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Liminal Insights: Bridging Economics and Thermodynamics

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Keywords: Thermodynamics; Economics; Internal economic energy; Created money; Destroyed work; Conservation.

1. Introduction

In the vast world of sciences, the temptation to draw analogies between different disciplines is significant, offering renewed perspectives and innovative angles of approach. Economics and thermodynamics, though seemingly disparate at first glance, have often been brought into parallel, establishing connections between energy flows and monetary streams. However, it is crucial to question the relevance and boundaries of such comparisons. This article aims to delve into the similarities and disparities between these two domains while underscoring the significance of caution when establishing interdisciplinary parallels.

2. Characteristics and Support Vectors

At first glance, the following anecdotes may appear either absurd or self-evident. However, they aptly reexamine the apprehension of certain characteristics. When asking someone to hold a length of 10 cm in their hand, they are compelled to grasp any object (a ruler, ribbon, string, etc.) with at least one dimension equal to that length, as it’s inherently impossible to grasp the length alone.

The same applies if the characteristic is no longer a length but a weight, by asking the person to lift, for instance, 1 kg—something well within the
capabilities of most individuals. Yet, to achieve this, they must use an object of that weight, as they cannot intrinsically hold the weight alone.

From these two anecdotes, it emerges that length and weight are intangible, untouchable, immaterial, and yet entirely real characteristics. This property of intangibility necessarily implies the simultaneous existence of a tangible object that permits handling—the support vector or vehicle of the considered characteristic.

The two examples (length, weight), from the physical domain, can be extended to numerous characteristics, even within the economic realm, as elucidated below.

It is noteworthy that the work required for creating an object or providing a service also possesses the property of intangibility. Although some amount of work is necessary for crafting any object (goods or services), if the fabrication speed doubles, the work becomes four times greater. Yet, if two objects are produced, one in time \( t \) and the other in time \( t/2 \), it is rigorously impossible to differentiate them based on their respective production durations and hence the work exerted for each. Just like length or weight, work, as energy, is intangible and must be incorporated into something tangible, defined here as the Product (goods or services).

In nature, evolution is always associated with a variation in a certain characteristic.

For example:

- variation in voltage \( \Rightarrow \) electromagnetism
- variation in force \( \Rightarrow \) mechanics
- variation in temperature \( \Rightarrow \) thermodynamics
- variation in concentration \( \Rightarrow \) chemistry
- etc.

Given the generality of this principle, it’s reasonable to ask whether the same might apply in economics. Indeed, throughout history, human beings have acted to modify matter for their use. Isn't it true that two million years ago, Homo habilis fashioned rough stones to enhance their utility for specific purposes? Isn't it true that today, Homo sapiens follows the same procedures with the objective of optimizing the use of goods or services? Hence, one can argue that all human volition is oriented towards a variation in Utility. The purpose of the technology surrounding us, developed by Homo ingenius, is to undoubtedly lead to the evolution of Product Utility (goods or services). Certainly, other terms could have been chosen, such as practicality or congruence, as well as adaptation, agreement, accommodation, conformity, harmony, integration, framing, adjustment, allocation, attribution, etc.

It is noteworthy that the defined Utility above possesses the properties of intensity, akin to the abovementioned physical characteristics (voltage, force, temperature, concentration, etc.). Furthermore, it shares no common properties with the concept of marginal utility (extensive) used in classical economic theory. In the latter discipline, only extensive characteristics are employed, possessing the property of additivity to conform to the rules of arithmetic accounting. This is evident in characteristics like supply and demand, considered as numbers when they should be treated as velocities or flows.

Nature became comprehensible when the ratio of two extensive characteristics was equal to the ratio of two intensive characteristics, as presented below:


\[ \text{intensive characteristic } A = \frac{\text{extensive characteristic } C}{\text{intensive characteristic } B} = \frac{\text{extensive characteristic } D} \]

or:

\[ \text{characteristic } A \times \text{characteristic } D = \text{characteristic } B \times \text{characteristic } C \]

with the most familiar example being Boyle-Mariotte's natural law:

\[ \text{Pressure} \times \text{Volume} = \text{type of gas} (\text{coef.}) \times \text{Temperature} \]

Which can be simplified to:

\[ P \cdot V = r \cdot T \]

Now, conventional economic research relies solely on the usage and handling of exclusively extensive characteristics, and therefore, additives. All the computational procedures related to these characteristics pertain to accounting, not physics—physics is concerned with relationships between extensive and intensive characteristics. However, we know that accounting can never explain anything; it can only observe an existing state under certain conditions. If these conditions change, accounting will note the new state and compare it to the previous one; yet, it will never explain how these conditions evolved.

