https://doi.org/10.55343/CogSust.66

Environmental Capacity Through the Moral Economic Lens – Dynamic Equilibria

Zsófia Hajnal
0000-0001-8089-9930
Corvinus University of Budapest,
Budapest, Hungary
zsofia.hajnal@stud.uni-corvinus.hu

Abstract

This article explores and maps hierarchical, dynamic environmental-economic equilibria. Based on the moral economic premise of finite human needs, on output that increases with the population number in a supralinear manner, and on technology levels, moral economic equilibria are identified and quantified. These equilibria are compared to environmental capacities – as a function of technology levels. A needs-based, theoretical attempt is made to resolve the tensions and conversion issues in the economic-environmental nexus. A novel, visual, moral, and economic model of equilibria with the environment is established and justified. The model is expected to suggest indirect economic adjustments to align with sustainability, which is more of a notion to be aligned with constantly than a handful of one-time economic targets to meet.

Keywords
moral economics, environmental capacity, technology, human needs, equilibrium

1. Introduction

Groups and networks of economists, economic advisors and decision-makers face global economic-environmental calibration challenges. Beyond the – many times literal – firefighting, they bare a responsibility for figuring out how life for future generations could be safer, free, and sustainable. This paper does not discuss recent phenomena of climate extremes around the world, albeit they are heavy reminders of our species' environmental overexploitation. Rather, it focuses on the general and long-term economic-environmental relationships. Establishing these theoretical connections is long overdue, for "there is an urgent need for more rapid integration of economics into the core of sustainable development, and more rapid integration of sustainable development into the core of economics" (*Polasky et al., 2019, p. 5234*). The largely visual model in this paper may lie at the heart of the integration on both sides.

1.1. Theoretical background

The paper's title calls for two initial concept introductions and clarifications: those of moral economics and those of environmental capacity.

Moral economics is a branch that can potentially incorporate ethical elements into economic theories or models. It is relatable to, but not to be identified or confused with, the "moral economy" tradition. It is one of the pluralistic economic expressions – humane economics and the social and solidarity economy – aiming to expand economic knowledge and well-being in tandem. In the author's interpretation, moral economics expands economic understanding in three major directions: incorporating ethical factors into economic models, expanding the economic understanding of the environment, and re-axiomatizing human needs. This research will borrow tools from the latter two directions. Hungarian scholars whom the author would categorize as advocates of moral economics include Balázs Hámori (from a behavioural economic viewpoint), Laura Baritz (from a religious perspective), Gergely Tóth (advancing the environmental aspects), and László Zsolnai (representing the ethical direction). Internationally, the author regards Amitai Etzioni, Samuel Bowles, and Mariana Mazzucato, among others, as key figures in advancing and popularising moral economics through experimenting with ethical-economic interactions, both in theory and practice.

https://doi.org/10.55343/CogSust.66

E*nvironmental capacity*, “the maximum population size an environment can sustain indefinitely” (Australian Academy of Science, n. d.), also called carrying capacity, is. Extraterrestrial space is included in this concept, interpreted as part of our environment. There appears to be a gap in the economic-environmental discourse in this area. Environmentally, in the short and mid-term (for the next few decades), humankind is in a “firefighting” mode, with incentives and attempts to restrict material production and consumption – growth, in general. The conversion between the economic and the environmental, however, is incomplete (*Bartus, 2008, p. 1021*), leaving theoretical space for increasing value-creation – both private and collective (*Mazzucato, 2022, p. 8*), and practical space as well, on the long term.

In finding economic-environmental equilibria, human needs play a decisive role. Like the environment, converting human needs into economically expressed units is incomplete. However, human needs are directly relatable to environmental ones. The author presumes that constructing a system of models which incorporates all three areas (human needs, the economy, and the environment) allows for a clearer overview of equilibria. This system will require the moral, economic axiom of finite needs, i.e. human needs being satiable, ultimately and sustainably.

1.2. Research questions and methodology

The paper's research questions are: What are the determinants of environmental-economic equilibria in the moral-economic sense? What are the moral and economic criteria for “sustaining sustainability” regarding economic relations? What are the practical and future implications of the findings?

