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Initial Approach to a System Study of Global Finance

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Abstract. The objective of this paper is to present an initial system study of global finance based on the Laws of Thermodynamics to investigate the nature of capital instability. It appears that the financial markets are measured in ways that only indicate the symptoms. It is like a group of individuals who are blind feeling an elephant to define what there are feeling. While the measures are symptomatic they are only partial indicators of the underlying processes and usually are lagging or leading, or shifting. In all instances we believe it is energy that produced by labor and the productivity based on human energy consumption which drives the system. We believe it is the energy created by labor that is the core element of the system, and is the fundamental variable to explain the nature of capital market and of financial systems.

Keywords: economics, thermoeconomics, global finance, soft assets, GDP, labor theory of value

1. Introduction

"What has gone wrong with the world?"(Soddy 1933, 17) This is the opening line of the seminal work by Nobel Laureate Frederick Soddy in 1933 on thermoeconomic theory. Today we still are trying to answer this question even though over 77 years have passed. While science and technology have given to many a higher standard of living many are still in poverty, "insecure, being now never free from the specter of unemployment and consequent submersion into destitution and degradation."(Soddy 1933, 19) The objective of this paper is to present an initial system study of global finance based on the Laws of Thermodynamics to investigate the nature of capital instability.

It appears that the financial markets are measured in ways that only indicate the symptoms. It is like a group of individuals who are blind feeling an elephant to define what there are feeling. While the measures are symptomatic they are only partial indicators of the underlying processes and usually are lagging or leading, or shifting. In all instances we believe it is energy that produced by labor and the productivity based on human energy consumption which drives the system.

In this paper, we argue that everything is a product of energy in the form of labor and that the basic principle of Labor Theory of Value is still valid and we validate this principle not relying on economics and finance models, rather on thermodynamic science. We believe it is the energy created by labor that is the core element of the system, and is the fundamental variable to explain the nature of capital market and of financial systems.

2. Labor as the Basis of Economics and Finance

In economics, labor is a measure of the work done by human beings and is conventionally contrasted with such other factors of production as land and capital. Economics considers the interrelations among the labor, the goods, the money, and the foreign trade. It looks at how these interactions influence macro variables such as employment levels, inflation rates, aggregate income and Gross Domestic Product. In no

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way the social science of economics considers the how human labor contributes to the total system. Some economists have postulated that understanding the labor market is fundament to understanding modern economy. (Devine. T.J.; Kiefer 1991) Labor economics tries to determine how labor is exchanged for wages. It does not explain how that labor results in an asset and what is the basis for that exchange.(Cahus 2001)

3. Thermodynamic Understanding of Economics and Labor

The nature of capital is multilevel; it can consist of property, resources, human labor and various other assets. But in reality it is the ability to trade one asset for another asset. In this regard, capital like money can be used to acquire another asset like someone's labor or a physical asset. In a way it is barter because liquid capital is only a way of exchange in fact since any asset, from a market perspective, only has value because someone wants it. If that asset was placed in a forest or desert or a high mountain and no one was there to claim it, then it would have no value. So for an asset of any type to have value someone must want it otherwise it would be valueless.

However, while its value depends on someone desiring it, the asset has a more fundamental "value" in the thermodynamic sense. That thermodynamic value is the amount of human labor expended to produce it. That must be the total "labor" cycle from basic resource acquisition to the final asset. This includes the labor to build any device and the material in that cycle allocated to that device. Thus nothing on this planet is produced "de novo", that is without human labor.

Therefore, the Laws of Thermodynamics hold and economic processes are not an exception.(Ksenzhek 2007, vii) Thermodynamics consist of two fundamental laws:

- First Law of Thermodynamics is the law of conservation of energy or energy balance. The first law of thermodynamics shows the equivalence between heat and work but not the direction of transformation.
- Second Law of Thermodynamics places limitations on the direction of transformation and that processes evolve in one direction only.

These laws applied to economics in particular labor and capital are the basis of this initial paper. Appendix A presents a logic used in developing this paper.