For example: Consider a power plant generating electricity of any type—thermal, nuclear, hydraulic, etc. Each of these categories can be further broken down by the type of fuel used, method of irradiation or cooling, height and flow rate of water, etc., as illustrated in the diagram L-01. To generalize these various inputs, they can be encompassed under the term "energy."

Thus, we can compare what enters and exits the system as follows:

- on one hand, the \textit{Products} (energy and electricity);
- on the other, the \textit{Money} (revenues and costs).
Given that:

- costs are linked to incoming energy \((E)\);
- revenues relate to sold electricity \((S)\),

it seems logical to assume a correlation between the energy \((E)\) in the fuels and the revenues \((R)\). However, even if a clear correlation were established between energy consumption \((TRE)\) and the wealth \((GDP)\) of an economic system, it still wouldn’t explain the transformation of the initial heat energy into final electricity. An accountant can always state what needs to be done but will never explain how to do it; they will always advise increasing productivity but never suggest the technical process enabling this evolution. This is why the problem will never be resolved. Yet, this resolution—the machinery transforming fuel into electricity—must be determined prior to any execution, elaboration, creation, etc., i.e., its implementation.

In a power plant, we know how to transform fuel into electricity, and that’s the sole reason why we can accurately specify what enters and what exits the system. Clearly, knowing the starting and ending states is futile if the means of transitioning, evolving, moving from one to the other remain unknown.

In summary and conclusion, we can state that:

- accounting observes states;
- physics explains the evolutionary phenomena between states.

3. Definition of Work

Let’s symbolize Work by the letter \(T\) instead of \(W\), as this Work is now of an economic connotation, for economic purposes, and no longer a physical endeavor. This economic Work \(T\) is no longer related to the displacement (acceleration or deceleration) of a moving object but rather to the modification (creation or utilization) of a Product (goods or services).

**Hypothesis 1**

Consider constructing the walls shown in the diagram L-02. Looking at the first two drawings, it’s evident that everyone would agree that the two Works \((T_A, T_B)\) are identical, while the Work \((T_C)\) is twice as much. Thus:

\[ T_A = T_B \]
which implies:

\[ T_C = T_A + T_B \]

or also:

\[ T_C = 2 \cdot T_A = 2 \cdot T_B \]

**Hypothesis 2**

However, if the execution time of the second wall B is halved, no one would argue that the Work remains equivalent to that of wall A. In fact, the laws of nature tell us that in this circumstance, we can write:

\[ T_B = 4 \cdot T_A = 2 \cdot T_C \]

**Conclusion**

These two hypotheses yield perfectly incompatible and even contradictory results, compelling us to resolve this ambiguity. This ambivalence arises from the fact that in the first hypothesis, the Product is designated as the reference, while in the second, it’s energy that serves as the reference. As it seems logical to model after physics, it’s imperative to adopt a new term related to the task, the undertaking, the chore, the labor \((l)\) to be performed or already performed.

Using the term “Work” in its common language sense would create confusion with the “Work” defined as the energy required to increase the production speed of a good or service \((Product)\). Henceforth, the term “Work” to denote something to be done or already done must be unequivocally abandoned; only the term “labor” should be used. This labor in economics has the same function as space in mechanics.

We know that the various walls schematized above can obviously be built more or less quickly, and consequently, the labor can be executed with varying swiftness. Thus, it’s possible to posit that the execution speed \((\omega)\) of this labor \((l)\) is:

\[ \omega = \frac{dl}{dt} \]

However, since this speed can vary, its acceleration \((\pm)\) is:

\[ \gamma_\omega = \frac{d}{dt} \frac{d\omega}{dt} = \frac{d^2l}{dt^2} \]

Yet, it’s certain that a Force \(F_P\) must be applied to alter this speed, meaning that the acceleration is a function of the applied Force \(F_P\), thus:

\[ F_P = c \cdot \gamma_\omega \]
At this stage, discussing the coefficient $c$ in these preliminaries is unnecessary.

