there is a natural force for altruism, that as long as the entropy-production I lose by my altruism is compensated by more entropy-production in my neighbor. My neighbor, however, must propagate this gene. Yet, if he has the gene, he'd immediately altruistically give me back my entropy-production channel.

The ones giving the orders enriching themselves is what we can call “corruption”, but is fully unavoidable and merely the law of nature. We have seen, as a nice example now that we are talking about shoes, how Imelda Marcos, wife of Philippine dictator—special agent—Ferdinand Marcos, while her people were suffering and needy, was famous for having had about 3 thousand (sic;  $3.0 \times 10^3$ ) pairs of shoes.

It can work on paper, mathematically, and for that we have to base the economy not on the character of humans, humans that have evolved a selfish strategy to maximize entropy, but to change the character of humans and give them collectivist ant-like strategy. We have to change humanity by changing all humans into a new species forcedly. This can be done by genetically changing the behavior of humans and remove the selfish gene from humans, something that trans-humanists propose. Or we can indoctrinate every human from birth to be a different human. Something that was tried in the Soviet Experiment. Or as Leon Trotsky wrote, the new authorities were forming “the man of our epoch, who has yet to

struggle to create the conditions out of which the harmonious citizen of the commune will grow” (Kravchenko, 2022). Alexandra Kollontai added,

“The new way of life of communism will re-educate and re-create man. The new person will have individual creative flair and talents to improve this way of life, where there will no longer be so many problems of the economy and the issues of relationships between people and the issue of the individual and the collective, i.e., a new morality, will come to the fore. For them, for that happy humanity, envy, jealousy, intrigues and slandering will disappear. There will be no wars, no killings”.

This experiment failed. And as long as we do not change the character of Man communism will fail. Because humans are selfish by nature. Or as Aristotle wrote,

“That which is common to the greatest number gets the least amount of care. Men pay most attention to what is their own: they care less for what is common”.

Contrasting communism is free-market capitalism, which is defined by that “capital” (means of production, MoP) takes the decisions in production and does this to maximize the capital. In this system all agents are “free”, meaning they can all optimize their own machinery, decide for themselves the right balance between laziness and greed, the system will automatically find an optimum of entropy production by Darwin’s adjustment scenario of survival of the fittest, meaning survival of the entropiests (more units producing entropy and more entropy per unit). Each agent trying to optimize on a large scale means economy auto-adjusting optimally; society is a gas of entropy-agents. And since this is the fastest way to entropy production it will inevitably wipe out societies that chose other paths.

We cannot even hope to come to an agreement and have a new world order in which all world citizens unanimously decide to temper their consumption in order to “save the planet”. It simply will not work, as already argued by Hardin in his *Tragedy of the Commons* (Hardin, 1968), or by Richard Dawkins in his *The Selfish Gene* (Dawkins, 1976); the world cannot only consist of doves, because that is genetically unstable. Both Dawkins and Hardin say that in a doves-only society there is a vacuum that will be occupied by hawks, since nature abhors vacuum (*horror vacuū*; Aristotle). In physics LMEP wording: agents that decide to reduce their entropy production will create space for agents that simply assume this entropy production and substitute the low-entropy-producing agents.

In the sociology study based on Monte-Carlo simulations mentioned above it was shown by the author that the cooperative “fascist” gene is actually winning in society (Stallinga, 2024b); agents cooperating in a join-believe-fight (JBF) system gyrated around a narrative will drive out those that do not cooperate. Yet, it is shown that, although this would favor such a world-saving movement mentioned above, before the entire world is converted to this narrative, factions within factions (hawks amongst doves) will be created that destroy the one-world-government. We now understand why this would happen; any dovish attempt to temper

entropy production is doomed to fail because nature will find a way to sabotage it. It was also shown in that work that cooperation is beneficial for all agents when there is a positive-sum-game (growing) economy, but this incentive for cooperation disappears in a sustainable economy with a zero-sum-game. The incentive for JBF disappears with it, and JBF will destroy itself.

At this point it is also interesting to refute the communist argument that the Great Depression was caused by intrinsic weaving flaws of capitalism, an argument often heard. Indeed, as Karl Marx has shown, capitalism will wind up in a crisis of overproduction—idle MoP alongside needy idle workers/consumers—when the system saturates; when the planet reaches its limits of resources. However, this reason is immediately refuted by reality that followed the Great Depression. Economy grew well beyond the pre-depression size, showing that the system was obviously not (yet) in saturation. The Great Depression was therefore undeniably not caused by capitalism. We could speculate about what caused it. Considering the above, we expect that the depression was simply in the interest of a powerful subset of agents, agents powerful enough to initiate a crisis. We might think about a bankers cabal. However, this is merely speculation and we will not address this point here.

It is at this moment thus fully clear why communism doesn't work and unfettered capitalism does. However, it is not clear why capitalism should bring forward a 5% yearly increase in capital gains, as empirically shown by Piketty (Piketty, 2013). 5% gain in capital means 5% increase in means-of-production, which means 5% increase in production. It must be pointed out here that non-producing "means-of-production" are not means-of-production, but useless combinations of atoms, wasted effort that will not help in an ordered way to increase entropy, something that in Darwinistic capitalism is thus avoided; means-of-production translates to *productive* and *producing* means. Piketty has shown that the MoP *will* increase by 5%. It means that part of the means-of-production are used to increase the means-of-production and the rest are directly consumption (entropy), meaning wealth or welfare. Because the 5% growth rate is constant (according to Piketty) also consumption grows by 5% per year in capitalism. It means that also energy usage increases by 5% per year and entropy production increases by 5% per year. However, it is not clear why the yearly increase should be 5%. May it be related to the fact that 20 years is approximately one human generation? Daniel Kahneman, in his book *Thinking, Fast and Slow* (Kahneman, 2011), has shed some light on the phenomenon by determining why and when people invest. It is therefore likely that it is a psychological effect, and this is outside the realm of the current work. We simply take the 5%-rule axiomatically for granted since it was shown to be empirically true.

We can summarize the empirical law in an equation with the 5% growth rate resulting in a geometric series. It is obvious that this series after a while leads to a situation in which the capital is effectively doing all of the production. Wealth production is exponential because capital grows exponentially and the production

is for  $(1 - \alpha)$  fraction used for wealth. To put it in an equation, when only capital is producing and human contribution to production has become irrelevant, the year-on-year increase of capital is given by:

$$\Delta K(t) = \frac{\alpha \eta_k P_k \times [1 \text{ a}]}{U_k} K(t). \tag{3}$$

In this  $K$  is capital (unit: joule),  $t$  is time,  $P$  is power (unit: watt),  $\alpha$  the fraction of system used to produce new capital,  $\eta_k$  is the efficiency of capital, and  $U_k$  is the energy (unit: joule) it costs to produce a unit of capital. The solution to the above equation is

$$K(t) = K_0 (1 + g)^{t/[1 \text{ a}]},$$

$$g \equiv \frac{\alpha \eta_k P_k \times [1 \text{ a}]}{U_k}. \tag{4}$$

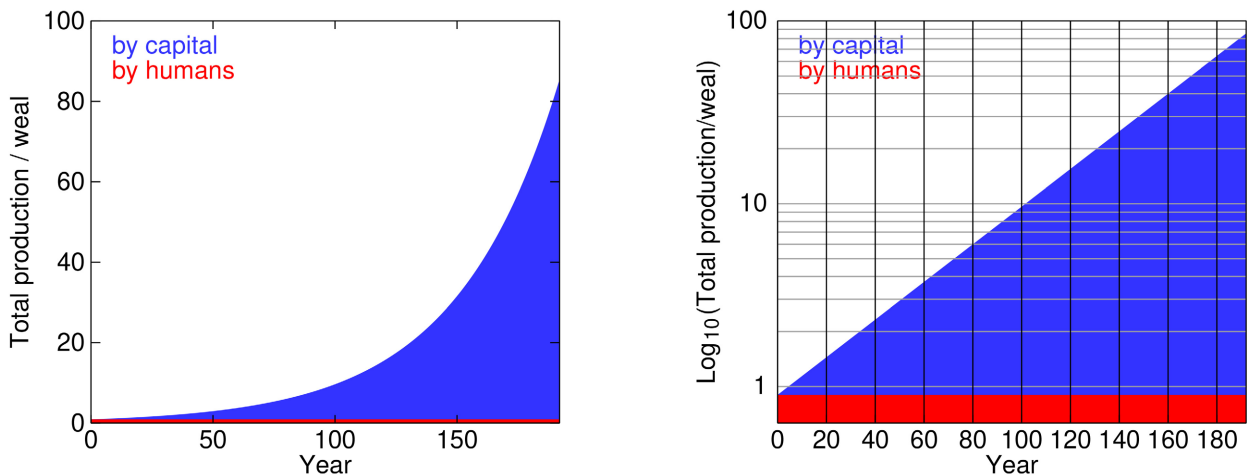
with  $K_0$  the (starting) capital at year 0. (“[1 a]” signifies 1 year). If we also include human contribution to production, rates of total production  $Y$ , production of wealth  $W$  and new capital in a year, are, respectively

$$Y(t) = K(t) P_k \eta_k + M(t) P_m \eta_m,$$

$$W(t) = (1 - \alpha) \frac{Y(t)}{U_w},$$

$$\frac{\Delta K(t)}{[1 \text{ a}]} = \alpha \frac{Y(t)}{U_k}, \tag{5}$$

with  $M(t)$  the number of humans—“M” for *Mensch*, where “k” stood for *Kapital*— $P_m$  the power consumed by a human, and  $\eta_m$  the production efficiency of humans, and  $U_w$  the energy it costs to produce 1 unit of wealth. Note that in this system newly created capital only starts production in the next year. Note also that production (also of humans) does not create new humans in this simplified model.  $M(t)$  was chosen constant at 1 in this example.