In order to answer these questions, the system mentioned above of models is outlined, illustrating how the altered axioms of finite needs and cooperation have far-reaching implications for the global economy. The analysis is conducted in the context of the relevant literature. Data from the World Bank is used to determine the system’s rightfulness. Due to its novelty and scope, however, the system of models will be presented as a simplified construct – it is rather opening doors for further research and adjustments than applicable straightaway.

2. Outline of the visual model

In order to make the system that is built comprehensible, the article will introduce the concepts used and premises applied gradually. The first two subchapters rely on the book *Moral Economics – A Theoretical Basis for Building the Next Economic System* (*Hajnal, 2021, pp. 76–78*).

The following relationships will be dealt with:

- human needs as a function of the population number;
- output as a function of the population number;
- the intersections of needs and output;
- the intersections of needs and output at different levels of technology;
- the intersections of needs and output as a function of the level of technology, limited by the environmental capacity.

Human needs, the population number, and the level of technology are seen as exogenous factors.

2.1. The aggregate of finite human needs

As mentioned, the “finite and satiable” premise applies to human needs. Human needs display a dynamic and wide variety of types and intensities, constantly changing in time for each individual. Traditionally, they are not measured in their aggregate due to the resulting lack of an unit of measure (UOM) and the aforementioned incomplete conversion between human needs and economic ones. This research, however, attempts to measure and illustrate the needs to combine the concepts. Units are used flexibly, referring both to economic value (utils, satisfiers) and to forms of energy.

When needs are seen as finite with respect to the individual, the needs-aggregate for a given number of people also yields a distinct value. Thus, the aggregate function of needs in the *population number – value or energy* coordinate system is an upward sloping, linear one, as depicted in *Figure 1*.

https://doi.org/10.55343/CogSust.66

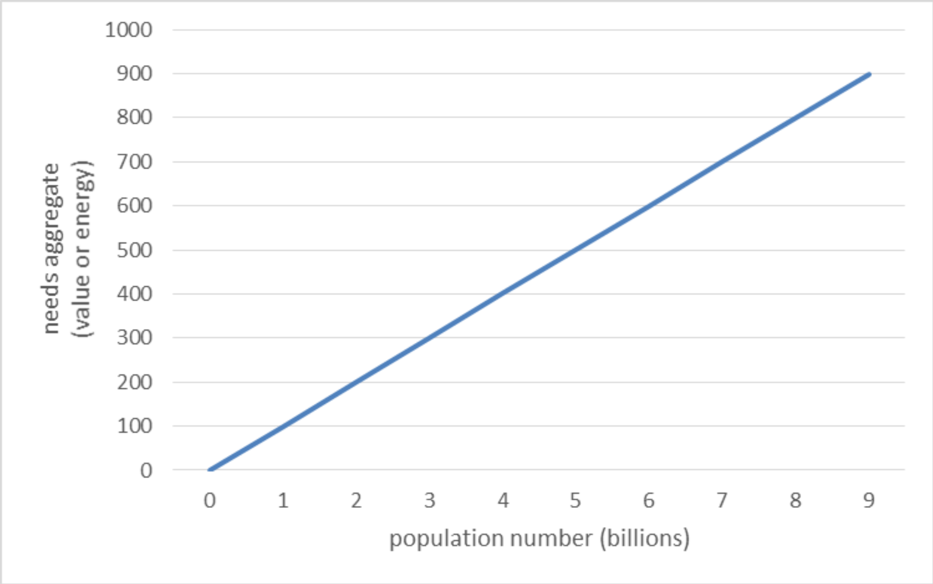

Figure 1: The needs-aggregate as a function of the population number. Generated by the author.

2.2. Output as a function of the population number

When depicting potential output, the paper operates with a more general notion than traditionally used in macroeconomics. Moreover, in this socio-optimistic approach, it will be presumed that output always increases with the population number increasing, in a supralinear manner. This approach relies on labour division and the increasing opportunities for cooperation, by incorporating the efficiency-increasing effects of these phenomena. In this form, output, as a function of the population number, resembles an exponential function, as depicted in *Figure 2*, with curve *1a*. With slightly more skepticism, pessimism, or simply a more critical attitude, taking challenges to cooperation into account, potential output in the “population number – value or energy” coordinate system can be depicted as an S-shaped curve (*Figure 2*, curve *2a*). The inflection point illustrates how the effects of cooperation become strengthened (through technology), but then, the given technology level is not yet suitable for facilitating an even larger-scale of cooperation.