From the foregoing, it’s possible to state that economic Work $T$ (for economic, not mechanical purposes) is:

$$dT = \pm F_p \cdot dl$$

Indeed, this Work has an economic nature rather than a mechanical one, as it’s no longer a function of space but of labor.

The relation is affixed with the ± sign, depending on whether the labor is to be performed or has been performed, or depending on whether the Work is to be performed or has been performed.

For the sake of this brief presentation, there’s no need to continue with analytical developments, but one can surmise that they are strictly analogous to the well-known mechanics.

Two conclusions can be drawn:

- Any given Product can contain multiple distinct Works depending on the speed at which its labor evolves.
- Several different Products can incorporate the same Work for each of them.

### 4. Definition of Money

Let’s now consider the diagram L-03 below. Suppose a consumer A purchases a packet of pasta from their preferred grocer for 1 Euro, and another customer B does the same from a different supplier, also for 1 Euro.

**Hypothesis 1**

It’s clear that one could write, with $M = \text{Money}$:

$$M_A = M_B$$

implying:

$$M_C = M_A + M_B$$

or also:

$$M_C = 2 \cdot M_A = 2 \cdot M_B$$
Hypothesis 2

The following week, agents A and B repeat their weekly ritual, but for the 1 Euro coin that B gives to their supplier. The supplier, in addition to the pasta, returns a coin of 0.1 € to B because the price of pasta has decreased (for some reason) from 1 to 0.9 Euro.

Now, no one can uphold the assertion from the previous hypothesis, as the initial relationship:

$$M_A = M_B$$

has become:

$$M_A < M_B$$

Be cautious not to confuse Money and Cash. In the first paragraph above, Money was defined as the value of the Cash, and Cash as the support vector (vehicle) of Money since Money is intangible and must be incorporated into something tangible, which is Cash.

Conclusion

Everyone would agree that it's not Money $M_A$ that decreased but rather Money $M_B$ that increased. Despite this inequality, both 1 € coins (Cash) are entirely indistinguishable and could be interchanged without consequences.

Similarly to how the Product is the support vector (tangible) of Work (intangible), Cash is the support vector (tangible) of Money (intangible). Just as Work, which is intangible, must be incorporated, supported, included in something tangible, which is the Product, Money, which is intangible, must be incorporated, supported, included in something tangible, which is Cash (coins, banknotes, drafts, feathers, cowries, etc.).

Thus, just like the Product, two conclusions can be drawn:

- Any given Cash can contain multiple distinct Moneys depending on the speed at which prices evolve.
- Several different Cash can incorporate the same Money for each of them.
For the construction of the wall (previous paragraph), the bricklayer might ask to be paid every time they cement a brick. This example illustrates that the price is formed as the labor progresses but without any correlation in speed between the two. Therefore, we can postulate the speed of price formation (tachyaxis):

$$\omega = \frac{dp}{dt}$$

However, since this speed can vary, its acceleration ($\pm$) is:

$$\gamma_\omega = \frac{d\omega}{dt} = \frac{d^2 p}{dt^2}$$

Yet, it’s certain that a Force $F_A$ must be applied to change this speed, meaning that the acceleration is a function of the applied Force $F_A$, thus:

$$F_A = c \cdot \gamma_\omega$$

(At this stage, discussing the coefficient $c$ in these preliminaries is unnecessary.)

From the foregoing, it’s possible to state that Money $M$ is:

$$dM = \pm F_A \cdot dp$$

The relation is affixed with the $\pm$ sign, depending on whether Money is received by the consumer or the producer, i.e., depending on whether the price increases or decreases. In principle, it’s evident that the wealth of an economic system is higher when consumers possess Money. Consequently, the lower the price, the richer the system. But price reduction is only possible through an increase in the speed of labor execution, which is only relevant to the producer.

Hence, we must admit that it’s the producer who enriches or impoverishes the consumer, depending on whether the price decreases or increases.

