Athens Journal of Technology and Engineering - Volume 9, Issue 4, December 2022 – Pages 321-338

Measuring the Level of Technology in Moral Economics

By Zsófia Hajnal [*]

This theory-based paper attempts classifying and combining methods of orthodox and heterodox economics regarding the measurement of technology levels. The importance of measuring the level of technology is illustrated by technology being a key factor in several neoclassical models. However, just as for the concept of utility, traditional economics treats the level of technology as an abstract scientific construct, without attempts for an absolute quantification. This paper argues that through a systematic classification and various methods, starting- and end points, milestones and even units can be determined. Through surveying the literature, the paper identifies the existing options of measurement, and their shortcomings. Technology is looked at as a "stock", as opposed to the overrepresented "flow" nature. This gives space for the methods of constructing an absolute scale, and for the unique concept of the "steady-state technology". Distinctions are made between demand-side and supply-side measurement, as well as between historical and geometrical methods of constructing scales. The methods are illustrated, though not fully implemented, due to limitations in scale and scope. Finally, the paper shows how heterodox economic branches, such as the newly emerging moral economic school, allow for the demand-side measurement to a greater extent, given the adjusted economic axioms.

Keywords: *technology, demand side, historical method, geometrical method, moral economics*

Introduction

By definition, technology is "the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment" (Encyclopedia Britannica 2021). In a professional context though, "a safe definition of what technology is troubles scientists of all fields" (Perilla Jimenez 2019, p. 826). In economics, beyond the understanding of technology being a "social construct" (Perilla Jimenez 2019, p. 826), technology is generally seen as a part of an efficiency coefficient which usually includes engineering or design elements. Economic literature is more specific on technology when it comes to levels and frontiers. The distinction between invention and innovation, and their circumstances, sophisticates the techno-economic picture: "Invention can be connected to almost anyone; however, in the case of innovation, at all events there is a need for a company or for some kind of organization" (Hámori and Szabó 2016, p. 52, footnote 1).

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https://doi.org/10.30958/ajte.9-4-4 doi=10.30958/ajte.9-4-4

By the level of technology, some scholars understand the extent to which technology is utilized by a population (Veiseh 2010, p. 211). An overall consensus – even on the economic technology concept itself –, is yet to be reached among economists from different backgrounds (such as mainstream and evolutionary) (Perilla Jimenez 2019, p. 825).

To approach the *level* of technology concept, it may be advisable to provide a definition for the concept of technological change as well: "an increase in the outputs possible with a given level of inputs through the processes of invention, innovation, and diffusion" (Seo 2017). This latter definition appears to be a step closer to economic application than the initial definitions given, yet, it is the static *level of technology* notion that needs to be conceptualised to a greater extent.

The level of technology influences the whole of the economy, from the smallest steps of production, up to the validity of ruling economic ideologies, and to the "tectonic" shifts of economic systems. Thus, the significance of the level of technology in the field of economics should not be underestimated, yet from its meagre representation as a factor, one could draw the conclusion that it is.

The Aim of this Study

Despite its significance, the level of technology in economics is underexplained. It is only minimally included in curriculae of basic economics subjects, in the form of – at best – two or three relatively marginal topics.

The level of technology as an economic factor (or at least: dimension) is not just underexplained – it is underexplored too: Not a single JSTOR item in the field of economics has the expression "level of technology" in their title, and only two on the website of ScienceDirect do, but both of those are industry-specific, not theoretical.[1] Easing the searches by removing quotation marks results in a handful of further, exclusively empirical works.

To bring the level of technology into the economic discourse more intensively is now timely, also for the reason of societies currently being at multiple technological brinks. Several of the technologies having been labelled as "frontier" ones (UNCTAD 2021, p. 17), such as artificial intelligence, blockchain and gene editing, carry – upon more active, and potentially combined implementations – further and greater potentials of revolutionising everyday life, as well as international power-balances.

In economic analyses, the level of technology should be an aspect to be controlled for. In other words, when comparing various (regional, country-level, etc.) economies throughout time and space, it should be possible to determine how much the (desirably – quantified) level of technology affects the other macroeconomic indicators.

Thus, the aim of this research is to open the door to alternative, potentially more allowing and promising ways of measuring the level of technology.

The research questions are the following:

[1]Searches conducted on January 8, 2022; at: https://www.jstor.org/;https://www.sciencedirect.com/.

RQ1: How can the level of technology be measured in an economic context, objectively?
RQ2: Why is moral economics a suitable branch to provide the framework for economic technology level measurement?