https://doi.org/10.55343/CogSust.66

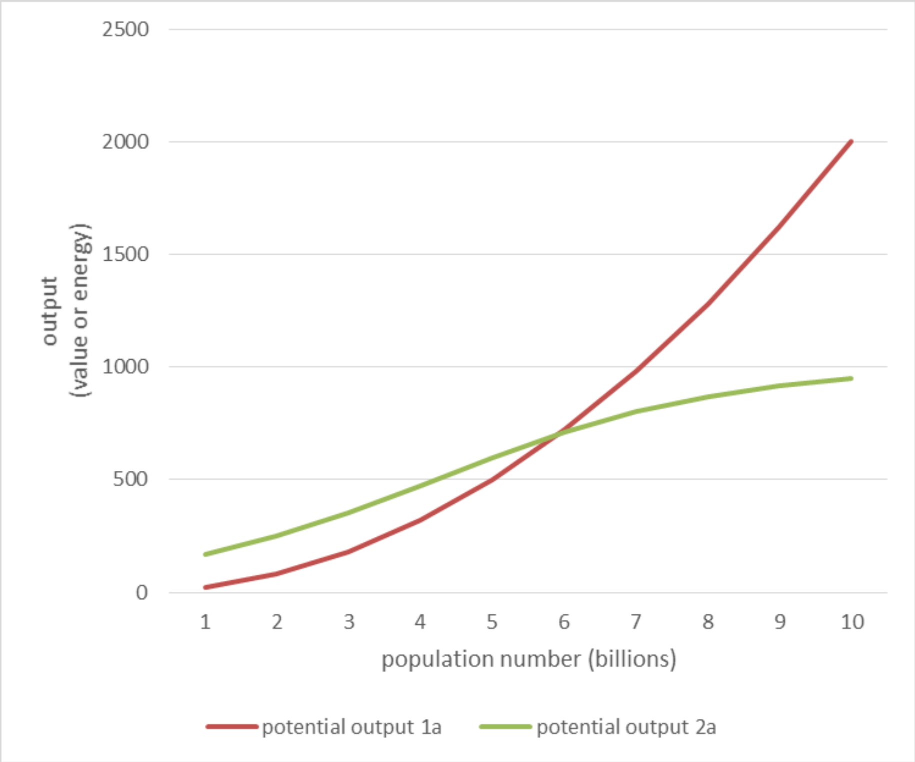

Figure 2: Two scenarios for (potential) output as a function of the population number – socio-optimistic (exponential) vs. critical (S-shaped) approaches. Generated by the author.

2.3. The intersections of needs and output

Combined in one system, as done in *Figure 3*, the needs aggregate and potential output have one or two intersections, depending on the shape of the functions at the given level of technology (whether potential output is seen as exponential or as an S-shaped function).