For the sake of this brief presentation, there’s no need to continue with analytical developments, but it’s reasonable to expect they are strictly analogous to well-known mechanics.

**RECAPITULATION – COMPARISON**

<table>
<thead>
<tr>
<th>PHYSICS</th>
<th>PRODUCTION</th>
<th>CONSUMPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support Vector: Gaz (Steam)</td>
<td>Support Vector: Product</td>
<td>Support Vector: Cash</td>
</tr>
<tr>
<td>Space: $e$</td>
<td>Labor: $l$</td>
<td>Price: $p$</td>
</tr>
<tr>
<td>Velocity: $v = \frac{de}{dt}$</td>
<td>Productivity: $\omega = \frac{dl}{dt}$</td>
<td>Tachyaxis: $\omega = \frac{dp}{dt}$</td>
</tr>
<tr>
<td>Acceleration: $\dot{y} = \frac{dv}{dt}$</td>
<td>Production gain: $\gamma_\omega = \frac{d\omega}{dt}$</td>
<td>Tachyaxis gain: $\gamma_\omega = \frac{d\omega}{dt}$</td>
</tr>
<tr>
<td>Force: $F = m \cdot \ddot{y}$</td>
<td>Force: $F_A = c \cdot \gamma_\omega$</td>
<td>Force: $F_A = c \cdot \gamma_\omega$</td>
</tr>
</tbody>
</table>
We can observe that the various relationships are strictly of the same nature, of the same essence, which is perfectly logical considering that nature is entirely indifferent to the elements that constitute it. Only the labels of variables and functions are specific to disciplines solely for the purpose of convenience, intelligibility, and clarity.

5. Banning Common Sense – Seeking Reason

To want to banish common sense from which generally accepted opinions arise might seem, at first glance, contrary to the firmest and most well-founded understanding, thought, and judgment. However, it often deceives us and leads us astray in error. The most striking example of this is geocentrism. Clearly, the observation that the sun rises in the east, reaches its zenith at noon, and sets in the west is undeniably correct and cannot be invalidated. Nevertheless, the consequence deduced from this, directly arising from common sense, that the Sun revolves around the Earth, is erroneous.

Four centuries ago, some inspired pioneers, in order to comprehend natural phenomena, rejected common sense and embarked on a quest for reason. Despite this singularity and atypical approach, we now all know that in the realm of physics, this approach was the correct one; excluding, proscribing, prohibiting all intellectual paths referencing human beings in any way. Indeed, every time a human is named, designated, qualified, it is thereby differentiated from the rest of nature, leading to the abandonment of the physical realm for the adoption of the philosophical one. The fundamental rule necessary for understanding nature is to consider the individual as one of its elements, neither more nor less, meaning without any particular attribute, without any singular property. Every time a person arrogates a specificity, a distinct quality, the intelligence of the manifestations of nature becomes impossible, insoluble.

The schism between rational physics (Galileo, Newton, …) and the physics of common sense (Aristotle, Thomas Aquinas, …) is now a well-established fact and should be complete. Nevertheless, it remains quite fragile, as whenever we are not careful, common sense prevails over reason because its imprint is indelible in our brains.

Throughout this paragraph, there has been discussion only of physics and never of economics, which, however, essentially concerns us. The rule stipulating the absolute neutrality of nature towards human beings should apply, logically and without restriction, in the economic field. Indeed, a priori, there is absolutely no argument that can invalidate the application of this rule to economics.

Of course, some opponents may point out that Money (monetary unit) can vary in space and time, unlike physical units, which would infer that Money is a human, not a physical unit. It is true that it is indisputable that humans have granted themselves certain arrangements with the value of the monetary unit by modifying it, either through changes in its vehicle’s composition (supporting vector) or by changing the number of units. But this overlooks the fact that humans have used their imagination to employ the same strategies for other units (physical ones). Indeed, it is well known that before the 19th century, units (length, weight, capacity, …) varied depending on the location (in space) but also depending on the need (in
time). In some cities, it was even necessary to have several standards depending on whether one belonged to the bishop's or the lord's jurisdiction (i.e., in space). They sometimes resorted to different standards depending on the transaction; the standards used in sales were of smaller dimension than those used in purchases (i.e., in time).