**Figure 4.** Geometric series of production by capital and humans. Because productive capital is produced in production, the production of wealth is exponential. Left: linear scale, Right: logarithmic scale. The first 6 years are presented in **Table 1**.

**Table 1.** First 6 years of the geometric series of production by humans ( $H$ ) and capital ( $K$ ). A human consumes 100 watt and produces with 10% efficiency, thus 10 watt effectively. A unit of capital consumes 10 watt and produces at 50% efficiency thus 5 watt effectively. These values are highlighted in the table by **bold font**. See also **Figure 4**.

Year	Producers	Power	Production	Wealth	Capital	Share
$t$	$M$ and $K$	$P$	$\eta P$	$W$	$dK/dt$	
0	<b>1.0 hum</b>	<b>100.0 W</b>	<b>10.00 W</b>	1.00 weal*	1.00 cap*	100.0%
1	1.0 hum	100.0 W	10.00 W	1.00 weal	1.00 cap	66.7%
	<b>1.0 cap</b>	<b>10.0 W</b>	<b>5.00 W</b>	0.50 weal	0.50 cap	33.3%
2	1.0 hum	100.0 W	10.00 W	1.00 weal	1.00 cap	44.4%
	2.5 cap	25.0 W	12.50 W	1.25 weal	1.25 cap	55.6%
3	1.0 hum	100.0 W	10.00 W	1.00 weal	1.00 cap	29.6%
	4.8 cap	47.5 W	23.75 W	2.38 weal	2.38 cap	70.4%
4	1.0 hum	100.0 W	10.00 W	1.00 weal	1.00 cap	19.8%
	8.1 cap	81.3 W	40.63 W	4.06 weal	4.06 cap	80.2%
5	1.0 hum	100.0 W	10.00 W	1.00 weal	1.00 cap	13.2%
	13.2 cap	131.9 W	65.94 W	6.59 weal	6.59 cap	86.8%

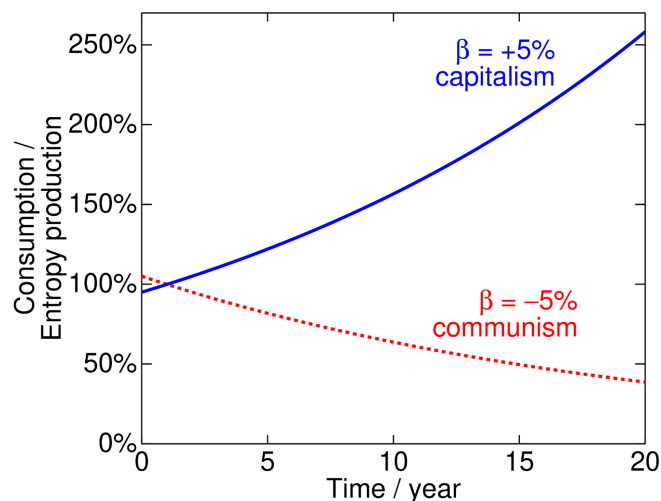
\*: by definition; defining the units “weal” ( $(1-\alpha)\eta_m$  times 100 watt-year = 299.592 MJ wealth) and “cap” ( $\alpha\eta_m$  times 100 watt-year = 15.768 MJ capital),  $\alpha = 0.05$ ,  $\eta_m = 10\%$ .

We see in this simulation how initially humans do the production, but rapidly taken over by capital. In the current stage of our society capital is doing most of the work. It can easily be estimated that every human worker has about 70 so-called energy-slaves. Meaning that human workers contribute only 1.4% to the total production. Since they are getting the lion’s share of the produced goods in the form of consumption rights (wages) we can state that the human workers are confiscating the surplus value created by the capital. It is the workers that are fleeing the capital, not the other way around, as communists commonly claim.

In communism, on the other hand, agents will democratically decide to consume more than 100% of production. Why? Because they can! Because that will increase their own entropy production immediately and that is the driving force of agents, as shown in the previous section. They would dedicate 5% of their production to increasing their *personal* capital—“saving”—however, they will not decide to dedicate any percentage to increase the capital of *other* agents. They will, if they can, try to confiscate the capital and production of others (and if they join forces to do so, it is called JBF (join-believe-fight) (Stallinga, 2024b)). In communism this can be done democratically, and that will thus be done. Democracy actually gears the system favorably for the less-powerfull (unproductive) agents, since in this system everybody has the same power, one-man-one-vote. Each agent will vote for a system that benefits himself. Even one where on average for every joule produced they get back more than 1 joule in consumption rights. In fact, agents do not even see this deficit on the production balance, because it is out of

sight. As Adam Smith wrote about his idea of the Invisible Hand (quoted above).

As such, consumption can be instantaneously bigger than 100% of production and the means of production thus decrease steadily. This then means also that the production decreases and we wind up in a poverty spiral. That while starting at the same level, communism initially creates *more* wealth than capitalism, because the capital “skims the surplus value created by the workers” and some production produced by the workers is used up by the capital (of which more later), see **Figure 5**.



**Figure 5.** Starting with a certain production capacity that is used in part  $\beta$  to produce new means of production (MoP) we can see how production grows and with it consumption (and thus entropy production). In unfettered capitalism this fraction  $\beta$  is about 5%, represented by the blue solid curve. In democratic communism people will vote to consume more than the production and thus the MoP will decrease, the dashed red curve shows an example of  $\beta = -5%$ . As can be seen, initially people in communism manage to satisfy instant needs better, however, in the long run unfettered capitalism wins. It is not clear why 5% should be the natural value, but this was found empirically (Piketty, 2013).

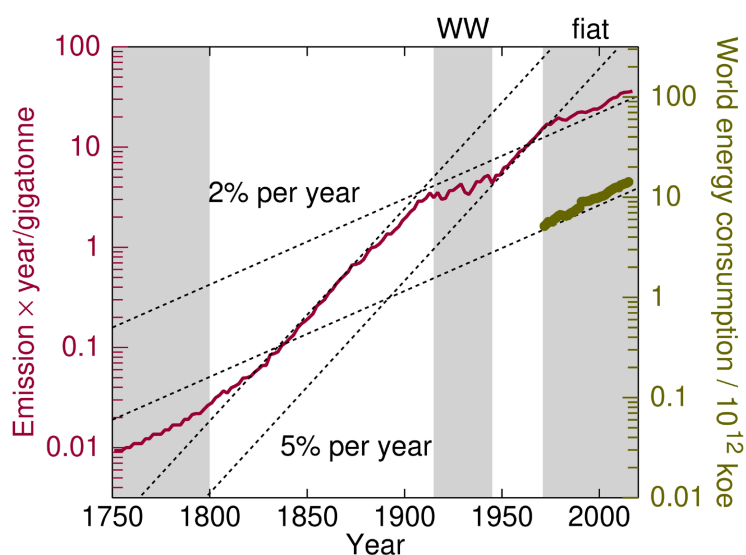
Indeed, capital “fleeces” the workers, but this surplus value is used to create more means-of-production that are operated by the workers that thus produce ever more (wealth and MoP). The capital is not an enemy of the worker, but rather his best friend. Or, as Ayn Rand writes in her book *Atlas Shrugged* (Rand, 1957) about the metal capitalist Hank Rearden,

“If you worked as a blacksmith in the mystics’ Middle Ages, the whole of your earning capacity would consist of an iron bar produced by your hands in days and days of effort. How many tons of rail do you produce per day if you work for Hank Rearden? Would you dare to claim that the size of your pay check was created solely by your physical labor and that those rails were the product of your muscles? The standard of living of that blacksmith is all that your muscles are worth; the rest is a gift from Hank Rearden.”

Even if the capital fleeces the worker by some percent, the worker still gets much

more than his contribution to the production. We can make an estimate. At this moment, every worker has many energy slaves working for him: A human body consumes about 150 watt of energy (3000 kcal per day). A person in the United States had in 2019 an estimated energy consumption of 304.414 BTU per year (CIA The World Factbook, 2022), equivalent to 10.175 kW, That means such a person has 70 energy slaves working for him. This is a lower limit, since the efficiency of production of a human is much lower than that of capital; large part of the calories are wasted on heating and other useless things. The capital can easily reach 50% efficiency in production, while humans cannot hope for more than maybe 10%. Thus we can say that for every unit of goods produced by humans, maybe about 300 are produced by the energy/capital. Thus, considering that humans take the lion's share of production, while only contributing a minor part (0.3%) to the production, in effect it is the humans that are skimming the added value created by the capital! Since capital is now doing nearly all of the production, the 5% y-o-y capital growth rate translate directly in 5% y-o-y production growth rate as well as 5% y-o-y wealth growth rate.