https://doi.org/10.55343/CogSust.66

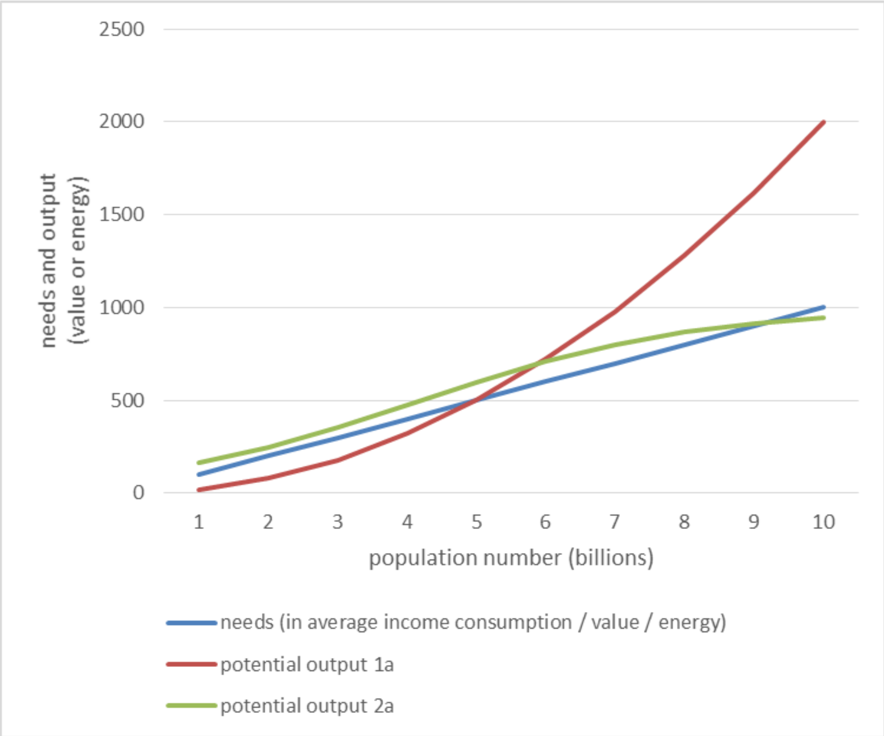

Figure 3: Intersection variations of the needs aggregate and the output function.
Generated by the author.

An S-shaped output function with two intersections implies three key phases on the given function:

- First, where the population number is relatively small, and output is below the needs, the population experiences scarcity.
- Second, where the population number is greater, and output crosses over to be more abundant, the problem of unemployment may arise.
- Third, beyond the inflection point and the second intersection of the S-shaped output with needs, output is scarce again. This, however, may be a more stable area of the coordinate system: despite the scarcities, the larger population number is a greater guarantee for non-extinction.

2.4. The intersections of needs and output at different levels of technology

The level of technology is traditionally not accurately measurable on a macro-scale, for some of its characteristics (unit of measure, maximum value) are undefined (*Hajnal, 2022, p. 10*). However, the interpretations thus far in the paper – of the output level and its intersection with the needs-aggregate – are interpreted in a temporal-technological context: at a given level of technology.

This paper operates with roughly constantly increasing technology levels in time. As technology progresses, the output draws closer to the Y axis (the "value or energy" axis), but aggregate human needs do not. These notions – the linear function of finite needs, and the exponential or S-shaped curves of potential output at increasing levels of technology – are illustrated below, in *Figure 4*.