4. Labor Theory of Value

"The labor theory of value presents one of the most puzzling and intriguing phenomena in the history of thought." (Foley, 1997)

Many researchers believe that Mr. John Locke (1632-1704) was one of the pioneers of Labor Theory of Value or LTV. Even though Locke assumed that all natural resources had been provided by God, he believed that when people took natural things and reshaped them into products, they mixed their labor with the raw naturally provided materials, and thus had the right to own the products. For instance, picking an apple off a tree, that labor entered into the object, and so the object became property of that person, which is the base of value, therefore, Locke indicated in his work the concept of LTV. (Locke 1689)

Others argued, however, that while Locke did indicated LTV, "the relative value or price of a thing was dependent upon its usefulness and scarcity and not the amount of labor it contained." (Vaughn 1978)These researchers, therefore, argued that Locke would have agreed completely with Archbishop Whately's famous dictum: "it is not that pearls fetch a high price because men have dived for them; but on the contrary, men dive for them because they fetch a high price." (Roll 1953) Adam Smith (1723-1790) and David Ricardo (1772-1823) were among the classic economists who advocated LTV.

5. Thermodynamics Approach

The basic approach is that everything requires labor and labor requires energy. The only energy that enters our planet comes from the sun. Even coal and oil are products of past sun light. Radioactive material was deposited when the planet was formed and like the planet itself is here. Meteors and galactic dust enter our planet but do not contribute much to the energy input.

On average each person on earth uses approximately uses 10,000 kilojoules of energy per day to meet their needs. This unit requirement is approximately of the same magnitude as required in the Neolithic era. Now that implies that approximately $6x10^{13}$ kilojoules per day or $2.2x10^{16}$ kilojoules per year can be related to all asset formation in combination with past human endeavor resulting in productivity or leverage through the application of existing past assets. Nothing results except from current and past human expenditure of human energy; this is the result of the First Law of Thermodynamics.

In one way or another all humans contribute some energy to formation of assets either by actually forming those assets or using them to develop other assets. This is independent if the worker is in a factory, farm, or office, or is unemployed. All humans must acquire sources of energy to survive and to accomplish their individual endeavors whatever they may be. The only source of this energy is the sunlight past and current and radioactive material formed when the earth formed. Thus all assets and capital are directly related to these expenditures of human energy.

Based on this premise we can develop how this is related to World Gross Product and Capital and its relationship to Liquid Capital or soft assets and in turn what may be the cause of the instability of the global financial system.

6. Model of World Gross Product

6.1. Systems Approach

The recent worldwide financial crisis illustrated that a real systematic understanding of the relationships between financial systems may not be fully understood in terms of a total system. If we consider the world as a system, the only things that enter earth are sunlight, radiation and extraterrestrial bodies; thus the financial system only results from labor, use of resources and productivity. While this is a simplistic system in fact its complexity and interactions can become extremely unstable. Financial crisis have been the "Sine qua non" of the 1970 to 2007 period with over 124 worldwide. (Stiglitz 2010, xiv)

Starting with the premise that we are dealing with a system, on a global level we need to understand the general interaction between the measures of the world's economic factors. Initially these factors can be given by the World Gross Product ("WGP") and the World Capital ("WC") and how they are related.

These factors when analyzed in a systematic and quantitative manner may allow the understanding of the system and variables which when perturbed can cause a cascaded instability.

The world gross product (WGP) or world gross income (WGI), is a basic measure of a world's economic performance, and is the market value of all final goods and services made in the world in a year. WGP can be defined in three ways, all of which are identical. First, it is equal to the total expenditures for all final goods and services produced in the world in a year. Second, it is equal to the sum of the value added at every stage of production (the intermediate stages) by all the industries in the world, plus taxes fewer subsidies on products, in the period. Third, it is equal to the sum of the income generated by production in the world in the period—that is, compensation of employees, and gross operating surplus (or profits).

The most common approach to measuring and quantifying WGP is the expenditure method:

WGP = private consumption (C) + gross investment (I) + government spending (G), or,

$$WGP = C + I + G \tag{1}$$

"Gross" means that depreciation of capital stock is not subtracted out of WGP. If net investment (which is gross investment minus depreciation) is substituted for gross investment in the equation above, then the formula for net domestic product is obtained. Consumption and investment in this equation are expenditure on final goods and services.

World Gross Product can be related to world population and productivity. Since caloric use per individual has been relatively constant for over thousands of years then based on estimates of WGP during periods of low productivity such as the dark ages, the basic WGP per population is between $350 to $500 per person or 4.4×10^{13} to 6.3×10^{13} joules per $ of WGP. Therefore:

$$WGP_t = K_p * P_{T_t} + Pr_t \tag{2}$$

Where

Kp = average value in terms of $ per person ($350 to $500) or in terms of joules per person (4.4×10^{13} to 6.3×10^{13}) if joules are used then WGP would be in terms of joules!