Limitations

One limitation of the paper that should be noted is the exclusion of details regarding the concrete nature or patterns of technology changes. When examining technological advancement, the emphasis is on the global pace of invention and innovation, and not technological diffusion throughout various geographies. (Although technological "followers" follow other patterns of the technological development process than "leaders" do, this paper will remain in the generalised, theoretical realm, and should thus be unaffected by the lack of the distinction.) Further, this paper does not distinguish between the various innovation types (product, process, organisational, etc.). The discourse is kept general from this perspective as well, and the focus is on examining the shifts between the technology levels from an economic perspective. Neither does the paper look into the causes, the underlying factors that contribute to innovation. Classification and nomenclature of historical technology levels – such as the ones that can be related to Kondratiew-waves (long-term business-cycles), or expressions such as "industrial capitalism" and "information capitalism" (Hámori and Szabó 2016, pp. 69–70) – also remain absent. All restrictions serve to keep a focus on the *level of technology* as an operational, quantifiable concept.

Hypotheses

The primary hypothesis is that the level of technology can be measured objectively through historical and geometrical methods.

Second, that the framework, a novel approach, is provided by the moral economic branch, due to the availability of adjusted axiom of finite and satiable needs therein.

Structure

Although economic technology level measurement – theoretically, explicitly – has little substantial body of literature to date, the paper will provide an overview of the types and attempts. To present and emphasize the relevance of seeing the level of technology through the economist's lens, the paper will explore the rather restricted micro- and macroeconomic applications, then move on to contemporary aspects and challenges, i.e., the shortcomings of contemporary technology level measurements in the field of economics, and finally, synthesise insights in the context of moral economics.

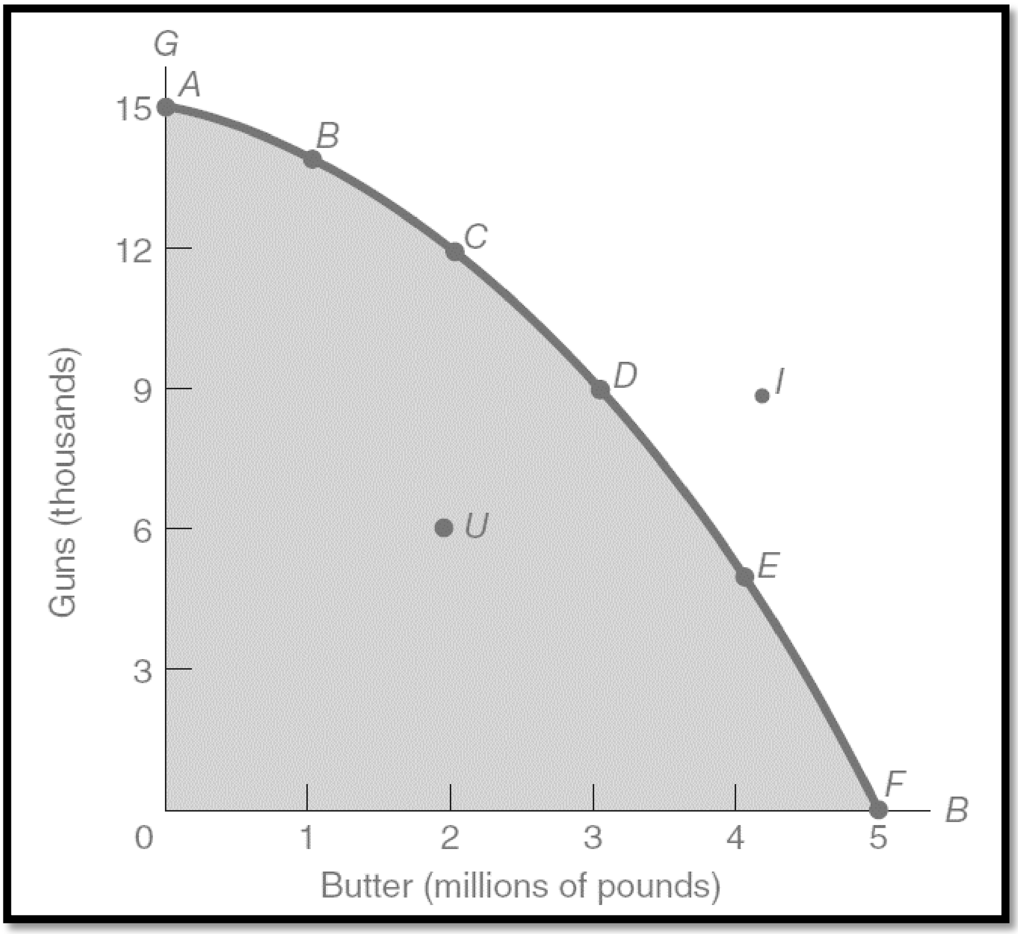
Measuring the Level of Technology in Micro- and Macroeconomics

In the classical education of microeconomics, it is only at two main points (throughout the entire semester) that the level of technology gets a role or mention.

The Production Possibility Frontier and the Production Function

One such point is at the topic of the production possibility frontier (PPF), depicted in Figure 1. In this economic model, which showcases the most effective production options when one has to distribute their resources between two products, the emphasis is on the resources and their allocation. However, the level of technology is implicitly included.