We can see this exact same 5% per year growth of capital also in the energy consumption that grows 5% per year, which neatly exemplifies the theory presented here. That is, it used to grow at 5% per year but this growth rate was stumped at the war era of the first and second World War, at what time the growth rate was only 2%, caused by a large part of the production machinery not to be dedicated to wealth creation or increasing the MoP, but rather to increasing the bellicose material that was actually also used to destroy MoP. In the post-bellicum times, the growth rate returned to 5% per year. Curiously, the 2% stumped growth is again observed after the fiat money was fully introduced in the world in 1971, see **Figure 6**; apparently fiat-money is as destructive to society as war was.



**Figure 6.** Evolution of energy consumption, initially measured by the proxy of carbon emission and later directly by energy consumption. It shows the growth rate of 5%, stumped by wars and the introduction of fiat-money, at which times it was about 2%.

The central idea of the Energy Theory of Value and the importance of entropy in economy is based on the LMEP law, which we called the Fourth Law of Thermodynamics. Some claim that it is not this law of Thermodynamics, as an optimization of the Second Law (entropy must always increase), that governs economy, but rather the First Law (conservation of energy), or the Minus-First Law (Lavoisier; conservation of matter), namely scarcity of products, determining the price settling at the free market through supply and demand. For instance Khalil argues that the First Law (“energy”) is most important (Khalil, 2004). Indeed, the (intrinsic) value of a product is determined by its energetic ingredient (as explained before). Yet, the driving force of *why* things are produced and traded in the first place is in the Second and Fourth laws. The Second Law saying why and the Fourth Law saying how it is optimized. The one who is optimizing its entropy production best and manages to produce entropy fastest will survive in the economy/society/world/nature in a Darwinist way.

Note also that scarcity cannot be considered important, since by the law of Lavoisier—nothing is created or *lost*—nature is by definition cyclic and all resources are effectively infinite. The only question is, how much energy will it cost (against the tendency of entropy) to put them in a form that is useful for production or trade? In other words, the “scarcity” is merely a measure of energy. Some, those in the area of ecological economy, including Georgescu-Roegen, consider the final state of the world one in which all useful (low-entropy) resources have been converted into high-entropy useless waste. However, things are only waste if there are other sources of these resources available that cost less energy to process. Once again, the example of freshwater made out of saline seawater springs to mind. Potable water can be made out of seawater given enough energy and will be done there where other sources of water are not available. Waste becomes a source of resources once other sources become energetically unfavorable. The free market will determine which ones are energetically favorable. Recycling waste will become energetically favorable and thus the natural free-capitalist solution. Inanimate nature would rather slowly decrease energy spending (flowing) when the entropy gets too big, and die a slow death. Humans, and other living entities, on the other hand will increase their energy spending. It shows once again how they are different and more entropy productive and the reason for their existence, as described before.

This sharply contrasts the work of Georgescu-Roegen. As stated by Wikipedia:

“In the history of economic thought, Georgescu-Roegen was the first economist of some standing to theorize on the premise that all of earth’s mineral resources will eventually be exhausted at some indeterminate future point. In his papers, Georgescu-Roegen argued that economic scarcity is rooted in physical reality; that all natural resources are irreversibly degraded when put to use in economic activity; that the carrying capacity of earth—that is, earth’s capacity to sustain human populations and consumption levels—is bound to decrease sometime in the future as earth’s finite stock of mineral resources is being extracted and put to use; and consequently, that the world

economy as a whole is heading towards an inevitable future collapse, ultimately bringing about human extinction. Due to the radical pessimism inherent to his work, based on the physical concept of entropy, the theoretical position of Georgescu-Roegen and his followers was later termed “entropy pessimism”. As he brought natural resource flows into economic modeling and analysis, Georgescu-Roegen’s work was decisive for the establishing of ecological economics as an independent academic sub-discipline in economics in the 1980s.”

In the current work the opposite statement is made. When resources become “scarce” (in the low-entropic state) their intrinsic energetic value, when offered on the free market, will increase and economy will rather grow in terms of energy, as well as in terms of any fiat-money.

The idea behind ecological economics, basing it on Physics, is that energy is conserved—after all, that *is* the First Law of Thermodynamics—and can thus never play any factor in any model. And that it is rather entropy that is the driving force. Indeed, this is correct. Energy is conserved, but *free* energy isn’t. Free energy is diminishing where entropy is increasing. Systems have the tendency to wind up in a so-called heat death, with a maximized entropy and no more free energy, and even our planet cannot escape this fate, not even the universe can. At that stage no processes can take further place, including any economic activity. Waste is a state of matter with high entropy, and we can thus imagine a “waste death” of the economy, something that pessimistic ecological economists envisage. Yet, that stage of heat death of the universe is very far ahead of us. Some estimate it at  $1.7 \times 10^{106}$  years (Wikipedia, 2024). Don’t forget, a state of high entropy (of waste) on Earth can always be brought back to low entropy by producing even more entropy in the rest of the universe, that will not die a heat death for a very very long time. The universe is only  $1.37 \times 10^{10}$  years old. We are not even in one percent of one percent of one percent of...(repeat some 48 times)...of that time. As long as the Sun is shining at 5800 kelvin and the rest of the universe is at 3 kelvin we are not at any heat death nor any waste death. The amount of free energy is truly astronomical, and the time it will remain so astronomical as well. We do not have to worry about entropic saturation.

The same reason why tree wood burns irreversibly into high-entropy matter by fire. Yet, with the help of the Sun the high-entropic carbon-dioxide and water produced in the fire can be returned into a low-entropic new tree. That is the cyclic nature of nature. Likewise, all fossil fuels are cyclic, and burning them up gives possibility for new trees growing—as we know, the planet has become substantially greener the last decades—and then decaying into fossil fuels, which are as renewable as any other energy source.

#### 4.1. Free Market

As mentioned above, in a free market both parties are by definition happy. This happiness is defined as the outlook on entropy production. A special case of non-

free markets are trade barriers between countries, the following idea copied from the author's book *Money: In Gold We Trust* (Stallinga, 2016). Adam Smith said about these markets the following (Smith, 1776: p. 457), *Wealth of Nations*, IV.2.11:

“To give the monopoly of the home-market to the produce of domestic industry, in any particular art or manufacture, is in some measure to direct private people in what manner they ought to employ their capitals, and must, in almost all cases, be either a useless or a hurtful regulation. If the produce of domestic can be brought there as cheap as that of foreign industry, the regulation is evidently useless. If it cannot, it must generally be hurtful. It is the maxim of every prudent master of a family never to attempt to make at home what it will cost him more to make than to buy. The taylor does not attempt to make his own shoes, but buys them of the shoemaker. The shoemaker does not attempt to make his own clothes, but employs a taylor. The farmer attempts to make neither the one nor the other, but employs those different artificers. All of them find it for their interest to employ their whole industry in a way in which they have some advantage over their neighbours, and to purchase with a part of its produce, or what is the same thing, with the price of a part of it, whatever else they have occasion for.”

This is the second important contribution of Smith, namely his Division of Labor. This optimizes production (and thus wealth). Any barrier on free trade reduces the Division of Labor and is thus “hurtful”. And as to why it happens anyway Smith writes (Adam Smith, *Wealth of Nations*, IV.2.8) (p. 453):

“That this monopoly of the home-market frequently gives great encouragement to that particular species of industry which enjoys it, and frequently turns towards that employment a greater share of both the labour and stock of the society than would otherwise have gone to it, cannot be doubted. But whether it tends either to increase the general industry of the society, or to give it the most advantageous direction, is not, perhaps, altogether so evident.”

In other words, it increases the share of the (smaller) pie to some subset of agents in society. Yet, for society as a whole, it is detrimental. Imagine a situation in which Germany and China do not trade with each other but produce cheese and electronics independently from each other. Germany is better at making cheese (production cost only 1 euro, while electronics cost 9 euro to produce) and China is better at making electronics (reverse costs). *Inside* both countries there is free trade and the market is fully crystallized. Every product that costs one euro also generates one “wealth point” (wp; which we must imagine as some amount of entropy with unit J/K). If this were not true, the Invisible Hand of Smith would correct this mismatch. If, for instance, in Germany the electronics were to produce more than 1 wp per euro people would retract from cheese production and go into electronics fabrication business. Until the return-on-investment is equilibrated (and probably a little more than 1 wp per euro). We thus have the situation as shown in the table below:

	Germany		China	
	cost	wealth	cost	wealth
Cheese	1 euro	1 wp	9 euro	9 wp
Electronics	9 euro	9 wp	1 euro	1 wp

Assume both countries have 10 production units, as in 10 factories or something like that, 10 joules of energy to spend on production (assuming an instant euro value of 1 joule):

Situation 1: Without open borders: Independent of how the means of production are used, the production of goods will always result in 10 wealth points in both countries. For example, Germany produces 1 unit cheese and 1 unit electronics which results in a wealth of  $1 \times (1 \text{ wp}) + 1 \times (9 \text{ wp}) = 10 \text{ wp}$  at a total cost of:  $1 \times (1 \text{ euro}) + 1 \times (9 \text{ euro}) = 10 \text{ euro}$ . The same applies to China: with a total cost of 10 euro always 10 wealth points are created.