Thus, there is no reason to distinguish characteristics based on whether they apply to the physical domain or to the economic field, as they all possess the exact same properties and are governed by the same relationship, namely:

\[ \text{Measure}(M) = \text{number}(n) \times \text{value}(u) \text{ of the unit} \]

which becomes for the measurement of Money:

\[ \text{Money}(M) = \text{number}(n) \times \text{value}(u) \text{ of the monetary unit} \]

or:

\[ M = n \times u \]

These relationships are absolutely undeniable and cannot be challenged under any circumstances in which they apply. Indeed, as an example, when asked: how much money do you have in your wallet? Any individual, even one who vehemently asserts that Money is a human characteristic, will always respond by associating a number \( n \) of monetary units with the appropriate monetary unit \( u \), in complete conformity with the above relationship.

But unless the validity of mathematical analysis is called into question, we know that the solution to the differential of this relationship must yield all (4) possible evolutions of Money \( M \). Hence the differential:

\[ dM = n \cdot du + u \cdot dn \]

Since there are only two variables \( (dn, du) \), there can be only four possibilities and only four, namely:

- Possibility 1: \( dn = 0 \) and \( du = 0 \) : \( \Rightarrow dM = 0 \Rightarrow \text{Monetary Stability} \)
- Possibility 2: \( dn \neq 0 \) and \( du = 0 \) : \( \Rightarrow dM = 0 \Rightarrow \text{Monetary Stability} \)
- Possibility 3: \( dn = 0 \) and \( du \neq 0 \) : \( \Rightarrow dM \neq 0 \Rightarrow \text{Monetary Evolution} \)
- Possibility 4: \( dn \neq 0 \) and \( du = 0 \) : \( \Rightarrow dM \neq 0 \Rightarrow \text{Monetary Evolution} \)

There is no need to delve into the analysis of each of these four possibilities in this exposition, as it is covered in detail in [1], the document that presents, elaborates, and exhaustively treats them, even when variations in the number \( (dn) \) of units and the monetary unit \( (du) \) are not equal in absolute value. Indeed, Possibility 2 above, representing monetary stability, imposes the equality of the differentials \( dn \) and \( du \). If this condition is not met, monetary instability sets in and increases according to the difference between these differentials. As already mentioned, all of this is perfectly demonstrated in document [1].

In the initial analysis, in the economic field that is of interest here, it must be noted that:

- any variation in the number of monetary units is solely due to a decision, will, and action of humans, meaning the volition of human beings;
• any variation in the number of monetary units leaves the overall wealth of the system constant;

• any variation in the number of monetary units changes the internal distribution of the wealth of the system.

In a second analysis of these four possibilities for the evolution of the quantity of Money, it is possible to note that:

• Possibility 1 does not induce any change and can be ignored since nothing varies in the considered economic system, neither the number of units nor the monetary unit. It thus provides no variation in wealth;

• Possibility 2 is entirely and strictly dependent on the number of units as well as the monetary unit, their variations offsetting each other inversely and simultaneously. It thus provides no variation in wealth;

• Possibility 3 is entirely and strictly dependent only on the monetary unit and independent of the number of units. It thus provides a variation (±) in wealth;

• Possibility 4 is entirely and strictly independent of the monetary unit and is dependent solely on the number of units. It thus provides a variation (±) in wealth.

However, it is possible to approach these four possibilities for evolution by respectively examining their cause and consequence. Thus, it is possible to create the following table:

<table>
<thead>
<tr>
<th>POSSIBILITY</th>
<th>CAUSE</th>
<th>CONSEQUENCE</th>
<th>MONEY</th>
<th>WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$dn = 0$</td>
<td>$du = 0$</td>
<td>$dM = 0$</td>
<td>$dT = 0$</td>
</tr>
<tr>
<td>2</td>
<td>$dn \neq 0$</td>
<td>$du \neq 0$</td>
<td>$dM = 0$</td>
<td>$dT = 0$</td>
</tr>
<tr>
<td>3</td>
<td>$du \neq 0$</td>
<td>$dn = 0$</td>
<td>$dM \neq 0$</td>
<td>$dT \neq 0$</td>
</tr>
<tr>
<td>4</td>
<td>$du = 0$</td>
<td>$dn \neq 0$</td>
<td>$dM \neq 0$</td>
<td>$dT \neq 0$</td>
</tr>
</tbody>
</table>

For your information, a column related to Work $T$ (Economic Work $T$, no longer mechanical work $W$, as specified earlier) has been added, which is necessary to provide (recover) to obtain (spend) a certain amount of Money $M$, that is, to increase (decrease) the wealth of the considered economic system.