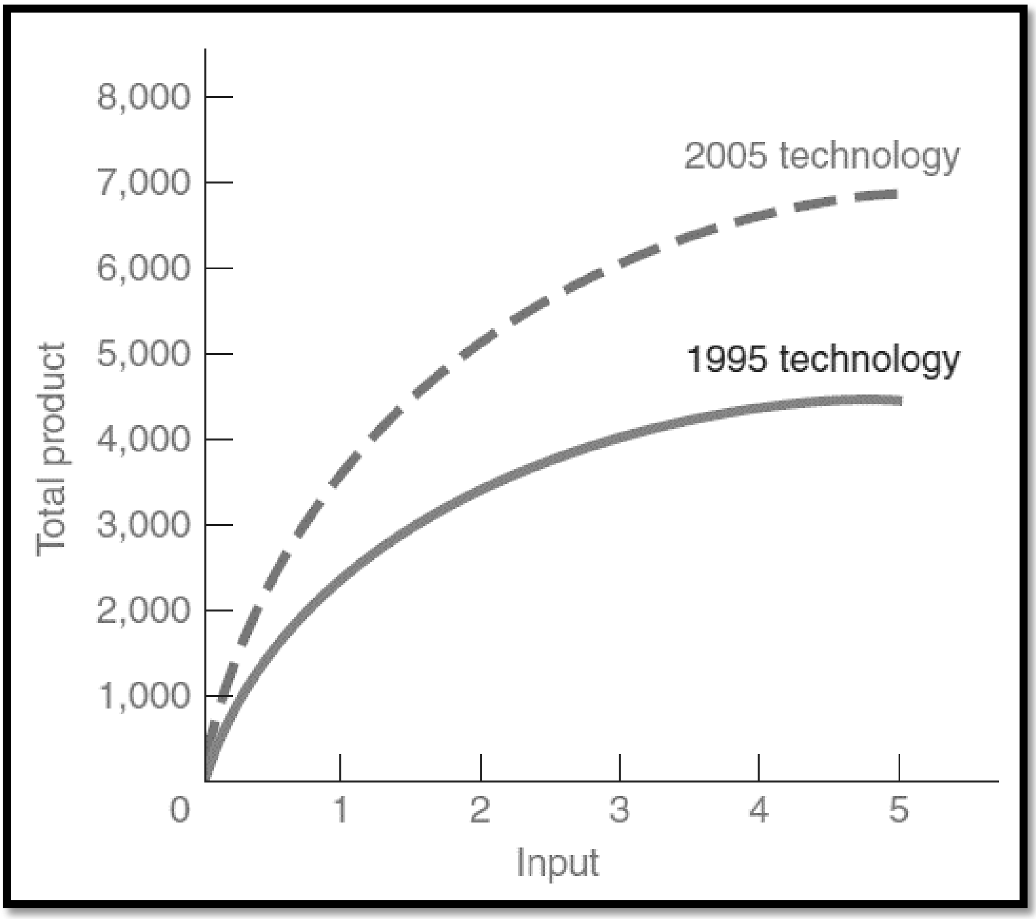
Figure 1. *The Production Possibility Frontier*



Source: Samuelson-Nordhaus (2010, p. 11).

The other microeconomic topic containing the level of technology, that has made its way into the classical study materials, is the production function (see Figure 2), specifying the maximum output that can be produced with a given quantity of inputs.

Figure 2. *The Production Function*



Source: Samuelson-Nordhaus (2010, p. 114).

This function then, is described with the Cobb-Douglas formula:

$$Y = A * L^{\alpha} * K^{\beta}$$

The letter Y stands for the total output, L and K for labour and capital inputs respectively, with the greek letters for the output elasticities, and – most importantly from this paper's perspective – A for the total-factor productivity (TFP), with the main, but not exclusive component of technology growth.

Endogenous Growth Theory

The next point in their studies, where an economic scholar-to-be learns about the level of technology, is upon hearing about the endogenous growth theory, which holds that "economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside" (Romer 1994, p. 3). The endogenous growth theory belongs to the macroeconomic realm (Romer 1994, p. 10), and is distinguished from the neoclassical model of growth (Romer 1994, p. 3).

In contrast to the latter, which assumes "that technological change is exogenous and that the same technological opportunities are available in all countries of the world" (Romer 1994, p. 4), endogenous growth draws relationships between technology and input variables: A (K, L) (Romer 1994, p. 7).

This yields the following formula of a production function (Romer 1994, p. 7):

$$Y_j = A\ (K, L)\ K_j^{1-\alpha}\ L_j^{\alpha}$$

As Romer puts it bluntly: "Technological advance comes from things that people do" (Romer 1994, p. 12). His article, which the author of this essay has been citing so far, includes statements, on technology leaders and followers, knowledge diffusion, and the technology gap,[2] (Romer 1994, p. 9) as well as a direct mention in that context of the term "the level of technology"[3] (Romer 1994, pp. 4, 9).