Situation 2: Open borders, *laissez faire*. If the wealth points for these goods stay the same, then the following situation is the best: Germany produces 10 cheese. Cost:  $10 \times (1 \text{ euro}) = 10 \text{ euro}$ . China produces 10 units of electronics. Cost:  $10 \times (1 \text{ euro}) = 10 \text{ euro}$ . They trade with each other. Imagine they do this on a one-to-one ratio basis (considering the symmetry in the example, it seems logical, yet it is not necessary). They'll trade everything with each other. Germany receives 10 units of electronics. wealth:  $10 \times (9 \text{ wp}) = 90 \text{ wp}$ . China receives 10 units cheese. wealth:  $10 \times (9 \text{ wp}) = 90 \text{ wp}$ .

It is obvious that opening the borders has increased the wealth in both countries from 10 wp to 90 wp. It is as simple as that! Well, in Germany the producers of electronics will send their lobby to Berlin (and the Chinese cheese lobby will go to Beijing). Often with success, because the lobbyist swarms in the political capitals whisper constantly in the ears of the politicians. The people suffer, because, apart from once every four years, politicians tend to not listen to them.

“Yes”, speaks the industry lobbyist, “China is flooding our country with cheap products and all our companies go bankrupt because of this”. Also that is not correct. In the table below is summarized a situation in which China makes everything cheaper, even Germany's cheese. To facilitate the calculation different wealth points are used for Germany and China. Wealth is something relative, there where a price is something absolute. In any case, absolute wealth is not relevant for the discussion. Also, we assume that the Chinese yuan has the same value as the German euro. For ease, we use the euro in the calculations:

	Germany		China	
	cost	wealth	cost	wealth
Cheese	1 euro	1 d-wp	0.9 euro	0.9 ch-wp
Electronics	9 euro	9 d-wp	0.1 euro	0.1 ch-wp

Imagine both countries again having 10 production units that they can use at

their choice.

Situation 1: Without open borders: Again, irrespective of how the 10 production units are used, the production of goods will result in 10 wealth points. For example, Germany produces 1 unit cheese and 1 unit electronics:

$$\text{wealth} = 1 \times (1 \text{ d-wp}) + 1 \times (9 \text{ d-wp}) = 10 \text{ d-wp},$$

with total production cost:

$$\text{cost} = 1 \times (1 \text{ euro}) + 1 \times (9 \text{ euro}) = 10 \text{ euro}.$$

The same applies to China, for example 10 units cheese and 10 units electronics:

$$\text{wealth} = 10 \times (0.9 \text{ ch-wp}) + 10 \times (0.1 \text{ ch-wp}) = 10 \text{ ch-wp},$$

$$\text{cost} = 10 \times (0.9 \text{ euro}) + 10 \times (0.1 \text{ euro}) = 10 \text{ euro}.$$

Situation 2: With open borders. *Laissez faire*. Germany has nothing to offer to China. China can make everything itself much cheaper. All German companies go bankrupt and everybody will be unemployed. But, wait, we have an open market with free market effects. The high unemployment pushes down the salaries of employees. Let's do this. "Let's ignore all those leftist idiots with their syndicates". Production cost will go down. And the problem will be solved. The salaries do not even have to go down much and it will actually result in higher wealth. 10% reduction is probably enough. We get the situation summarized as:

psblue	Germany		China	
psblue	cost	wealth	cost	wealth
Cheese	0.9 euro	1 d-wp	0.9 euro	0.9 ch-wp
Electronics	8.1 euro	9 d-wp	0.1 euro	0.1 ch-wp

The optimal situation (for both countries!) is achieved when Germany uses all its infrastructures to make cheese and China uses them all to make electronics and fully exchange them:

Germany:

$$\text{cost} = 11.11 \times (0.9 \text{ euro}) + 0 \times (8.1 \text{ euro}) = 10 \text{ euro}.$$

$$\text{wealth} = 0 \times (1 \text{ d-wp}) + 100 \times (9 \text{ d-wp}) = 900 \text{ d-wp}$$

China:

$$\text{cost} = 0 \times (0.9 \text{ euro}) + 100 \times (0.1 \text{ euro}) = 10 \text{ euro}.$$

$$\text{wealth} = 11.11 \times (0.9 \text{ ch-wp}) + 0 \times (0.1 \text{ wp}) = 10 \text{ ch-wp}$$

It is clear. Because Germany opened its borders with China and brought all the factories on the brink of bankruptcy that demanded lowering of salaries, the wealth *increased* from 10 to 900; a factor 90! It matters nothing that the salaries were lowered. Fiat-money is only a number anyway. What matters is that wealth increased. The opening of the borders *cannot* have a negative effect. Never ever. Absolutely impossible. Every form of protectionism always has a negative effect on wealth. This is based on the fact that both parties, per definition, are happy in

a free trade, as we have seen before. If it is not the case that both parties are happy in a trade, the trade is not finalized, or it is not free. The vague concept of happiness translates to the concise concept of entropy in the framework of Thermodynamics. Trade increases entropy. Blocking trade reduces entropy production, a.k.a. “wealth”.

## 4.2. Politics

Considering all the above, a society that has an agenda to reduce energy consumption is a society that writes its own death certificate. Take for example a government that wants to stimulate “green” energy. This seems at first thought a very noble endeavor. To protect the environment that we are all living in, and thus to protect ourselves, it is a good idea to not soil ourselves and to prevent death from our own waste.

However, we should not do virtue-signaling reasoning in a virtual society in our heads. We should base our reasoning on the laws of physics stipulated above, even if we do not like these laws (we cannot democratically outvote the laws of Thermodynamics, any more than we can ponder over the morality of gravity). The laws of physics and biology state that evolution itself will find the optimal “sweet point”. Any interference in this process will reduce the efficiency and thus create *less* life. Poverty and death will be the inevitable outcome. In fact, as an unavoidable outcome of the above, our “species” that piously adhere to this sustainability mantra, will be replaced by those that *teach* the sustainability mantra. In a simple method of survival of the fittest (read: survival of the entropy producers), the haves will make sure the have-nots will have-even-less so that there can be more of the haves-species that produce more entropy. The image of virtue-signaling actors, preaching the sustainability mantra from their yachts or flying in to Davos in their private jets springs to mind. In a world of limited resources (energy) we are all out there to create an environment where there are more of these resources for our own offspring. This is coded in our genes, as the result of entropy-optimization strategies in nature as presented in the previous section.

Dying from our own waste is not possible in a thermodynamic system. At best we would saturate when the entropy-production rate can no longer grow. The entropy-production is given by the number of entropy-producing agents multiplied by the amount of entropy produced per agent. Death would reduce the number of agents and thus the total entropy production. Such a process goes against the laws of thermodynamics, *unless* these agents are being replaced by the offspring of the other classes in the world that produce even more entropy. Preaching low-energetic agents into offing themselves is very good for one’s genes and for the overall entropy (and waste) production. Imagine, you the reader will be replaced by *Übermenschen* of the ruling class that will all be going around in the world by gas-guzzling 100-foot yachts. Them having saved the planet morally entitled to a bigger yacht. Preaching sustainability is merely a strategy to get a bigger slice of the entropy pie. As we will see, no even less entropy is produced at the end

of the day.

Even so, it has to be noted that generally capitalism pollutes less than communism. Once again, this is the simple result of the fact that in capitalism capital must grow (it defines the concept of “capitalism”; if capital does not grow, it is not capitalism. We can only argue if a state of full capitalism is attainable in society). Empirically it grows by 5%. Take for example a forest. It is a form of capital, since with the trees products can be made that have added value. As such, capitalism will automatically preserve the forest and try to increase it, or convert it to croplands if that has higher capital value. In communism, the workers, that are also consumers, will decide to cut all trees to optimize their own consumption, for instance by directly producing entropy in the form of heat by burning the firewood coming from the forest. Up to the last tree will be felled. As an example, the amount of forests in Poland has been growing from 8.9457 million hectares in 1995 after the fall of communism to 9.4629 million hectares in capitalist 2020 (Statista, 2022). Well-fed people generally care more about the environment than hungry people. The latter will vote for increased consumption even if at the detriment of capital and environment.

Another good example is the government putting tax on products in a hope that the market will switch to other products, a form of proto-communism by steering the means of production and permitting (or not) consumption; he who controls the MoP owns them and “allowing consumption” means distributing consumed goods. Communism.

