Use thermodynamic laws to describe macroeconomics

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Abstract

There is a great analogy between thermodynamics and economics. Here, I will use the laws of thermodynamics to describe the laws of macroeconomics. The first law of thermodynamics explains the conservation of energy. Thus, the internal demand and external trade will contribute to citizens' income. The second law of thermodynamics says that entropy will always be enlarged. Thus, developed nations will have larger entropy compared to developing or non-developing nations. The third law of thermodynamics also reaches because there is no perfect monopoly.

Text

Just like thermodynamics, economics will tend to reach an equilibrium status. Thus, I am interested if I can use thermodynamic laws to describe economic principles. Here, I will use the laws of thermodynamics to explain the phenomenon of macroeconomics.

We know the first law of thermodynamic is due to energy conservation. Energy exchange happens and let the system to reach an equilibrium. The law is stated as:

$$\Delta U = Q \pm W$$

In addition, if we use the concept of free energy deltaG, the above equation can be transformed into:

$$\Delta G = Q \pm W - T\Delta S$$

Here, Q is internal energy, W is external work or energy, T is temperature, and delta S is entropy change. When the reaction reaches an equilibrium, the delatG will be zero. We will change to above form to macroeconomics components. From my previous paper, Q can be described as $1/2mV^2$ due to internal market, and W can be described as GMVmv/r due to trade. Thus, we see:

$$0 = 1/2mv^2 \pm GMVmv/r - T\Delta S$$

This above equation is made by conservation of energy. If we subtract velocity V from

the above equation, we can also get the form of conservation of momentum. And, from the Fisher equation(MV=PQ) and Kaznet GDP formula, we will get:

$$0 = (\mathrm{C} + \mathrm{G} - \mathrm{T} + \mathrm{I}) \pm \mathrm{NX} - \mathrm{T}'\Delta\mathrm{S}$$

C is consumption, G is government expenditure, T is tax, I is investment, and NX is net export. If the external work item is net gain from other nation, the sign is positive. If the external work item is net loss to other nation, the sign is negative. In the later case, the NX=NCO. Actually, NX=-NCO in the later case. In addition, we know saving S' is equal to I+NX. Thus, the first two item will become C+S'+G-T=income. That is to say the last item T'S is equal to income which is from internal demand and external trade. In large nation, inner demand is more important. In small nation, external trade is more important.

Then, what is the meaning of T'deltaS? We can explain this item by GNI or national average income per person. The entropy S in economics is defined by the randomness in distribution or diversity. There is an entropy index to define S:

$$\mathrm{S} = \sum \mathrm{P_i} \log \frac{1}{\mathrm{p_i}}$$

If there is perfect even distribution or maximal diversity, the entropy S will reach its maximum value logN. If the wealth all belongs to a single person or no economic diversity, then S will have least value 0. Here, T' can be defined as economic temperature. Since the second law of thermodynamics saying that entropy will always be enlarged toward equilibrium status, T' can be viewed as economics development status marker like the inverse of time(T*t=h'/k). Here, I don't view this by one year duration. This equilibrium will happen in the long run. Thus, developed nations will have more even distribution with larger entropy. During the development of economics, the wealth will be toward even in the given nation. It is interesting that Kazets proposed an invert U curve for the wealth distribution and economic development. However, the left side upward line is challenged by many economists. For example, the even wealth distribution was seen in the early economics development of the four small dragons of east Asia. Thus, economics development will let economic equality and economic diversity with a downward line only compared to Kaznets' original graph. It is interesting that the third law of thermodynamics is also fulfilled in economics since temperature and entropy will become zero in any given nation that is a perfect monopoly. This perfect monopoly will easily trigger a revolution. This is the analogy between macroeconomics and thermodynamics.