Since the publishing of Romer's article, two generations of endogenous growth models have evolved. "First generation models (FGMs) are associated with the idea that technology leads to "persistent" and "increasing" rates of growth in the long-run. These models have been abandoned […] and replaced by second generation models (SGMs), a number of technically more appealing models that seek to explain what determines the observed empirical regularities of diminishing returns to technology investments." And even the SGMs have split since (Perilla Jimenez 2019, p. 830).

The reader can observe advances on the thinking of how and where technology changes, and on how to incorporate it as a factor in economics, but nothing substatially new arose on the measurement of its level, at this point.

As Perilla Jimenez notes: " […] even within mainstream economics—the nature of technology progress, its impact on economic growth and the role of public policy in this regard are not yet safely established" (Perilla Jimenez 2019, p. 831). It should be stated that the current paper does not focus on relating technology levels to economic growth and policy aspects, only on the measurement itself.

The Level of Technology – Contemporary Aspects

In this chapter, the paper will look at contemporary aspects and challenges, i.e., the shortcomings of contemporary technology level measurements in the field of economics, by investigating technology level roles in trade models, in trade statistics and in general trade dynamics. Empirical methods will be looked into as

[2] "Because the flow of knowledge from the technology leader makes the technology grow faster in the follower country, income per capita will grow faster in the follower as diffusion closes what has been called a technology gap."

[3] "The assumption that the level of technology can be different in different regions is particularly attractive in the context of an analysis of the state data, because it removes the prediction of the closed-economy, identical-technology neoclassical model that the marginal productivity of capital can be many times larger in poorer regions than in rich regions."

well, along with the possibilities of technology frontiers, in the context of innovation theory.

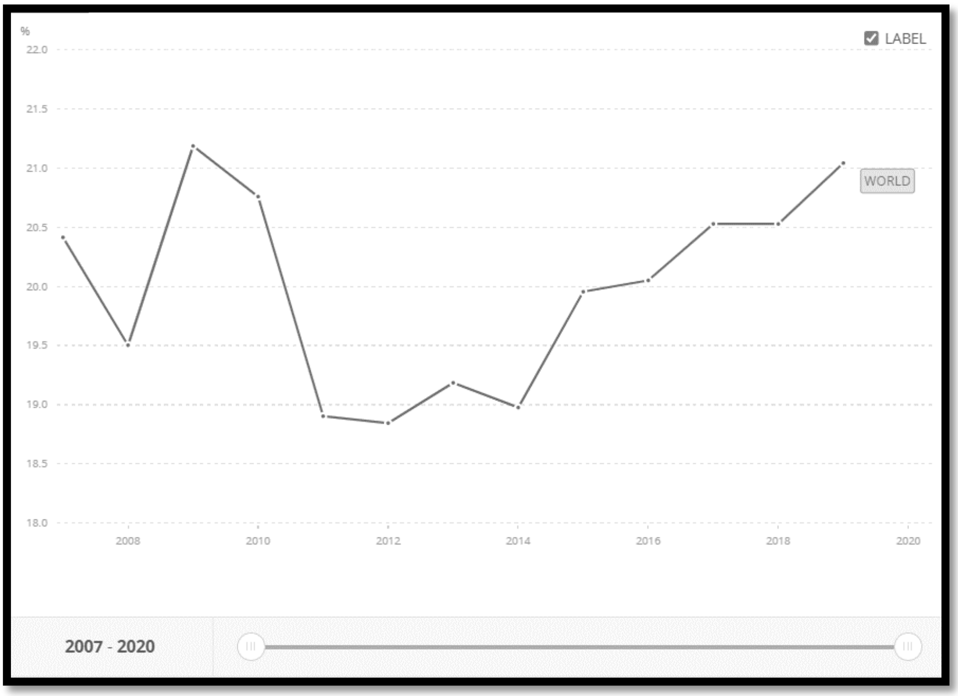
In International Trade

The level of technology impacts the majority of trade models, but is relatively rarely mentioned explicitly. The articles that relate trade theory and technology levels directly are few and far between. The level of technology either only emerges in country case studies on trade (which typically provide an arbitrary scale for technology), or – less frequently – as an explanatory factor.

An example for this latter trend is Daniel Trefler's 1995 article *The Case of the Missing Trade and Other Mysteries*. Therein, Trefler finds the explanation for a generally poorly performing model (the Heckscher-Ohlin-Vanek theorem) in part in technology level differences between countries. Technology is quantified to some extent, but only in relative terms, for the purposes of the article.

Although there are plenty of statistics on scientific performance regarding trademarks, and in the form of R&D expenditure data for instance, specific technologies individually do not appear in the main sections of the major statistics offices, thus it is difficult to aggregate. The overall level of technology is not being measured and displayed either. Trade statistics in connection with technologies, or the level of technology are similarly hard to find. One data collection both the World Bank (see Figure 3) and Eurostat look at though, is high-technology exports.