https://doi.org/10.55343/CogSust.66

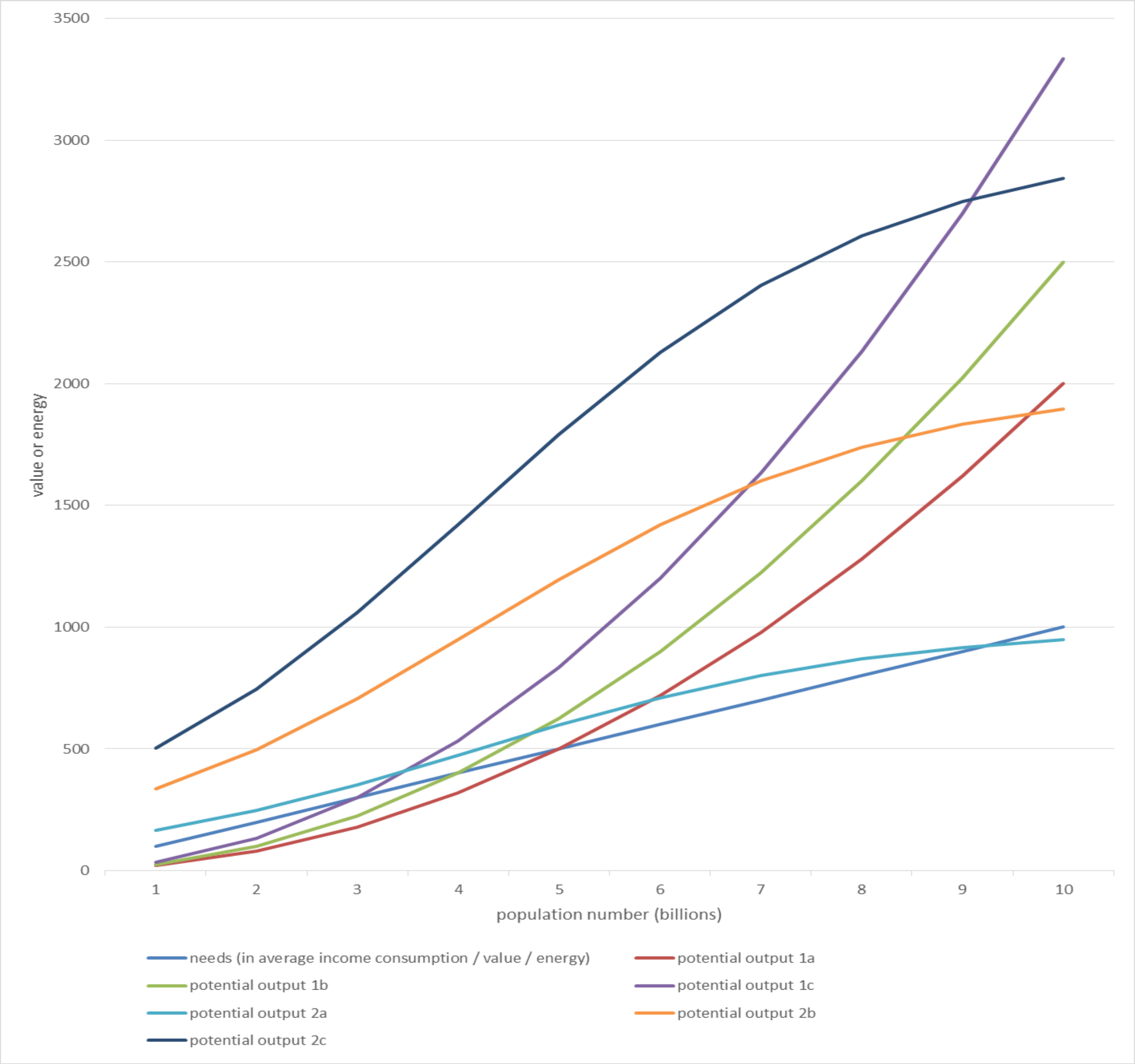

Figure 4: Intersections of the aggregate of needs and potential output, as a function of the population number. Different levels of technology are denoted by the letters a, b and c in the indices. Generated by the author.

2.5. The dynamic equilibria in the environmental context

This subchapter provides the theoretical synthesis of technology levels, needs-output intersections, and the environmental capacity.

The way environmental capacity comes into the picture is as follows. Moral economics views needs, thus, consumption, and thus the demand on environmental resources too, as finite. Would human needs and the level of technology be quantified, the debates of estimations around environmental capacity could be mitigated.

Changes in the level of technology affect the environmental capacity (the sustainable population number) mostly positively, but the capacity can fluctuate (as a function of the level of technology), due to damaging uses of technology, which may lead to the overexploitation of nature by humans *(Figure 5)*.

https://doi.org/10.55343/CogSust.66

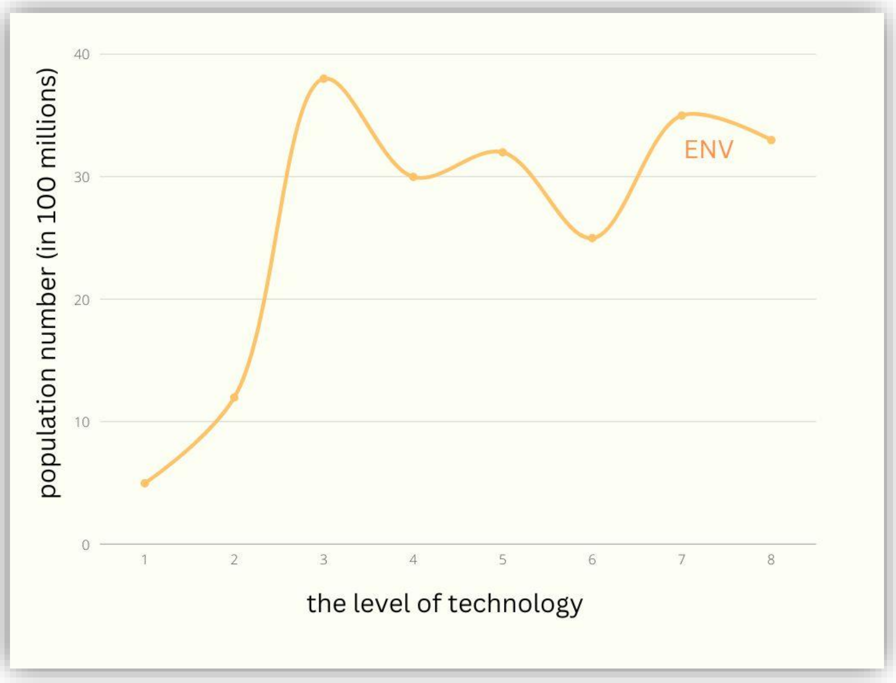

Figure 5: Environmental capacity to "carry" humans, as a function of the level of technology.
Created by the author.