Especially worth mentioning is an agenda of energy-transition. To tax fossil fuels and subsidize “green energies”. Without a shred of doubt, it will lower the energy consumption overall (or increase it at a slower rate), reduce the efficiency in economy, and create, once again, poverty. In the best of all outcomes, all prices will simply go up, including the price of alternative energy sources at the exact same rate. Because in a fair market the prices of products are exchanged at a certain ratio determined by the market, as evidenced by the oil and gold prices of **Figure 1**. The increased price of energy simply percolating into the prices of products of *all* other sectors of economy. If, on the other hand, non-fossil fuels are competitive in price (that is, energy to produce them), then no government incentive is needed to make society switch to these new sources. No free-market entrepreneur will willingly pay more for a product if he can get the same for less. In a non-free-market with governmental subsidies, on the other hand, the market will even offer joules that cost more than 1 joule per joule to produce. In this case it can mean that even more fossil fuels will be used in production, just so as to rake in the lucrative subsidies. Fossil fuels that might have been used to create wealth, instead they are used to produce waste heat; it is the opening of the cabin door described before. As such, governmental interventions can only have a detrimental effect on wealth. These societies with a heavy participation of government will be conquered by societies with a liberal structure sooner or later.

We can see this effect in the renewable energy swindle taking place in society.

Companies, optimizing their own thermodynamic state, reduce their effort of investing and optimize their income in the form of subsidies. This is enabled by a powerful government—consisting of agents that are primarily concerned about their own entropy production—that has confiscated the wealth of agents in society and can be bribed to hand them over to these entropy-optimized entrepreneurs. It is a win-win-lose situation, with entrepreneurs and government winning, the losers being the powerless individual agents that are swindled out of their entropy channel. A smart government will even convince those agents that it is for their own good. A greedy government can be swayed into this action by lobbyists of companies. It is a well-known public secret that the European Union laws are written in most part (75%) by these lobbyists, organized in the European Round Table of Industrialists (ERT) (Kauppinen, 2014; Moser & Lietaert, 2012). This enables “scandals” (from the point of view of the swindled) such as the one where the mafia cashed in on lucrative EU wind farm handouts—especially in Sicily (Meo, 2010). Which is simply a situation in which all agents are trying to optimize their own entropy production.

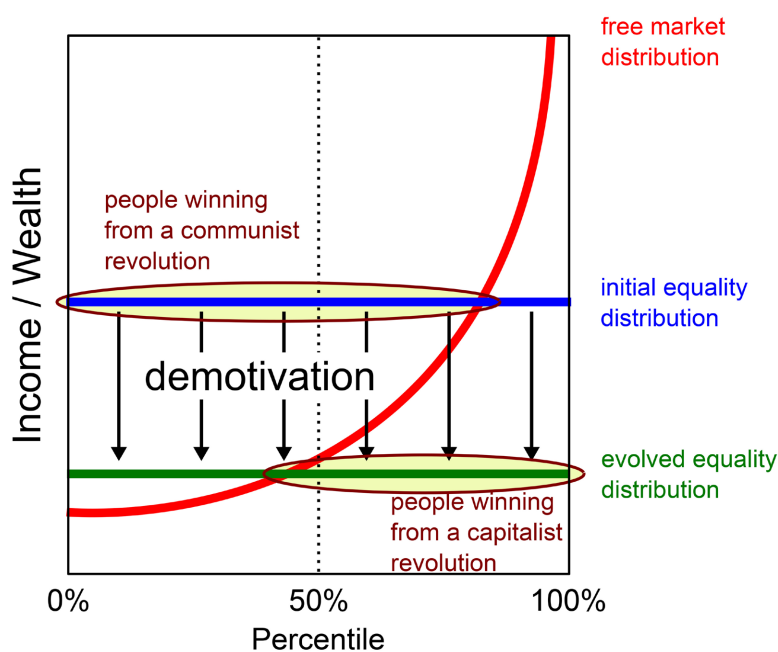
These countries with a heavy agenda on renewable—inefficient—energies will be overtaken by countries that continue to go for the most efficient way of production, such as China. Moreover, renewable energies—“renewables”—in a *free* market, would never come *instead* of fossil fuels even if they are energetically favorable; they’d rather come *on top of* them. Why? Because all agents want to increase their entropy production. Renewables, even when energetically profitable, would just be opening another (welcome) entropy channel. It is an unrealistic simplistic idea that we are going to produce a steady X amount of goods and then decide to do that “ecologically” with renewables. Renewables will just add Y to X and accelerate the entropy production  $\Delta S$ . Why? Because we can! It is the Law of Maximum Entropy Production.

Look around you. Note, for instance, that the planet-saving sustainability transformation of the economy implies ... an *increase* of consumption (energy use and entropy production), the exact opposite of what one might imagine it to consist of. As an example, to save the planet from climate doom, caused by burning fossil fuels, we are supposed to throw out all our old—still perfectly working—cars and replace them with electric versions. These electric cars do not consume less energy—at best the difference would be marginal; electricity does not come out of thin air, but from (mostly) fossil sources—nor are they cheaper to produce or are they more “ecological” (especially the batteries have a serious destructive effect on the environment). They are simply a way for the economy to increase in real terms of boltz-GDP. Forcing products onto consumers that do not need them otherwise. And feeling good about it. Factual overexploitation of the planet sold as a way of saving the planet. At the end of the day, more entropy is produced.

### 4.3. Capitalism vs. Communism

In the above we have already pitted capitalism vs. communism, and have explained that capitalism leads to more wealth, that is, more entropy produced,

where it is based on the mechanism that if each agent optimizes its own local thermodynamic machine, the total machine of the entire society produces most entropy. Or, according to Equation (2), each agent  $i$  will try to get as much energy  $\Delta U_i$  as possible, preferably by doing as little work itself (laziness), thereby optimizing its entropy production by increasing efficiency  $dS/dU$ . Agents are lazy, greedy and proliferate. It is obvious that confiscating wealth from others instead of doing work oneself is more efficient and agents will do that if they can get away with it. If they are powerful enough. As we have seen, agents can join forces to be more powerful and be able to arrange such theft. This we called join-believe-fight. The logical consequence is that in democracy, where everybody by law has the same power (namely one vote), people will organize themselves—in so-called political parties—and start confiscating wealth. This is a thermodynamic inevitability.



**Figure 7.** Schematic of showing politics of economy driven by thermodynamics. A plot of income (or wealth) vs. population percentile in various situations. In free-market capitalism the income distribution is highly skewed (red line) and in democracy people can simply vote to increase their personal wealth by redistributing all wealth equally (blue horizontal line). For more than 50% of the people it is advantageous and a communist revolution will ensue for thermodynamic reasons. However, because of lack of incentive for production, people will be demotivated and produce less; the equal-income will steadily drop over time (black arrows). There comes then a point where the equal-income (green line) drops below the 50%-percentile point of the free-market distribution. For most of the people a free-market income would then be better and thus a capitalist revolution will ensue, thermodynamically driven. The cycle will repeat forever: red curve → blue curve → green curve → red curve...

To show how this works, consider **Figure 7**. It shows schematically the absolute income (or wealth) of agents ordered in percentiles. Now, if we let free-market

capitalism unbridled, the result is that everybody gets richer—as a direct result of how the free market works—but some get richer than others, the wealth distribution gets skewed, as for instance the red curve. If the 50%-percentile median wealth is below the average wealth, there is a democratic majority to confiscate all the wealth and distribute it equally, resulting in the blue curve. There is, of course, some moral barrier, because most people understand that theft is immoral. But morality is in the eye of the beholder—cannot be objectively measured or quantified—and thus quite flexible. Opinion in public will shift toward the idea that the rich people are immorally rich and thus that a redistribution of wealth is morally justifiable. As we know from propaganda, repeating a story makes people believe it. So, more and more people will believe this socialist ideology, unknown to them driven by their innate thermodynamic machine. Sooner or later the wealth will be distributed and we wind up in the blue horizontal line. We can call this the communist revolution. This is also why Karl Marx stated that, “capitalism [in a democratic environment] leads to socialism leads to communism”.

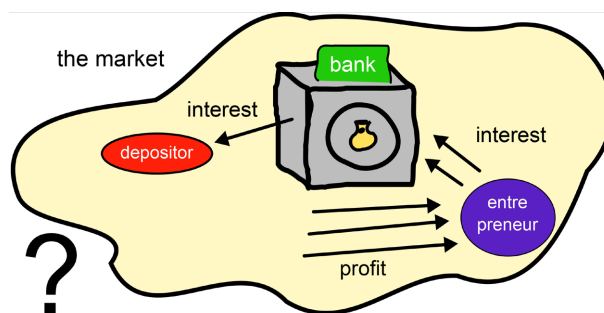
That is, because even if the communist revolution is not immediate 100% confiscation of wealth, but only partial theft is done, as in socialism, the result is a demotivation of workers. Why work if you can get your goods for free by voting for them?! The result is a reduction in productivity and thus a drop in income and wealth. This will be attributed by the ideology to failings of the free market and capitalism in general, and thus voices are heard to implement a stronger socialist regime. Which will inevitably lead to more poverty and more confiscation and redistribution, up to the point where all wealth, including all means of production are confiscated. Marx was fully right.

