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MODELING THE ECONOMY AS A DISSIPATIVE STRUCTURE WITH SCARCE RESOURCES

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ABSTRACT

We provide a formal framework allowing to embed macroeconomic modeling within a thermodynamic realm. An economy is viewed as a dissipative structure, that is, an out-of-equilibrium complex system obeying the laws of irreversible thermodynamics, perpetually trading energy and matter flows with its environment to grow, sustain, and complexify itself. Manufactured goods are reshaped matter whose economic value rests partly on its added internal orderliness. Industrial production is modeled as a thermodynamic conversion, operated over finite stocks of resources, whose physical consistency obtains courtesy of a minimal disaggregation of firms into two sectors of complementary thermodynamic roles: The energy sector extracts energy from the degradation of low-entropy natural resources; the manufacturing sector uses that energy to order up raw materials into manufactured non-recyclable goods and capital. The latter is reinvested into the balanced growth of both sectors. The resulting stock-flow consistent thermo-economic dynamics highlights the effects of resource scarcity on GDP and other economic indicators like under-employment, production costs and income distribution. Useful power is identified as the key through-flow of the economic process. We show that energy shortages result in immediate recessions. By contrast, the progressive dilution of mineral resources critical to industry can result in long-standing secular stagnation accompanied with rising inequalities.

Keywords: macroeconomic modeling, dissipative structure, exhaustible resources, energy peaks, secular stagnation

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