Figure 3. *High-technology Exports (% of Manufactured Exports)*



Source: The World Bank (2021).

The problem with such statistics is that the definition of "high-technology" is rather vague: "High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery" (The World Bank 2022). It is not guaranteed that technology level movements in time are reflected too, overall, in such data.

Technology levels related concepts described in articles on trade dynamics include phenomena partially touched upon in the subchapter on endogenous growth: technology leaders and followers, knowledge diffusion, and the technology gap. The actors and processes behind these concepts may yet be different from what the reader might expect. In the article *Human Capital and Technological Catch-Up of Developing Countries: In Search of a Technology Leader*, which used the so-called Nelson-Phelps model to revisit technological diffusion and catch-up, it is stated how a group of countries (the OECD and regional leaders, in this case) serve better as technology leaders for developing countries, than having that role designated to one single, (geographically relatively distant) state, namely the US (AtiqurRahman and Zaman 2016, p. 168). The "extent of […] technology in the export structure" (McAuthur and Sachs 2002, p. 43) is another term linking technology levels with trade dynamics.

Indicators

Moving slightly closer to concepts and indicators of direct use when aiming for measuring the level of technolgy, it is worth looking at the state of science, technology and innovation (STI) indicators, measured by various international organisations. These indicators show GDP proportionate expenditures on research and development (R&D), by country and region. The OECD's STI Scoreboard provides such an opportunity, (OECD 2022a) along with an outlook document (OECD 2022b) and a site (OECD 2022c) for related policies. The United Nations Conference on Trade and Development (UNCTAD) has a detailed methodology for STI measurement, for the firm level, in the public sector, and at the system level too (UNCTAD 2010, p. 3).

These indicators may provide more spectacular information, especially in terms of comparisons, than the World Bank data did, in the context of the present paper. Yet, for economic theory in general, there is still a lack of absoluteness regarding the level of technology.

Frontiers

Another step closer to measuring technology levels is identifying its main frontiers. Prior to mentioning concrete frontiers[4], however, it should be noted that human needs (e.g., employee needs) have started to emerge in competitiveness and technology reports, (World Economic Forum 2020, p. 6), such as the World Economic Forum's *2020 Global Competitiveness Report*, which identifies technology as a response tool (World Economic Forum 2020, pp. 47, 55). The role of human

[4]As for frontiers, the frontier of technology should in no case be confused with the production possibility frontier.

needs in measuring the level of technology will be reemphasised and explained in the next main chapter of this paper.

Frontier technologies as classified by the UNCTAD *Technology and Innovation Report 2021* are as follows: Artificial Intelligence (AI), Internet of Things (IoT), Big data, Blockchain, 5G, 3D printing, Robotics, Drone, Gene editing, Nanotechnology, Solar photovoltaic (UNCTAD 2021, p. xvi).

Particularly interesting from the economic perspective will be to observe how one of the above frontiers, namely AI, will become more interwoven with economics. Questions may arise, such as: Do individuals know best what they actually need? How long would mainstream models of the economy be applicable? Would the applicability change with individuals relying more and more on, and accepting AI algorithms and smart devices telling them what they need?

The disruptive frontier technologies may not just influence or change the economy, they may alter and assist sciences as well. For instance, AI may assist economics in shifting further away from the homogeneous homo oeconomicus model, through patterns and categories of agent diversification.

The importance of human needs has already been indicated. At this point, AI as a frontier, needs, and knowledge can be connected, as for many of the individual problems, solutions exist in the initial form of knowledge. Knowledge is spreading and sticking fastest and strongest along needs. And likely candidates for recognising individual needs on a larger scale are artificial intelligence programmes.

Jumping slightly ahead, through moral economics, AI can be put into the bigger economic picture as well, through its own potential morality. However, most of those familiar with the concept of supermoral singularity seem to be afraid of it. Presumptions generally omit the possibility of humans possessing undiscovered virtues. The chance for societies having intrinsic, genious-by-design mechanisms is also left unregarded.

The Gap of Concrete Measurement

As it was presented in the sections above, there are several approaches to, and uses of the level of technology, but there is a lack of punctuality, theoretical usefulness and absoluteness. Similar as for utility, for the level of technology too, economists would need a scientific measure, a more concrete construct.

The gap appears in works as significant as Thomas Piketty's *Capital in the Twenty-First Century*: "[…] β was fixed by the available technology […] so that the growth rate was entirely determined by the savings rate" (Piketty 2014, p. 230). The concept of available technology (the given level of technology), however, is not being further elaborated on, or quantified for the fix mentioned.