In any case, once the distribution is equalized (shown simplified in the figure as a horizontal blue line), productivity will drop all along the line. Productive people will not produce, because “what’s the use?! the fruit of my work will be taken away anyway!” And unproductive people will not be motivated to become productive by education, relocation, or any other way. Productivity will steadily decline. There then comes a point where a majority of the people will understand that if society goes back to free market capitalism, it would be better for them personally. Some inertia can be expected, because the socialist propaganda will not give up from one day to the next, and try to blame everything on foreign players, such as “evil capitalist empires”. But with enough pressure on the system, with the equal-distribution line ever sinking to represent evermore poverty, a capitalist revolution is thermodynamically inevitable. We can see here the cycle of the Soviet Union, where an (inevitable) communist revolution was started in 1914 lead by Lenin and Trotsky and an (inevitable) capitalist revolution in 1991 by Gorbachov. A new cycle started and Russia is currently rapidly increasing its productivity, there where the collective West is in a socialist evolution of ever-decreasing productivity. In the West, a communist usurpation of power is thermodynamically inevitable. This will bring misery until the point where a capitalist revolution will be started.

## 5. The Financial Structure

As shown above, the money has been disconnected from energy and has become a rather meaningless tool, at first sight. However, it is a method—a *modus operandi*—of a subset of people to set society to their own hand. (With the objective of optimizing their own entropy production). In energy-linked currencies (like gold, or shekels, or sea-shells) goods are traded in the fair market in an equal-energy way. We can now take a closer look at the market. We recognize two types of trades: those that are qualitative and those that are quantitative. In quality-trades different goods are exchanged. A trader will do so with an outlook on increasing personal entropy production, as mentioned above. A miller will enter the market with flour and hope to leave the market with something else, maybe some tools to work on his mill to produce more flour, or something else that he has lack of and he needs to survive or optimize his entropy. However, as Socrates already observed, on the market there are also so-called quantitative traders. They enter the market with a certain good and leave it with more of the *same* good. For instance gold. We can also call them bankers. Banking whatever they feel like banking. They must have profit, or they will not do a trade. And being quantity-traders entering and leaving with the same good, we can also say they must have energy profit; whatever the ratio is between energy and the good they are trading, they'll wind up with more energy equivalent. Bankers are in the market to get energetic gain, so always aiming for unfair trades.

Even Socrates observed that this inevitably goes wrong. If essential agents in society need a *quantitative* profit in gold (or another energetically limited product) or else will not engage in their essential activity, these agents will confiscate all that gold ... and then stop their essential activity anyway. In a system where gold is essential and bankers are confiscating it all, the system will halt. That is what leaders like King Midas already knew. Banks were lending out money and they wanted to be compensated for assuming risk of losing the investment, plus a bonus. The ones taking the loan also were doing that with an objective of profit. Yet, also the ones that were depositing the gold at the bank were doing that with a profit-objective. Gold being basically a zero-sum game would mean this system will run amok; not everybody can have profit, thus at least one will have a loss, thus at least one will stop the game, thus the game stops! See **Figure 8**.



**Figure 8.** Gold as a zero-sum game. In quantitative trading all agents want to have profit, which is impossible, thus the game stops. Reproduced by permission from Ref. (Stallinga, 2016).

We can think that this necessity of (energy-equivalent) profit no longer exists with fiat money since it is disconnected from energy. We can be running a scheme in which we simply print money and let the agents in the economy try to get a hold of it. It is becoming a positive-sum game, with a constant input of fresh money to make it so. The state exchanges promises for the money and thus runs an eternal budget deficit; it can never pay back the money. Paying it back would make the economy a negative-sum game and thus unsustainable (would you invest with an outlook on loss? Why do you think others would?!). But since money is a unilateral contract—“deed”—in which nothing is promised (which is illegal, since a contract needs “consideration”, some kind of promise), this scheme can technically exist; nothing can be “claimed” from the one having issued the money, and it is thus fully worthless. This money accumulating at the few that park it in tax havens like the Cayman Islands. In other words, the money velocity dwindling, as its volume increases. This would work if the money creation is slower than the entropy production increase. In that case, the monetary gains continue to represent energetic gains and entropy-production rights gains and there is an incentive to endeavor in economic activity. If this is not the case, if money is growing faster than energy consumption, gains can be monetary without them being energetically profitable. In that case, why would somebody loan out capital in the form of money that would be worth less in the future when it is paid back with new money, where the principal plus interest represents *less* consumption rights?! After all, an agent loans out money with an outlook on profit. That means it loans out money if the interest is larger than the risk of losing the investment plus a profit margin (that depends on the risk  $r$ ; the larger the risk  $r$  the larger the margin) plus the monetary devaluation, also often called inflation.

$$\text{interest} > \text{risk} + \text{profitmargin}(r) + \text{inflation} \quad (6)$$

Note that the risk and profit margin are necessarily positive values. If there is large inflation, it becomes rapidly prohibitive to do investments. Thus we have seen in the times of Covid that huge amounts of money were printed and issued, while the economy was halted. After some months this inevitably caused a huge inflation. As a side effect (or was this the intention from the beginning?), the money was issued by governments that thus took control of economy—i.e., communism—and started doling out the money “to each according to his needs”, and especially to non-energetically-profitable pet projects, thus accelerating the inflation (the money-to-energy ratio) even more. No wise investor in his sane mind would invest capital in these circumstances and the only way the defunct economy can now be kept marginally alive—albeit dysfunctional—is by this eternal money-printing scheme, a racket. We now have de facto communism, with a central committee telling what should be produced by whom—“from each according to his abilities”—or be cut off from the money (and energy) supply—“to each according to his needs”. Such economies are a death spiral, as shown above, and in history.

## 6. The Society

To stave off the envisioned entropy catastrophe we could all agree on reducing our consumption. As shown above, it will not work, because any agent in power will simply ignore the general need for general action and simply optimize its own entropy production. Moreover, it cannot be done in a free society. For the exact reason that in a free society (capitalism) *all* agents will optimize their own entropy machine. Morality (even a planet-saving one) does not enter the equation, it is at best a way to convince others to make way for the genes of the agent preaching the morality.

As an example, imagine we increase the tax on energy, in the hope that thus society will find energy-efficient ways of producing. Who understood the narrative until now, understands that a free society does not need an extra incentive to energy-efficiency because it is the *only* driving force in society, see our core equation (Equation (2)). More bang for less buck. More entropy for less energy. On top of that, if we add a tax to the economy—imagine it is taking place in a zero-sum game, although the same reasoning applies to a positive-sum game, as discussed above—either the taxing agent—“government”—keeps this tax, or spends it. If it keeps the tax, the economy becomes a negative-sum game and we will spiral into poverty and death. No investments will be done if the average yield is negative. We call this a pessimistic outlook on economy and it brings misery and poverty. If, on the other hand, the government spends the tax by injecting it back into the economy, thus keeping the economy a zero-sum game, these investments are equally efficient or less efficient than the free untaxed market would have done. Thus, at best the government will create the exact same society before taxing, but probably it will just introduce inefficiency into the system. Less wealth for people or *more* energy for the same wealth. No interference into the system can create wealth.

We have seen this many times. In western countries often consumer fuel is heavily taxed. This did never reduce fuel consumption. It only increased the prices of fuel, which then percolated into the price of everything, just making us poorer by inflation. At best the effect is zero. And then the question arises, why to introduce a tax that has no effect? The answer is that power-hungry agents want to be in power, as a way to optimize the survival rate of their genes. The enigma is how such agents often manage to sway the population at large to agree with laws that reduce their survival rate. This text is not about psychology, but from a thermodynamic/biology point of view, we expect it is because *not* agreeing with these laws generally reduces the survival probability of one's genes even more. Cooperation is a surviving asset of any agent, as was shown in the Monte Carlo simulations mentioned earlier (Stallinga, 2024b).

An idea that recently again gained popularity is to have a price cap on products, for instance oil. This, obviously, will also not work. Because, do not forget, these “rights” of a low price, as declared by the government should be fulfilled by someone else. And, as Jordan Peterson said, “Your rights are my responsibilities.” In

other words, the big question is, *who* is forced to deliver the goods at the capped price? In a free market, agents will decide to produce something else, or even to produce nothing at all, not producing goods that will be sold at a loss, or below the profit target of 5%. The joke goes that in Brazil the price of a tonne of coal was capped. Inventive traders found a way out by converting inflation into a diminishing “tonne” at the fixed price. So, at the free market the thing negotiated was not the price for a tonne of coal, but the tonne for the price of coal. Without such inventive traders, a price cap will simply stop the economy and create poverty.

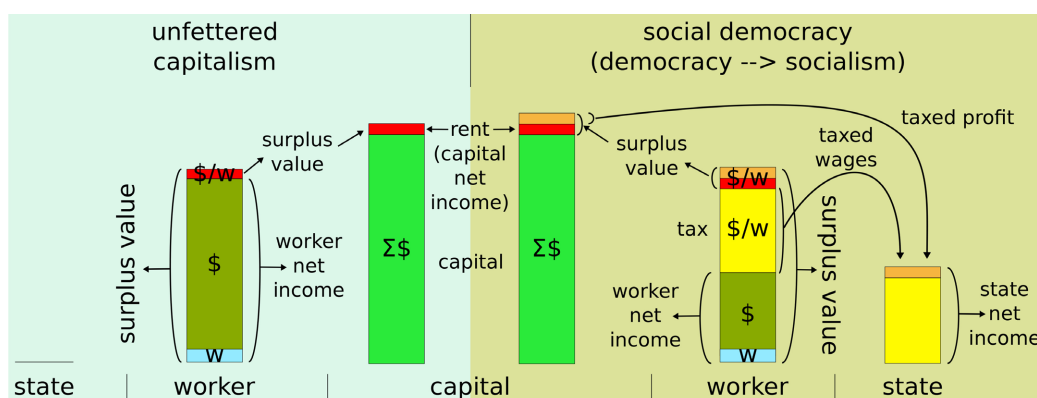
A popular measure of modern globalist governments is a so-called carbon-credit system. Taking all the above into consideration, a carbon-credit system, which is an energy-credit system (if we keep the carbon-emission to energy ratio constant), is the closest thing to “each according to his needs” one can come up with. As such, it is simply communism packaged in technological jargon. It is, once again, a central committee deciding who can consume how much. The reasons why they do it are explained above. And the outcome of a carbon-credit system is as readily predicted: poverty and misery.