The distinction between the characteristic and its supporting vector (vehicle) has been highlighted in paragraph 1 of this document in order to clearly mark its specificity. Indeed, in the physical world, no one confuses: a household scale and an individual’s weight, an odometer and the distance traveled, an ammeter and the intensity of an electric current, a stopwatch and the duration of an event, etc. Furthermore, characteristics are perfectly defined there. However, in the economic field, confusion reigns due to the use of multiple appellations designating a single characteristic (cash, money, currency, …), and if there is only one, it can mean several things (work, labor, task, …). That is why this note presents in paragraphs 2 and 3 the definitions of Economic Work and Money.

In both economics and physics, characteristics must be defined in a strictly unambiguous and as monosemous as possible manner. All engineers and physicists know that their initial physics courses consisted of determining, establishing, specifying, and circumscribing the definitions of certain characteristics, particularly pressure and temperature. It is absolutely necessary to act in the same way in economics, lest one become lost in confusion and misunderstanding.
It should be noted that Possibility 4 can be apprehended as a superposition of Possibility 3 and Possibility 2. Indeed, initially, the monetary unit \( u \) evolves but leaves the number \( n \) of units constant, creating a variation \( \pm dM \) in \( \text{Money } M \). However, in order to return the unit \( u \) to its original value, it is necessary to invoke Possibility 2, which stipulates that a variation \( d n \) in the number \( n \) induces a variation in the monetary unit \( u \), equivalent in sign.

6. Definition of the Work ⇒ Money Cycle

In economics, it is common to distinguish between goods and services, which is not relevant to our current discussion. Indeed, in physics, laws are absolutely general and apply equally to each of these categories. Consequently, goods and services will henceforth be referred to as "Product", a term that seems suitable for the generality of cases; a Product can be either a physical object (good) or a service, considering that a banker offers and sells financial Products.

We all know that there are generally a significant number of producers sequentially placed over time, each contributing a well-defined portion of the considered Product (good, service). For example, there are dozens of manufacturers involved in the creation of a washing machine, from the first extractor of raw materials to the final supplier making it available to the end customer. Let us consider, therefore, a continuous series of three agents, situated at our discretion in a chain of actors involved in creating any Product (good, service).

These three agents are conventionally designated as follows:

1. first, a Seller (V), manufacturing the Product and selling it to a Transformer;
2. then, a Transformer (T), buying the Product from the Seller, processing it, and selling it to an Acquirer;
3. finally, an Acquirer (A), purchasing the Product from the Transformer, manufacturing it, or using it.

It is understood that the agents mentioned above can represent any economic entity: individuals, families, businesses of all types, associations, administrations, etc., capable of either selling, transforming, or acquiring any Product. From these observations, it is possible to establish the following sequence:

1. production by the Seller (V);
2. transaction Seller-Transformer (V-T);
3. production by the Transformer (T);
4. transaction Transformer-Acquirer (T-A);

and to note that, during the production stages (1 and 3), the actors have no contact with each other but modify the Product, whereas during the transaction stages (2 and 4), they are in contact but there is no modification of the Product, in a strictly similar manner to physics. It is then possible to draw a comparison between economic transformations and thermodynamic transformations (with the Greek letter \( \omega \phi \epsilon \lambda \text{e } \alpha = \text{utility} ):

1. production \( V \Rightarrow \text{adiabatic transformation} \Leftarrow \text{adiabatic transformation}
2. transaction \( V-T \Rightarrow \text{isophelic transformation} \Leftarrow \text{isothermal transformation} \)
3. production $T \Rightarrow$ adiabatic transformation $\Leftrightarrow$ adiabatic transformation
4. transaction $T-A \Rightarrow$ isophelic transformation $\Leftrightarrow$ isothermal transformation

Moreover, it is certain that all modifications made to a Product during its production are directed towards an increase in its Utility, the definition of which is taken, in the context that interests us here, in the sense of Walras. Indeed, the operations and modifications performed on the Product always have the sole purpose of approaching the desired goal as quickly as possible.