P_{T_t} = world population at time "t"

Pr_t = productivity value in terms of "t" or $\alpha_t * P_{T_t}$ where α_t is the measure of productivity per person at time "t"

Therefore

$$WGP_t = P_{T_t} * (K_p + \alpha_t) \quad (3)$$

Let us assume that "αt" can be described by logistic equation in the form:

$$\alpha_t = \frac{\beta e^t}{\beta + (e^t - 1)} \quad (4)$$

Where "β" represents the maximum range of the productivity.

However, this productivity must relate to prior human energy expenditures less loss of assets from a First Law of Thermodynamics viewpoint. Therefore the total amount of world "human thermodynamic assets" consists of human energy plus all prior expenditures less losses. When pseudo-assets and hard assets approach this value instability in world finances may result.

There many deferent definitions of capital.

Capital is something owned which provides ongoing services. In the national accounts, or to firms, capital is made up of durable investment goods, normally summed in units of money. Broadly: land plus physical structures plus equipment. But it is also a measure of the accumulated financialstrength of an individual, firm, or nation, or the world created by sacrificing present consumption in favor of investment to generate future returns above investment costs. It can be defined also as assets available for use in the production of further assets or as wealth in the form of money or property owned by a person or business and human resources of economic value.

We will use the definition that total capital (C_{T_t}) at time "t" is the value of all the equipment, land and liquid assets.

Now capital (C_{T_t}) consists of current and past capital ($C_{T_{(t-1)}}$) plus input from past World Gross Product ($WGP_{(t-1)}$).

Applying a preliminary analysis we can show that:

$$C_{T_t} = \left\{ \frac{K_p * [1+R] * [1+S_f]}{\left[1 - \frac{C_{S_t}}{C_{T_t}}\right]} \right\} * \sum_{i=0}^{i=t} \left(P_{T_i} + P_{T_{i-1}} \right) \quad (5)$$

Where

R = is a logistic function over a period "0" to "t" (assumption)

S_f = is an unknown function at this time possibly another logistic function (assumption)

C_{S_t} = is the amount of liquid or soft capital at time "t"

This equation seems to indicate that as liquid or soft capital (C_{S_t}) grows where it represents the majority of the total capital (C_{T_t}) the equation will "balloon", i.e. a bubble and likely lead to instability! We believe this is what happened during the "Great Recession of 2009".

7. Preliminary Results

7.1. What drives world financial instability?

As we have seen world financial instability may be driven because the growth of liquid capital overwhelms real capital, i.e. capital formed due to labor not just paper. We should divide total capital (C_{T_t}) at time "t" into also real or hard capital, i.e. assets based on labor (C_{H_t}) at time "t" and representational or soft

assets such as mortgages, bonds, stocks, derivatives, etc.(C_{S_t}) at time "t". The assets based on labor (C_{H_t}) can be divided between the base assets (C_{Hb_t}) when they were originally placed into service and their growth based on either supply-demand or other pricing mechanisms (C_{Hp_t}):

$$C_{Hp_t} = \gamma_t * C_{Hb_t} \tag{6}$$

Where

γt = growth factor for assets at time "t"

So if Eq.5 is reviewed in reference to these factors, then:

$$C_{T_t} = C_{S_t}\left[\left(\frac{C_{Hb_t}}{C_{S_t}}\right) * (1 + \gamma_t) + 1\right] \tag{7}$$

Therefore when representational or soft assets such as mortgages, bonds, stocks, derivatives and other non-labor based assets become so large that base assets become much debased then as:

$$C_{S_t} \rightarrow C_{T_t} \tag{8}$$

Then an asset "bubble" occurs and instability becomes very likely! Basically this result from the First Law of Thermodynamics, which you cannot obtain, more than enters the system. Financial crisis in any era is an illustration of this factor, as is the collapse of financial markets.

8. Factorial Basis for Financial Systems Model

We believe while we have initially shown a relationship in the global markets, these factors also hold in all financial systems from global down to individuals. This factorial relationship is illustrated by various situations. We have demonstrated the initial global case now let us consider some other areas.