As Marx wrote, “capitalism leads to socialism, socialism leads to communism”. This absolutely correct in thermodynamics terms. Capitalism is the free market. Now if we equate this to democracy—which technically it isn’t; capitalism is a constitutional republic—then people will vote for a socialist confiscation-and-redistribution of wealth organized by the state, if at least 51% of the voters thermodynamically benefit from it. That is quite easy. Theft by vote reduces energy spending and increases entropy production of those on the receiving side. Democracy will thus lead to socialism.

Yet, it will not work. We have mentioned above that according to Marx capital has to make profit. That is, capital must grow. These are means of production, so one would expect it to be presented as something good. However, socialists are heavily bashing “capital”, as if it is a dirty word. They do so, since it then morally justifies theft. Yet, capital is merely a concept. It is similar to saying that “chemical reaction equations are bad”, because all bad products in the world are the result of such equations and we should thus do our best to prohibit reaction equations.

What will happen in practice? We had axiomatically assumed as a law of nature that capital must grow 5% y-o-y. Now consider the effect of taxing by the state in order to create a “socially just” society. It is obvious that the profit of the capital we are talking about here is the one *after* taxing, after all it is the owners of the capital that take the decision of investing and do that with a certain outlook on profit (Kahneman, 2011). That means that if we tax capital profit, the capital profit *before* taxing will increase with the exact same amount as the taxing, so that the net profit—“rent”—remains 5%. The taxing has no effect whatsoever on the capital. Then, either the taxing has no effect at all, or the effect is at other elements in society, those without capital. That latter would mean that mostly poor people are suffering from the tax that was introduced to alleviate their suffering. **Figure 9** shows that the workers bear the full brunt of the taxation. In fact, the taxation of

capital has *increased* the surplus value confiscated from the workers, now by the capital and state alike. Socialism leads to poverty, especially poor people will get poorer. They may get more money, freshly printed by a socialist regime, but one way or another, they will have less energy-value to spend. Since the old Cree Indian proverb goes, “When the last tree is cut down, the last fish eaten and the last stream poisoned, you will realize that you cannot eat money”, the result will be rather hunger in society after having taken society on a down-spiral. With socialism not working the imagined solution is then communism; not only confiscating wealth, but also the means of production. Marx was right; socialism leads to communism.



**Figure 9.** In unfettered capitalism the capital confiscates part of the surplus value, leaving behind the worker with less consumption rights than he has produced in surplus value together with the energy slaves of the capital (in a ratio  $w:\$ = 1:70$ ). In capitalism with a strong socialist state—“social democracy”—that taxes both workers and capital gains equally, here shown as 50%, the capitalist does not notice any changes—the rent stays at 5%, see the red cap—the worker thus pays the full brunt of the taxes, see the reduction in net income of the worker (light blue and grass green). As such, “socialism” is asocial in that it benefits the rich capitalists. The state is the one that laughs the loudest; it gets a net income (yellow and orange) without producing any surplus value. (Note: capital, worker and state not on same scale, and worker and state shown as power (watt), while capital shown as the value joule; the orange and red blocks a year-integral).

Instead of taxes, a similar reasoning we can use for socialist subsidies. If average 5% profit is a natural law, and the state gives subsidies to preferred companies, then only these preferred companies will survive eventually. The market has no morality. That means that not companies with most capital (energy) growth will survive, those that produce more MoP and therefore create wealth more rapidly. The companies that survive have most *financial* growth, and their capital growth will be less than 5%. They can even have the capital shrinking as long as the subsidies are big enough to compensate. If the system of subsidies and taxing is substantial enough, overshadowing other incentives in society, the economy turns effectively into communism, with the state deciding who will produce where and what for whom, to each according to his needs and from each according to his abilities. Since the state then controls the MoP, and as we have seen control is ownership, the state has effectively confiscated the means of production and

society has become communist; production not based on capital gain, but on satisfying the needs of the consumers. This is especially made possible by the monetary system of fiat currency. The state can borrow *any* amounts of money, since the money does not have to exist beforehand and costs nothing to create. The state uses whatever amount of money to be able to implement the above program. It can never run amok. Or, as Alan Greenspan of the Federal Reserve famously said in 2011,

“The United States can pay any debt it has because we can always print money to do that. So there is zero probability of default”.

Indeed. It can thus run society, communist style. In comparison, if gold, or any energy-based currency was used, that gold cannot be created out of thin air, and the then more-obvious theft of the MoP by the subsidy-mechanism would have to come through a taxing scheme. A taxing scheme that does not work, as argued above, since it only creates poverty.

It is also rather remarkable that socialists talk about the skimming of the workers, the confiscation of surplus value by (the *concept* of) “the capital”, which is, as shown, only a small fraction. Yet, they remain fully silent when the political class confiscates huge portions of the remainder, the salary of the workers earned by producing added value. In some egregious cases in socialist countries this confiscation of added value (value-added tax and income tax) produced is far above half (Wikipedia, 2022) and nobody bats an eye. No, the call for communism—100% confiscation of wealth and added value—is heard ever louder. What is done with the confiscated wealth? Apart from uttering beautiful promises of a world of “equality” without poverty and hunger, for sure not the fulfillment of the needs of the people fleeced. The people themselves would decide what their needs are and are in the best position to determine how they can be fulfilled. Substituting them by a central committee that evaluates the needs of the people can, at best, match this with satisfying these needs equally if the system is 100% efficient. No system being 100% efficient, it implies that the satisfaction of the needs is less than optimal. The state, without having produced any added value, gets to take away a significant part of the production and nobody complains. As Milei said,

“The State can give you nothing, because it produces nothing”,

or Friedrich Nietzsche,

“Everything the State says is a lie; and everything it has it has stolen”.

Further explained by Margaret Thatcher,

“The problem with socialism is that you eventually run out of other people’s money”.

The enthusiasts of this system consider that people are generally not wise enough to decide for themselves what their needs are and how to best fulfill them. They have to be “educated” to become better, modern, moral persons. The free

people at large are treated as morons. How it can be that they themselves are not part of this class of morons, these enthusiasts—for not calling them morons—do not specify. It seems they simply want to create a class, an elite, that rules over others, and then optimize their own entropy production—more bang for less buck—by not spending any energy while confiscating the energy-products of others, simple thermodynamic automatons as they are. To give you an idea how much energy-value is added by this elite, consider the fact that what they are doing is mostly writing reports, or in other words, generating documents with “information”. As is well known, each bit of information costs  $kT$  joules of energy (Pierce, 1961). At  $T = 300$  K, and  $k$  the Boltzmann constant ( $1.380649 \times 10^{-23}$  J/K), this is about  $4 \times 10^{-21}$  J. A typical document being some megabytes, and maybe writing ten per day, gives a total production of  $2 \times 10^{-17}$  (2015) \$ per year per person of the political class. Twenty millionths-of-a-millionth-of-a-millionth of a dollar; It does not seem anybody is skimming *their* surplus value! (Of course this calculation is rather faulty, since it does not include the information destroyed in the process, where data processing is the act of destroying information. But the reader gets the idea).

This is well described by the words of Larken Rose in his *The Most Dangerous Superstition* (Rose, 2012),

“It is also worth noting that the political left and right are both enamored with the concept of ‘equality’, with the political right pushing for ‘equality under the law’, and the left pushing for equality of outcomes. But neither actually wants true equality. because they both exempt the ruling class from such ‘equality’. True equality rules out all ‘government’, because a ruler and a subject obviously can never be equals. What statist actually want is equality among the slaves, but enormous inequality between the slaves and the masters, this again shows that they view ‘government’ as being superhuman, because it never occurs to them, as they push ‘equality for all’, that the equality should also include the politicians and the police.”

In other words, there is a power struggle in society. The competent, productive class of workers and investors is being skimmed by the incompetent, political class. This class struggle is nowhere mentioned in any political literature. All such literature is written by the incompetent class trying to justify—on mere virtue-signaling—why it is morally correct to parasite on the competent class. While this work is not about a moral analysis, it is explicable why this exists in a thermodynamic framework. All agents are simply optimizing their entropy production and parasitism is quite a good strategy.