The needs-output intersections, as equilibria, are one condition of economic balance. In the broader view, the intersection(s) of needs and potential output have to be at a population number on – or more preferably – below the environmental capacity boundary (curve).

The last illustration, *Figure 6*, displays population numbers as a function of the levels of technology. The four curves are:

- EXP.: the population numbers at the intersections of needs and potential output (exponential version) at the given level of technology;
- S_1: the population numbers at the first intersection of needs and potential output (if the latter is an S-shaped curve) at the given level of technology;
- S_2: the population numbers at the second intersection of needs and potential output (if the latter is an S-shaped curve) at the given level of technology;
- ENV.: the environmental capacity (in terms of the population number) at the given level of technology (as depicted in *Figure 5* as well).

https://doi.org/10.55343/CogSust.66

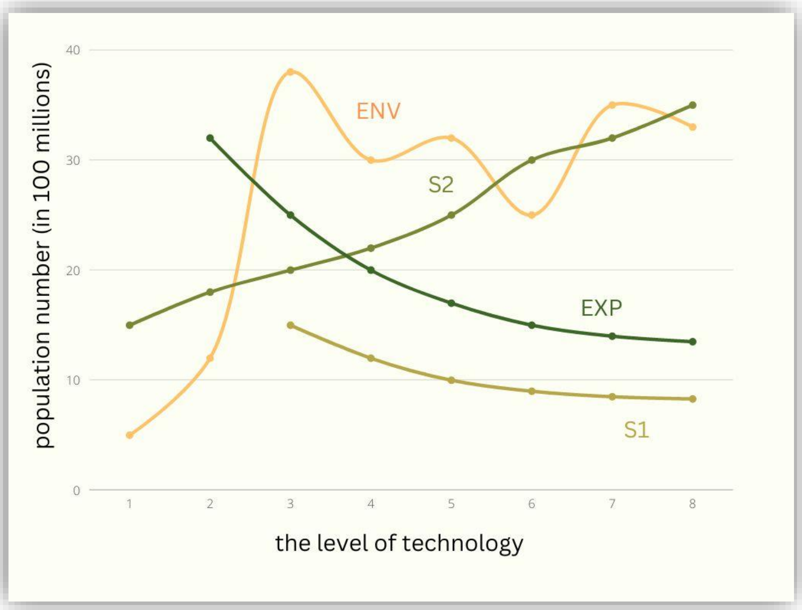

Figure 6: Population numbers at the intersections of needs and output as a function of the level of technolog, limited by the environmental capacity. Created by the author.

There are environmentally stable and unstable phases over technology level changes. When the population numbers given by needs-output intersections move below the environmental capacity, humankind can be said to be environmentally safe, on the aggregate. This varies with which needs-output intersection function we look at – the one resulting from exponential output curves, or those stemming from S-shaped ones. The curves denoted with EXP and S_1 represent economic equilibria mostly below the environmental limitations, yet these equilibria stem from decreasing population numbers, as a function of technology. They illustrate the fear of labour, or of human inputs becoming unnecessary. S_2 represents a sequence of economic equilibria, where the population number remains large enough for probable survival, despite balancing around environmental limits at subsequent levels of technology.

Environmental capacity has increased for much of human history, starting to change with the second industrial revolution. The “troughs” on the environmental capacity curve (ENV) illustrate the overexploitation of nature.

A stable state may be hoped for in the distant future, for technologies, when applied properly, make humankind more self-reliant, less exploitative, and increase environmental capacity. Once it becomes economically and politically profitable to completely transition to renewables, harnessing those resources ought to have the aforementioned, desired effects.