The Asian financial crisis that held much of Asia in its grip began in July 1997. This crisis started because Thailand floated its currency due to serve financial overextension. This overextension was due to a large foreign debt that caused a bankruptcy of the country. Foreign debt to GDP ratios increased from 100% to 167% in 1993-1996 in four major countries of the ASEAN region. This is a regional example of our preliminary thesis.

The major recession in many countries including Latin America in the 1950-1990 time periods provide other examples. In these cases, countries borrowed heavenly from various international organizations. This caused hyper-inflation and eventually bankruptcy as many of these nations defaulted on their debts.

Industries also experience over expansion with a rise of equity values far exceeding their real asset values leading to a collapse of equities and the collapse of many companies due to the growth of pseudo-capital, i.e. capital without a labor base. This was the case of the technology equity "bubble" in 2000. Corporations similarly fail by incurring debts which exceed available assets. Similarly, individuals fail for exactly the same reasons. The failure of the American and British housing due to mortgages that exceed the real value of the assets is also illustrative of this failure. In many instances when the First Law of Thermodynamics has been ignored, the overall cascade also destroys much more then the failure of just the industry, company or individuals involved, causing further hardships in human terms.

According to the First Law of Thermodynamics, the system balance can only be maintained by decreasing the value of and/or amount of labor. Therefore, promoting more soft capital or assets that are not directed into producing hard assets through capital injections, debt issues and derivatives and other instruments decreases the portion of hard assets and thus soft capital or assets becomes a higher proportion of the total capital. The real impact of this is that labor loses its value through inflation and other economic mechanisms and/or the proportion of labor used to make assets decreases. Therefore, generating more soft capital or assets that do not result in hard assets has negative impacts on labor either through reduced value or lower utilization or both.

9. New Basis of Global Reserves – Joules?

We believe that we may have initially shown the importance of the First Law of Thermodynamics in determining the stability of financial markets from global down to individuals. Furthermore, Appendix B demonstrates the relationship between capital and the Laws of Thermodynamics. Also, we believe that we have shown that the basic principle of Labor Theory of Value explicated by Marx in his "Capital" is still valid and we validate this principle not relying on economics and finance models, rather on the Laws of Thermodynamics. This is shown by the equation:

$$\nabla = (C_{T_t} - C_{L_t}) = \sigma_t \mu_t \tau_t P_{T_t} E_{T_t} + \sum_{i=0}^{i=(t-1)} \sigma_i \mu_i \tau_i P_{T_i} (1 - \epsilon_i) E_{T_i} \quad (9)$$

The above equation shows that the difference between total capital (C_{T_t}) and liquid capital (C_{L_t}) is strictly a function of human energy. This equation basically shows the impact of the First and Second Laws of Thermodynamics on capital.

As the availability of liquid capital increases then the right side of the equation has to decrease. The only way this can occur is by decreasing the value of labor (μ_t). Therefore, promoting more liquid capital through capital injections, debt issues and derivatives and other instruments decreases "∇" since soft capital or assets (C_{L_t}) becomes a higher proportion of the total capital(C_{T_t}). The real impact of this is that labor loses its value through inflation and other economic mechanisms and/or the proportion of labor used to make assets decreases. Generating more liquid capital or soft assets that do not result in hard assets results on negative impacts on labor either through reduced value or lower utilization or both.Also as Eq. 8 shows this also results in a "bubble". Thus injection of capital that does not produce hard assets beyond a certain level could result in human value destruction.

One potential way of dealing with the abuse of this Law would be to develop a reserve currency based on energy denominated in "Joules".

Realizing that the maximum amount of real assets is based on labor past and present, the First Law of Thermodynamics says that we cannot obtain assets that exceed a maximum number of "joules" during any period. Therefore, the world capital will grow through growth in population plus net additions due to WGP less losses. To determine this, additional research will be required including quantifying this premise. This preliminary analysis shows that based on the First Law of Thermodynamics, the world financial system is in fact a "Zero Sum Game". There only gainers and losers in this "game" and it is imperative that we have a methodology to have a level playing field in global finance.

10. Conclusion

In this paper, we develop a model based on laws of thermodynamics to analyze the global financial system. We argue that based on our equation: any activities increase soft capital by promoting more liquid capital through capital injection, issuance of debt, derivatives and other instruments will inevitably result in decrease in labor value by either through reduced value of labor (inflation) or lower utilization of labor (unemployment) or both. And that is exactly what is happening now in many economies.

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