## 7. Conclusion

In conclusion, we have shown here how the natural state of maximum entropy production is obtained, namely through free-market capitalism. Free-market capitalism is a rephrasing in economists’ terms of Darwin’s survival of the fittest,

which is biological wording for the law of maximum entropy production (LMEP). Because humans have the gene of selfishness, in contrast to collectivist species like ants, to reach maximum wealth the system should rely on this selfishness. This is then best for the entire society, as Adam Smith already pointed out. In sociological terms it is what Jeremy Bentham in his Utilitarianism called, “the greatest happiness of the greatest number that is the measure of right and wrong”, or maximum wealth for a maximum number of people. With wealth equal to entropy production, this is of course equal to LMEP; the entropy produced is equal to the number of agents times the entropy produced per agent. Any interference in this system will move us away from LMEP, and then Darwin’s theory will kick in and we will be removed from the genetic pool, to be substituted by a society that does manage to implement the LMEP better. That because unavoidably we must obey the most fundamental law of all physical laws, the laws of thermodynamics, whether we like it or not.

It is also clear why there would be forces to move us in the direction of collectivism. But in a skewed distribution of wealth, this is beneficial to a majority. A majority that will thus vote to confiscate and redistribute wealth. This is helped by democracy because in democracy everybody has the same power, there where otherwise those with less wealth are generally speaking less powerful, either as cause for lower wealth or as the result of it. Democracy enables the powerless and unproductive to take a bigger piece of the pie, what they inevitably do, driven by thermodynamic mechanisms.

A monetary system based on fiat-currencies is a way to prevent such democratic collectivist tendencies, but on the other hand it turns society into a system being managed by a cabal of bankers. Those that do not contribute to production at all, but who simply hoard resources in “banking” (quantitative trading), which brings us even further from a state of Bentham’s maximization.

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## Conflicts of Interest

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## References

- Britannica (2022). *Surplus Value*. <https://www.britannica.com/topic/surplus-value>
- CIA The World Factbook (2022). *Energy Consumption Per Capita*. <https://www.cia.gov/the-world-factbook/field/energy-consumption-per-capita/>
- Dawkins, R. (1976). *The Selfish Gene*. Oxford University Press.
- Downey, L. (2024). *Efficient Market Hypothesis (EMH): Definition and Critique*. <https://www.investopedia.com/terms/e/efficientmarkethypothesis.asp>
- Eddington, A. S. (1928). *The Nature of the Physical World: Gifford Lectures 1927*. Cambridge

- University Press.
- Grant, E. (1974). *A Source Book in Medieval Science*. Harvard University Press.
- Hardin, G. (1968). The Tragedy of the Commons. *Science*, 162, 1243-1248.  
<https://doi.org/10.1126/science.162.3859.1243>
- Juggler, U. (2020). *Convert kg of Oil Equivalent to Megajoules*.  
<https://www.unitjuggler.com/convert-energy-from-koe-to-MJ.html>
- Kahneman, D. (2011). *Thinking, Fast and Slow*. Farrar, Straus and Giroux.
- Kardashev, N. S. (1964). Transmission of Information by Extraterrestrial Civilizations. *Soviet Astronomy*, 8, 217-221.
- Kauppinen, I. (2014). The European Round Table of Industrialists and the Restructuring of European Higher Education. *Globalization, Societies and Education*, 12, 498-519.  
<https://doi.org/10.1080/14767724.2013.876313>
- Khalil, E. L. (2004). The Three Laws of Thermodynamics and the Theory of Production. *Journal of Economic Issues*, 38, 201-226.  
<https://doi.org/10.1080/00213624.2004.11506672>
- Kravchenko, A. (2022). *The Creation of a New Soviet Man*.  
<https://arzamas.academy/materials/1499>
- Lavoisier, A. (1789). *Traité élémentaire de chimie (Elementary Treatise on Chemistry)*. Chez Cuchet.
- Lorenz, R. D. (2010). The Two-Box Model of Climate: Limitations and Applications to Planetary Habitability and Maximum Entropy Production Studies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365, 1349-1354.  
<https://doi.org/10.1098/rstb.2009.0312>
- Lorenz, R. D., Lunine, J. I., Withers, P. G., & McKay, C. P. (2001). Titan, Mars and Earth: Entropy Production by Latitudinal Heat Transport. *Geophysical Research Letters*, 28, 415-418. <https://doi.org/10.1029/2000gl012336>
- Louise, L. (2012). *Michael Parenti on Capitalism*.  
<https://lumpy.substack.com/p/michael-parenti-on-capitalism>
- Martínez-Kahn, M., & Martínez-Castilla, L. (2010). The Fourth Law of Thermodynamics: The Law of Maximum Entropy Production (LMEP). *Ecological Psychology*, 22, 69-87.  
<https://doi.org/10.1080/10407410903493160>
- Marx, K. (1867). *Das kapital. kritik der politischen oekonomie*. Verlag von Otto Meissner.
- Marx, K. (1970). *Critique of the Gotha Program (German: Kritik des gothaer programms) (1875)*. Progress Publishers.
- Marx, K., & Engels, F. (1895). *The Communist Manifesto*. Dodo Press.
- Meo, N. (2010). *Mafia Cash in on Lucrative eu Wind Farm Handouts—Especially in Sicily*.  
<https://www.telegraph.co.uk/news/earth/energy/renewableenergy/7981737/Mafia-cash-in-on-lucrative-EU-wind-farm-handouts-especially-in-Sicily.html>
- Money, B. (2024). *Surplus Value*. <https://www.britannica.com/money/surplus-value>
- Moser, F., & Lietaert, M. (2012). *The Brussels Business*.
- Paillard, D., & Herbert, C. (2013). Maximum Entropy Production and Time Varying Problems: The Seasonal Cycle in a Conceptual Climate Model. *Entropy*, 15, 2846-2860.  
<https://doi.org/10.3390/e15072846>
- Pierce, J. R. (1961). *An Introduction to Information Theory. Symbols, Signals and Noise*. Dover Publications.
- Piketty, T. (2013). *Capital in the Twenty-First Century*. Editions du Seuil Harvard University Press.

- Post, N. (2024). *Javier Milei Addresses World Economic Forum in Davos*. <https://www.youtube.com/watch?v=4z44XP4u9Xs>
- Prigogine, I. (1978). Time, Structure, and Fluctuations. *Science*, 201, 777-785. <https://doi.org/10.1126/science.201.4358.777>
- Rand, A. (1957). *Atlas Shrugged*. Signet.
- Reinhart, C. M., & Rogoff, K. S. (2010). *Growth in a Time of Debt. Working Paper Series*. <https://doi.org/10.3386/w15639>
- Rose, L. (2012). *The Most Dangerous Superstition*. Larkin Rose.
- Schneider, E. D., & Kay, J. J. (1995). Order from Disorder: The Thermodynamics of Complexity in Biology. In *What is Life? The Next Fifty Years* (pp. 161-174). Cambridge University Press. <https://doi.org/10.1017/cbo9780511623295.013>
- Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. In *The Glasgow Edition of the Works and Correspondence of Adam Smith, Vol. 2: An Inquiry into the Nature and Causes of the Wealth of Nations, Vol. 1*. Oxford University Press.
- Stallinga, P. (2016). *Money: In Gold We Trust*. <https://www.stallinga.org>
- Stallinga, P. (2020). On the Energy Theory of Value: Economy and Policies. *Modern Economy*, 11, 1083-1120. <https://doi.org/10.4236/me.2020.115081>
- Stallinga, P. (2024a). *On the Existence of Things and the système International (d'unités) (s.i.). A Critique to Modern Science*.
- Stallinga, P. (2024b). Self-Organization of Social Hierarchies Studied with Monte-Carlo Simulations; Self-Destroying Join-Believe-Fight System as an Inevitable Outcome. *SN Social Sciences*, 4, Article No. 137. <https://doi.org/10.1007/s43545-024-00905-w>
- Statista (2022). *Total Amount of Forest Area in Poland from 1995 to 2020*. <https://www.statista.com/statistics/435131/forest-area-poland-square-kilometres/>
- Swenson, R. (2000). Spontaneous Order, Autocatakinetic Closure, and the Development of Space-Time. *Annals of the New York Academy of Sciences*, 901, 311-319. <https://doi.org/10.1111/j.1749-6632.2000.tb06290.x>
- The World Bank (2020). *Databank*. <https://databank.worldbank.org>
- Ulanowicz, R. E., & Hannon, B. M. (1987). Life and the Production of Entropy. *Proceedings of the Royal Society B: Biological Sciences*, 232, 181-192. <https://doi.org/10.1098/rspb.1987.0067>
- Wikipedia (2022). *List of Countries by Tax Rates*. [https://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_tax\\_rates](https://en.wikipedia.org/wiki/List_of_countries_by_tax_rates)
- Wikipedia (2024). *Graphical Timeline from Big Bang to Heat Death*. [https://en.wikipedia.org/wiki/Graphical\\_timeline\\_from\\_Big\\_Bang\\_to\\_Heat\\_Death](https://en.wikipedia.org/wiki/Graphical_timeline_from_Big_Bang_to_Heat_Death)
- World Economic Forum (2020). *The Great Reset*. <https://www.weforum.org/agenda/2020/06/now-is-the-time-for-a-great-reset/>