Despite being unanswered, the question or gap of measurement is not novel. In a 1969 article on technological change, William Nordhaus identified the "absence of an adequate theory" that would explain the part of growth of output, which the growth of input in time could not. Nordhaus was seeking answers through his microtheory of the generation and transmission of new knowledge, (Nordhaus 1969, p. 18) but the ultimate goal of measuring the technology levels has not been stated. Nordhaus was focusing on the causes of change, but not the levels themselves: "Although technology has long been recognized as an important part of the economic scene, invention has not been fully integrated into economic analysis. (Invention will be used as a general term for activities which expand the level of technical knowledge)" (Nordhaus 1969, p. 18). This paper suggests a different approach.

It appears that the traditional branch of economics alone is less able (or its representatives are less willing) to provide a scale for unified technology measurement. Thus far, the factor *along* which the level of technology is to be measured, has not been fixed – which is where moral economics and human needs come into the picture.

Measuring the Level of Technology in Moral Economics

Thus far, the reader could familiarise themselves with a geographically and temporally rich and beneficial base of technology level applications. The research will now narrow the focus, and zoom in on the theoretical and technical details.

As a matter of fact, there have been no successful attempts for an absolute quantification of technology levels. Thus, economics in regard of technology is lacking: methods of measurement; designated starting- and end points; milestones; and a unit of measure.

Moral economics – the branch that aims at incorporating the ethical factor into economic models – may have an advantage here, for two reasons: (1) It does not abstain from normativity. (2) It gives space for human needs to play a central role.

These statements will be elaborated in the subchapters to follow, thus let it now suffice to briefly connect the two statements by saying: If satisfying needs is a natural instinct or aspiration, then human progress should not be judged unnatural overall.

Compatible Axioms

The scarcity premise of the classical/neoclassical school points to a model with people's needs being infinite and insatiable. In moral economics, however, human needs are ultimately finite and satiable (which is one of its adjusted axioms) (Hajnal 2020, p. 66). Humans are the main drivers, carriers and beneficiaries of technology, and they also hold the key to measuring its level, through their needs. "Marrying" needs as a factor, and the level of technology, is carrying the potential of redefining technology, taylored to the human needs concept.

In a recent doctoral dissertation, looking into innovation theory, it has been suggested that the next Kondratiew-waves will have – in contrast to the earlier themes of machines – the human person in their focus, potentially expanding this new viewpoint onto the entire planet. After the – also: pandemic-induced – motto "heal the human", the next, "heal the planet" will gain centre stage (Stukovszky

2022, p. 25). This is a modern view, which resonates well with alternative branches of economics, such as Buddhist economics, and moral economics as well.

As for the normativity theme, in the current context one may ask if the level of technology should draw any normative (value) judgement upon itself? From the general starting point of the whole economic system, in practice, it could not be avoided. Changing levels of technological progress historically tailor positive and negative implications, on the different stages. The subject of technological dualities has been touched upon, for instance, in Martin Heidegger's widely known book, *The Question Concerning Technology* (Heidegger 1954, pp. 83, 105). Moreover, certain technologies are seen as inherently violent, "brute force" technologies (Josephson 2002), in contrast to inherently non-violent ones.

The latter statements, however, do not suggest that technology (and its increasing levels) would be a comprehensive cure for societal issues in itself. "Progress toward economic and technological rationality need not imply progress toward democratic and meritocratic rationality. […] technology, like the market, has neither limits nor morality. The evolution of technology has certainly increased the need for human skills and competence. But it has also increased the need for buildings, homes, offices, equipment of all kinds, patents, and so on, so that in the end the total value of all these forms of nonhuman capital (real estate, business capital, industrial capital, financial capital) has increased almost as rapidly as total income from labor. If one truly wishes to found a more just and rational social order based on common utility, it is not enough to count on the caprices of technology" (Piketty 2014, p. 234). Technology in itself is necessary, but – despite the gain on normativity one achieves by modifying technology levels' definitions – not sufficient.

"Stock" vs "Flow" Nature, Supply- vs Demand-Side Measurement

Overall and in general, there are essentially two ways to look at technology in the context of human progress. One can view the process of technological advancement more as a path (a "flow") that humankind is on. The other way to look at it is in terms of accumulation.

The "flow" perspective is overrepresented as the general modern viewpoint, yet there are economists, who touched upon, or even delved into the accumulative nature of technological progress, such as the late Hungarian economist and engineer Ferenc Jánossy, with his trendline theory (Bekker 1995).

The overrepresented "flow" nature results in the dominance of relative measuring, as opposed to absolute scales and numbers, for which the "stock" nature provides enough space and methods. Instead of measuring just technological change (as in a flow), moral economics too has the ambition to attempt measuring the level of technology as an absolute value, in the process of progress.

