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Energy and the capital of nations

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The economically useful time of fossil fuels in Earth is estimated in just ∼160 years, while humanity itself counts ∼150*103 years. Within only ∼0,15% of this time, humanity has used more energy, accumulating so much wealth than within the rest of its existence time. According to this perspective, the availability of heat gradients is what fundamentally drives the evolution of economic systems, via the extensive enhancement –or even substitution- of human labor (Ayres and Warr 2009). In the modern industrial civilization it is estimated (Kümmel 2011) that the average human ability to generate wealth (productivity) has increased by ∼40%-50% –including the effects from the growth of human population- further augmented by significant economies of scale achieved in the industrial era. This process led to significant accumulation of surpluses that generally have the form of capital. Although capital is frequently confused with the stock of mechanical equipment, capital can be generalized as any form of accumulated (not currently consumed) production factor that can deliver a benefit in the future. In that sense, capital is found in various forms, such as machinery, technology or natural resources and environmental capacities. While it is expected that anthropogenic forms of capital are accumulated along the increase of energy use, natural capital should be declining, due to the validity of the Second Law of Thermodynamics (2nd Law), entropy production and –in turn- the irreversible (monotonic) consumption of exergy (Wall 2005). Regressions of the LINear EXponential (LINEX) function (an economic growth function depending linearly on energy and exponentially on output elasticity quotients) (Lindenbeger and Kummel 2011) for a number of industrialized economies -like the USA, Germany and Japan, found that output elasticities were highest for energy (except for US where it was second highest after capital); meaning that in industrial economies, energy comprises the most significant production factor. This work enriches such studies via integrating the analysis all forms of capital and for a wider range of countries; estimating the trade-off –as output elasticity ratios- between the accumulation of various anthropogenic capital forms and the deterioration of natural capital –considered both as resource stock and carrying capacities of the environment.

Keywords: energy, fossil fuels, industrial civilization, capital, production factor, natural capital, 2nd Law, entropy, irreversibility, exergy, LINEX function, output elasticity

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