To contrast the techno-optimism in the paragraph above, one could argue that technology will not save us fast enough from a complete environmental disaster – but that is not what was stated. The level of technology changes at various speeds over time, so its axis does not represent time in an absolute manner. There were only relations and mechanisms sketched. Without proper environmental and economic policies, the real population number may rise so much above both the environmental limit and the needs-output equilibrium, that it causes an irreversible environmental disaster. This latter view reflects the economic pessimism in theory.

3. A potential paradox

There is an economic-evolutionary paradox, relatable to the system outlined above. Nature initially nurtured our species to compete (law of the jungle). Having overcome that phase through cooperation, we have surpassed other species in several aspects. The scale of division of labour, particularly in the industrial beginnings, was yet another level of effectiveness (between competitive communities, competitive nations). Meanwhile, the competitiveness of an economic system appeared to have become dependent on its internal levels of competition. In the end, we have become so effective at production and consumption, that now, we can compete with time itself, to stay within our environmental limits.

https://doi.org/10.55343/CogSust.66

4. A quantitative illustration

From the system outlined, there are factors that can be quantified, and there are some that cannot. The latter type (currently unquantifiable factors) includes primarily the level of technology, certain types of human needs (as part of the aggregate), but there is debate around the environmental capacity as well. As for the latter: “The range of estimates is enormous, fluctuating from 500 million people to more than one trillion. Scientists disagree not only on the final number, but more importantly about the best and most accurate way of determining that number—hence the huge variability” (*Australian Academy of Science, n. d.*).

In the discussion below, concrete measures for needs and output are discussed. Figures for the year 2021 will be used to illustrate findings.

For the record, population number in this year exceeded 7.84 billion (*The World Bank, 2022c*). Economic needs can be approximated with final consumption expenditure data (for energy, food, and other products and services). The monetary (value) expression is wider than that in energy, thus the monetary expression is applied. By definition: “Final consumption expenditure consists of expenditure incurred by resident institutional units (Households, NPISHs, sector of general government) on goods or services that are used for the direct satisfaction of individual needs or wants or the collective needs of members of the community” (*Insee, 2021*). Final consumption expenditure in 2021, globally, exceeded 62.03 trillion, in current USD (*The World Bank, 2022a*). The production, or output (or supply) side is also expressed through a monetary term: Global GDP in the same year was around 96.1 trillion, in current USD (*The World Bank, 2022b*). In terms of moral economic equilibria, this may be interpreted as a point of abundance in the population number – value coordinate system.

The drawbacks of this economic arrangement are detectable in the fact that the Earth Overshoot Day, i.e. “the date when humanity’s demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year” (*Earth Overshoot Day, 2022*) steadily draws closer to the beginning of the year, with the date falling on the 29th of July in 2021 (*Willige, 2022*).

These rough numbers for 2021 confirm what we already know: humankind (beyond partially overconsuming) overproduces, and that despite the global overall economic abundance, we are in an environmental “trough”.

5. Practical and future implications

Solutions to the economic-environmental imbalance do not have to be restricted to or to start with the macro-factors (such as the population number) of the model outlined earlier. Environmental-economic consciousness should start with an exact mapping and quantification of human needs, before moving on to operate with the population number. Technology levels would also need to be quantified at the macro level. The model is a starting point for moral economic – environmental orientation.

Once there is a possibility for approximate (or even exact) quantifications, the moral economic approach to needs and output may theoretically enable the mathematical description of more of the various economic systems’ benefits, implying distinct levels of technology and abundance where, in terms of progress, it may be beneficial to shift from one system to another, with special regard to market vs. state powers.

Last, but not least, it should be stated that physical (environmental, or planetary) boundaries may contribute to the short/mid-term arguments for holding economic growth at bay. (See, for instance*: Rockström et al., 2009.; Steffen et al., 2015; O’Neill et al., 2018*) On the longer term, however, finite needs may be used in a more suitable and convincing reasoning. The rightfulness of this statement still depends on whether it is environmental or ecosystem services (as in: *Costanza et al., 2014*), or human needs that will be better quantifiable, better convertible into economic units and forces.