However, for each agent, the Utility of the Product increases during its elaboration by the previous agent but decreases during its use by itself. Indeed, each agent desires to possess (high Utility) the Product from the preceding agent but wishes to get rid of it (low Utility) to the following agent. Utility is thus a function of the observer's position. An important conclusion is that, for any agent, the Utility of the Product is high when purchasing and low when selling. Thus:

- The Seller sees:
  - The Utility of the Product increase during its production by the previous agent;
  - The Utility of the Product decrease during its production (use) by itself;

- The Transformer sees:
  - The Utility of the Product increase during its production by the Seller;
  - The Utility of the Product decrease during its production (use) by itself;

- The Acquirer sees:
  - The Utility of the Product increase during its production by the Transformer;
  - The Utility of the Product decrease during its production (use) by itself;

Since each agent plays all three roles (Seller, Transformer, Acquirer) successively in relation to the other two, then each participant sees:

1. Utility increase during its production by the previous agent;
2. Utility decrease during its own production;
3. Utility increase during its production by the following agent.

7. Created Money

We have already defined the quantity of created Money based on the applied Force and the resulting price change, as follows:

$$dM = - F_A \cdot dp$$

We are now in a position to determine this quantity of created Money, or the increase in wealth for each stage of production and transaction, i.e., during a cycle (L-04 diagram) of producing any Product. This cycle has already been established above as follows:

1. Production by the Seller (adiabatic transformation);
2. Transaction Seller-Transformer (isophelic transformation);
3. Production by the Transformer (adiabatic transformation);  

This cycle, similar except for the (positive) direction of rotation, to the  
classic (negative) thermodynamic cycle of a steam engine determining the  
mechanical work $W$ from a certain amount of heat $Q$, therefore allows us to  
determine the quantity of $Money M$ created from a certain amount of $economic Work T$ destroyed.

The following relations provide, for each type of transformation  
(isophelic, adiabatic), the quantity of $created Money$ and thus the resulting  
increase in wealth.

Isophelic Money:

$$M = r \cdot U \cdot \ln \frac{p_f}{p_i}$$

Adiabatic Money:

$$M = - \frac{r}{y-1} \cdot (U_f - U_i)$$

Of course, we observe the strict similarity of these relations with those  
in thermodynamics, with the sign reversed since the economic and  
thermodynamic cycles rotate in opposite directions.

8. Destroyed Work
Having now understood the definition of Money (paragraph 3 – Definition of Money), it’s reasonable to know that Money cannot be created *ex nihilo*, which can be analytically demonstrated as presented in the document [1]. Indeed, only efficient economic Work can reduce the cost price of a Product and thus potentially offer it on the market at a lower cost. However, it’s essential to differentiate between accomplished Work (completed labor) and work to be done (labor to be done). It’s evident that, of these two types of Work, only work to be done holds economic significance, as it signifies that there is labor to be done. If only accomplished labor exists, it means there’s nothing left to do, to manufacture, to produce, etc., as both labor to be done and work to be done would be null; the workforce would be unemployed, and the machines idle.

Consequently, we can assert that it is the diminished (destroyed) work to be done that is transformed into realized Money that increases (is created).

However, the previously presented relation in the Work definition:

$$dT = \pm F_p \cdot dl$$

cannot be employed in the context at hand. In this relation, it’s the change in Work $dT$, measured by the change in labor $dl$, that would result in the change in Money $dM$. However, presently the change in labor is not known and cannot be known. Despite this challenge, physics and specifically thermodynamics show us the path to resolve this issue.