Measuring the level of technology can also be classified in supply- and demand-side approaches. As per Perilla Jimenez: "there is a striking amount of dimensions in which the innovation issue can be analyzed, including both supply and demand sides of the economy" (Perilla Jimenez 2019, p. 829). What is meant in this paper by supply-side measurement is a focus on productivity and effectiveness through engineering parameters dominating the scales, which is well illustrated, for instance, by Moore's law, and microprocessor performance chronology (Aizcorbe and Kortum 2005). This "technolgy-for-the-sake-of-technology" type of attitude is the more widespread approach of the two, and results from the economic practice of relating "technology to "something' that increases productive efficiency, offsetting the tendency of other factors (capital, labor) to yield decreasing returns" (Perilla Jimenez 2019, p. 826).

On the other hand, there is demand-side measurement, envisioned within the field of moral economics. It refers to the level of technology being defined by its function and capability of satisfying human needs[5] and fostering human progress. Measuring the level of technology in moral economics (from the demand side) may be judged as more utilitarian than the traditional measurment method.

If the level of technology were to be defined by the demand side, it could not avoid a historical element. It can be put as follows: The extent to which the scientific knowledge of the time can optimally be applied to satisfy human needs.[6]

The intriguing point is that moral economics uses a finite and satiable axiom of human needs, thus it would allow for a steady-state-technology, or an end-of-technology, if human needs were to be satisfied fully and sustainably. (More on this in the subsequent subchapters.)

Moreover, a demand-driven definition of technology levels would alter the definition of technology itself, not necessarily by changing the wording, but by having transformed it into a normative concept, with expressedly human end goals. One should note, however, that taking, for instance, Heidegger's lines – about how the technical concerns the revealing of truth (Heidegger 1954, pp. 106, 108) – into account, the distancing of the meaning of technology from the technical in itself is not completely new in social science. It aligns with the "embodiment notion" in its process, yet contrasts with it in technology not being something "that is primarily embodied in artifacts" (Perilla Jimenez 2019, p. 826).

Historical and Geometrical Methods of Constructing Scales, and the Steady-State-Technology

As a last dimension of technology level measurement classification, historical and geometrical methods will be presented here.

As for the historical method, the expectation with this approach is that discovery and innovation milestones be determined, from both the human need related, and the technical perspective. In the literature on innovation theory and technology cycles[7] there is generally not a word mentioned on ultimate technology directions or goals, for the ambitiousness of the endeavour to determine them.

According to the moral economic approach, technology may have a minimum or start, and a maximum or end. The start is difficult to define, the end is difficult

[5]Perilla Jimenez refers to technology as being "forged through the organization, functioning, and needs of the society at large" (Perilla Jimenez 2019, p. 826, footnote 8).

[6]A more inclusive and holistic definition (relatable to Buddhist economics) would refer to the needs of all living beings.

[7]See, for instance: Szanyi (2021).

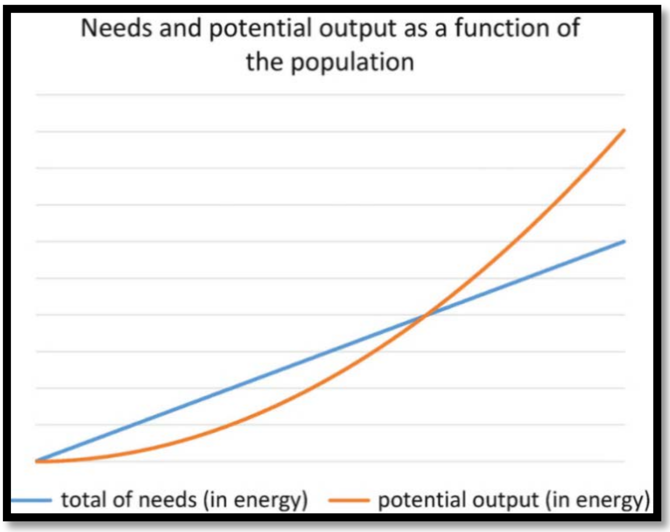
even to imagine, so the paper will stay hypothetical on this topic. The start is proposed to be determined by the first human invention, or the first human imitation of nature. Without details on the significance of individual inventions – which is out of scope and capacity for this paper – the method jumps to determining an end-point.

The end could be the so-called steady-state technology. (If the level of technology reaches its "top", it does not mean that the economy too has to be steady-state, that is, the lack of further developments would not hinder economic expansion, i.e., growth.) This steady-state end-of-technology would be characterized by an absolute well-being (fully and sustainably satisfied human needs, and ideally of all living beings). If it were not just needs under consideration as conditions, maximal effectiveness and sustainability of processes, and the completion of the body of knowledge could be added – all unprecedented, yet theoretically existing objectives.

After designating the two ends of the technological scale, the unit of measure and the current position are to be determined. This is the point where the geometrical method completes the picture. The geometrical measurement of the level of technology generally means functions "drawing closer" to the vertical axis in their respective economic models: in neoclassical, as well as in moral economic ones.