6. Conclusion

The article has dealt with the environmental-economic imbalances on a macro-scale, in simplified terms, which nevertheless resulted in complex models, with dynamic equilibria. Starting from the moral economic premises of finite needs and effective cooperation, the following factors have been identified as determinants of moral economic equilibria: human needs, potential output, the population number, the level of technology, and environmental capacity.

https://doi.org/10.55343/CogSust.66

The condition for sustainability was for the *human needs aggregate – potential output* intersections (as interpreted in the *population number – value/energy* coordinate system) to remain below the environmental boundaries in terms of the population number, in the *level of technology – population number* coordinate system.

The article has refrained from being "to the ground" in terms of principles and guidelines for moral economic sustainability, as the system of models sketched allows for space, in this context. However, the quantification requirement of needs and technology levels has been emphasized, and the models' potential to suggest systemic shifts in economic policy has been foreshadowed.

Despite not giving a direct solution to the conversion problem in the economic-environmental nexus, the paper suggested operating with human needs as a "workaround", which – in the opinion of the author – have a greater likelihood to be mapped and expressed economically in the future.

References

Australian Academy of Science. (n. d.). *How many people can Earth actually support?* URL: https://www.science.org.au/curious/earth-environment/how-many-people-can-earth-actually-support accessed: September 21, 2022

Bartus, G. (2008). Van-e a gazdasági tevékenységeknek termodinamikai korlátja? [Is there a thermodynamic constraint on economic activity?]. *Közgazdasági Szemle.* 55, 1010–1022. URL: http://epa.oszk.hu/00000/00017/00153/pdf/05.pdf accessed: September 14, 2022

Costanza, R., de Groot, R., Sutton, Pl. van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change*. 26(26), 152–158. DOI: https://doi.org/f577jk accessed: September 15, 2022

Earth Overshoot Day (2022). *About Earth Overshoot Day*. URL: https://www.overshootday.org/about-earth-overshoot-day/ accessed: September 15, 2022

Hajnal, Z. (2021). *Moral Economics – A Theoretical Basis for Building the Next Economic System.* In: Róna, P., Zsolnai, L., Wincewicz-Price, A. (eds) *Words, Objects and Events in Economics.* Virtues and Economics, vol 6. Springer, Cham. DOI: https://doi.org/jk54

Hajnal, Z. (2022). Measuring the Level of Technology in Moral Economics. *Athens Journal of Technology & Engineering* 9(4), 321–338. DOI: https://doi.org/kjxj

Insee – Institut national de la statistique et de études économiques. (2021). *Final consumption expenditure – definition.* URL: https://www.insee.fr/en/metadonnees/definition/c2216# accessed: September 22, 2022

Mazzucato, M. (2022). Collective value creation: a new approach to stakeholder value. *International Review of Applied Economics.* DOI: https://doi.org/kjxh accessed: July 15, 2023

O'Neill, D.W., Fanning, A.L., Lamb, W.F., Steinberger, J. K. (2018) A good life for all within planetary boundaries. *Nature Sustainability 1*, 88–95. DOI: https://doi.org/cj8t accessed: July 15, 2023

Polasky, S., et al. (2019). Role of economics in analyzing the environment and sustainable development. *PNAS*. 116(12), 5233–5238. DOI: https://doi.org/gfz7fc accessed: September 21, 2022

Rockström, J., et al. (2009). Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*. 14(2), 32. URL: https://www.ecologyandsociety.org/vol14/iss2/art32/ accessed: September 15, 2022

Steffen, W.; Richardson, K.; Rockström, J.; Cornell, S. E.; Fetzer, I.; Bennett, E. M. . . . Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223). DOI: https://doi.org/f3m6n9 accessed: July 15, 2023

The World Bank. (2022a). *Final consumption expenditure (current US$).* URL: https://data.worldbank.org/indicator/NE.CON.TOTL.CD accessed: September 15, 2022

The World Bank. (2022b). *GDP (current US$).* URL: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD accessed: September 15, 2022

The World Bank. (2022c). *Population, total.* URL: https://data.worldbank.org/indicator/SP.POP.TOTL accessed: September 22, 2022

https://doi.org/10.55343/CogSust.66

Willige, A. (2022). Earth Overshoot Day. What is it and why do we need it? *The World Economic Forum*. https://www.weforum.org/agenda/2022/06/earth-overshoot-day-human-consumption-biocapacity-ecological-footprint/ accessed: September 15, 2022