This relation gives the result, effect, consequence of a transformation, but not the cause. And precisely the cause is what we are seeking. We can indeed admit (as stipulated above) that it’s the accomplished Work (which increases), i.e., the diminished work to be done (which decreases), that triggers, induces, causes, the creation of Money through a decrease in the cost price of the considered Product. Knowing for a long time that "nothing is lost, nothing is created, everything is transformed", we can posit:

$$\text{Cause} + \text{Effect} = \text{Constant}$$

or alternatively:
Variation_{\text{cause}} + \text{Variation}_{\text{effect}} = 0

No one can deny the fact that all economic agents, including entrepreneurs, employees, slaves, but also animals and engines, \textit{i.e.}, any entity capable of performing \textit{Work} to accomplish \textit{labor}, economizes its expenditure of energy, though always subject to exerted constraints. This can be presented as follows:

\begin{itemize}
    \item Work economization naturally increases up to a maximum, depending on external constraints.
\end{itemize}

which is strictly identical to the expression of entropy in physics, namely:

\begin{itemize}
    \item Entropy naturally increases up to a maximum, depending on external constraints.
\end{itemize}

Over time, and as already mentioned above, natural evolution, \textit{i.e.}, without additional constraints, generally and indisputably implies that \textit{Work} decreases, \textit{i.e.}:

\begin{equation}
\Delta T < 0
\end{equation}

This can be understood by approaching the phenomena that occur during deceleration in mechanics, where the change in work is negative. This change in \textit{Work}, having the consequence and aim of bringing the \textit{Utility of the Product} to a certain level, by setting:

\begin{equation}
U = \text{Utility of the Product},
\end{equation}

can be expressed as:

\begin{equation}
-\frac{\Delta T}{U}
\end{equation}

which is nothing but the \textit{realized Work economization} for each level of \textit{Utility} (still in a natural evolution, \textit{i.e.}, without additional constraints, as stated above). Consequently, setting:

\begin{equation}
P = \text{Work Economization}
\end{equation}

we get:

\begin{equation}
\Delta P = -\frac{\Delta T}{U}
\end{equation}

Indeed, the lower the amount of \textit{Work} expended to perform any given task (\textit{work, labor}), the greater the \textit{economization of Work}, so it's normal for this ratio to be preceded by a negative sign. This \textit{economization of Work}, as well as \textit{Work} itself, are characteristics that can evolve continuously, which allows us to express this relation in conventional differential form, as:

\begin{equation}
dT = -U \cdot dP
\end{equation}

This relation can be compared to that of thermodynamics, namely:
\[ dQ = T \cdot dS \]

These two relations clearly demonstrate that variations in Work economists \( P \) and in entropy \( S \) are the causes of respective evolutions in Work \( T \) and heat \( Q \).

9. Internal Economic Energy

In an isolated economic system, depending on whether Work and Money are known or undetermined, we are entitled to express the relationship as:

\[
\begin{align*}
\text{cause} & + \text{effect} = 0 \\
dT + dM & = 0
\end{align*}
\]

or:

\[
\begin{align*}
\text{cause} & + \text{effect} = 0 \\
\delta T + \delta M & = 0
\end{align*}
\]

if we assume, as a principle, that the same change in Work always causes the same change in Money. At this stage, with this principle accepted, it becomes possible to substitute these characteristics with their values and account for the directions of Work and Money movement:

\[
\begin{align*}
\text{cause} & + \text{effect} = 0 \\
-U \cdot dP + F_A \cdot dp & = 0
\end{align*}
\]

This relationship is strictly analogous, with the sign difference, to that of thermodynamics, namely:

\[
\begin{align*}
\text{cause} & - \text{effect} = 0 \\
T \cdot dS - P \cdot dV & = 0
\end{align*}
\]

For an economic system in contact with other systems, that is, engaging in transactions among them, where Work and/or Money can be exchanged between different elements, the relationship is no longer equal to zero and becomes:

\[
dE = dT + dM
\]

with:

\[
E = \text{Internal Economic Energy within the system}
\]

10. Conclusion

The exploration of the analogy between thermodynamics and economic systems provides an innovative perspective on how wealth and money are generated, transformed, and spent within an economy. Through the juxtaposition of these two domains, we are led to reconsider fundamental concepts such as value, utility, and conservation. However, while acknowledging the enlightening potential of this analogy, it is essential to keep its limitations in mind. Economic mechanisms, influenced by human, social, and cultural factors, possess a complexity that can be apprehended through this interdisciplinary approach, which reinforces the
idea that economics, much like thermodynamics, operates based on principles of transformation and conservation, thus offering exciting avenues for future economic research and analysis.