In the neoclassical sense, this is what was illustrated with the microeconomic production function. As for moral economics, the author takes a model (illustrated in Figure 4), where the hypothetical aggregate of human needs and potential output are depicted (measured on the vertical axis) as a function of the population number (horizontal axis):

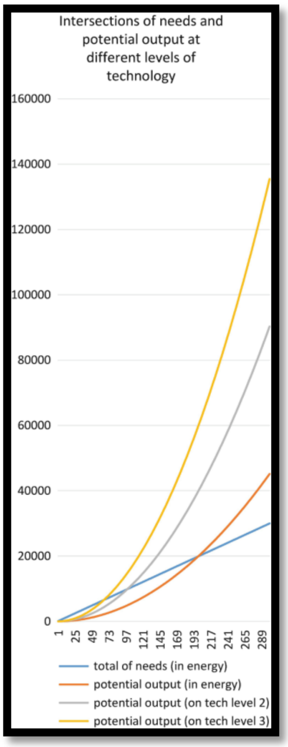
Figure 4. *Human Needs and Potential Output*



Source: Hajnal (2020, p. 78).

With time, technological progress draws the upward bending "potential output" function closer to the Y axis, as depicted in Figure 5. The closer it is, the more technologically advanced a society, as there are fewer people needed to produce the same amount of output. The aggregate needs function, however, remains static:

Figure 5. *Different Levels of Technology*



Source: Hajnal (2020, p. 85).

Over a certain level, technological advance is self-perpetuating. “Each new technological innovation triggers yet further innovation, in a kind of chain reaction that fuels long-term economic growth” (McArthur and Sachs 2002, p. 29). According to this observation and logic, the positive changes in “potential output”, as on the graphs above, can be expected to occur at an ever increasing pace. The acceleration is justified not just by chains, linear processes as outlined above, but also by network effects. New forms and actors of technology and – more specifically – “innovation do not emerge independently […]; rather, they are interconnected with each other” (Hámori and Szabó 2016, p. 52).

The steady-state of technology would be the output function becoming fully vertical, that is, people not needing to work anymore themselves, whilst remaining capable of satisfying their needs. In the geometrical approach to technology level measurement, it is rather the minimum level of technology that is difficult to determine. Where is the function the “flattest”? How did it start “bending up”? It must have been nature to give us the starting push, but how exactly? These questions would push the paper into the realm of evolution and cognitive science, which currently – again – is out of scope. Independently of these questions, once the factors are quantified, the level of technology can be measured along the tangential lines (to the output functions).

The moral economic view of technology levels has an allegory, in the "mountain of progress" (Hajnal 2015, p. 34). The levels of technology can be imagined as different stages on this mountain. Each stage is a step in human life getting better in general, moreover, the individual levels of well-being are determined by this overall level too. There are steps of different sizes, depending on the significance of progress made in satisfying a given human need with a given new technology. Through counting the (weighted) steps from the "start", and estimating them to the "top", it is possible to determine the current level on the path, up that mountain, which is the allegoric version of combining the presented historical and geometrical methods. This version is a broad interpretation though.

Finally, it should be emphasized that in practice, technology is just one pillar of human progress. As another pillar, the quality of public institutions (McAuthur and Sachs 2002, p. 45) could be named.

Conclusion and Outlook

Throughout this paper, various approaches, applications and methods of measuring the level of technology have been looked into. It started with the micro- and macro-economic models, which, even if carefully selected, according to relevance, barely touch upon the subject of technology levels. In trade models, statistics and dynamics, the level of technology gains on importance, yet is rarely expressed explicitly. Through indicators and frontiers, one is equipped with more tools, still far from a concrete and unified theory or method though.

Moral economics has been brought into the picture, because through its axiom of finite and satiable human needs, this economic school carries the potential of defining technology through its capability of satisfying those needs, ultimately constructing a finite scale for technology levels. In order to describe economies more and more comprehensively, with the advance of the economic fields of science, accurate technology level measurements are unimaginable to bypass. On the quest for the "holy grail" of economics, or an economic "theory of everything", but even in the more modest economic endeavours, the level of technology must be a part of the equations. This measure should be "precise enough to represent trends in specific countries yet broad enough to allow global comparability is a long-term research endeavor" (McAuthur and Sachs 2002, p. 39). The level of technology, if applied in the form as it was approached in this paper, should be applicable to both to technoligical "leaders", and the pace of their innovative journey, as well as to their "followers", signalling their speed of absorption and implementation.

The paper has opened a door to an alternative way of measuring the level of technology. Accepting and refining the moral economic measurement method could result in a reinterpretation of technology overall, casting a novel viewpoint on future technologies. Special attention should be brought to the theoretical end point it enables. The circumstances of this "steady-state technology" may yet be unimaginable, but the conditions can be set, if one ties technology to needs.

Acknowledgments

The author is grateful to her supervisor, Dr. Balázs Hámori, for his critical review and thoughtful comments.

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