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The Limits to Growth – 50 Years Ago and Today

***The Limits to Growth* was published 50 years ago. Ordered by the Club of Rome, the study was a milestone in the analysis of the economic, demographic, technical and ecological effects of the existing economic system. In industrialised Western countries in particular, the critical examination of the development model of continuous economic growth led to a broad discussion about the far-reaching implications of a global economy focusing on growth, on a planet with finite natural resources.**

Criticism of the growth paradigm, dominant in both market-based and planned economic systems, has existed (almost) as long as economic growth itself. For example, Thomas Malthus (1798) reflected on the natural boundaries of economic and population growth very early on (Hussen, 2018). However, Meadows et al. (1972) carried out a notably broad system analysis. On the one hand, they examined existing ecological as well as socio-economic development trends and their global effects in detail. Secondly, the use of computer models to simulate different development scenarios of the world economy, based on the availability of data, was a methodological novelty at the time.

The study of 1972, as well as its later updates, paved the way for growth-critical contributions of the recent past. Existing approaches that dominate current discussions, such as "post-growth", "de-growth", or "green growth", do not merely reproduce the critique of growth, but rather expand it to include additional perspectives on global consequences, such as climate change, species extinction, social inequality or unemployment (see e.g. van den Bergh and Kallies, 2021; Jackson, 2017). Moreover, from today's perspective, the limits to growth are no longer seen primarily in terms of depleting raw materials, but rather as planetary boundaries, with the ecological functioning of the planet being endangered (see Rockström et al., 2009; Foley et al., 2010; Persson et al., 2022 for more details). Due to the intensity of human intervention in nature, researchers believe that the limits of biodiversity, the nitrogen and phophate cycle, chemical pollution and climate change have already been exceeded, creating a threat to the natural basis of life for future generations. The German Federal Environmental Agency (2021) estimates that the cost of the global consequences of climate change and the loss of biological diversity alone will be around 25% of global GDP by 2050.

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The Limits to Growth report

Based on a computer-simulated world model, the report analysed five basic development trends with global consequences: population growth, industrialisation, malnutrition, exploitation of raw materials and destruction of the living environment. The scenarios analysed differed in their assumptions in supply of raw materials, efficiency in agricultural production, as well as the level of birth control and environmental protection. Most of the simulations found an initially ordinary population and economic growth until the year 2050. After that, there was a tipping point that marked a sharp and unstoppable reduction in population and industrial capacity, combined with environmental destruction and widely depleted raw materials. The source of this collapse of the world economy in the various scenarios was, above all, the dynamics of growth that tended to be unproblematic initially but had increasingly negative environmental aspects as time progressed.

Nevertheless, it was also possible to calculate scenarios characterised by a long-term sustainable ecological as well as economic equilibrium with a constant population and prosperity level. However, the prerequisite for this was fundamental changes in the preconditions for growth, such as instant and drastic measures for environ-

mental protection, birth control, a reduction of economic growth as well as various technological measures such as an increase in the recycling rate, an extended use of investment and other capital goods and an increase in agricultural productivity.

In order to address the problem of partly unavailable data, the calculations assume a much higher stock of raw materials than known in 1972. Additionally, different assumptions concerning the economic growth rate were applied. However, despite these modifications, the stock of raw materials still ran short before 2100 in the majority of simulated scenarios. Moreover, according to the forecasts, a possible state of equilibrium could only be achieved under a rapid implementation of massive countermeasures.

Reactions and updates

In light of the oil crisis in 1973, *The Limits to Growth* has led to a recognisable rethinking in industrialised countries in the course of a more qualitative-oriented growth. This rethinking was reflected in technological innovations aimed at a better energy efficiency as well as an improved decoupling of economic growth and use of resources.

However, the results of the study were controversial from the beginning. Points of criticism were: underestimated possibilities in solving growth-related environmental problems due to a pure extrapolation of technological progress; a lack of traceability based on an inconsistent use of growth functions for the future development of the world population, industrial capital, environmental pollution and technologies for a more efficient use of resources; and the opinion that predictions about the potential end of raw material sources were unfounded (for more details, see Wallich, 1972; Simon, 1981; Bardi, 2011).

Against this criticism, the Meadows et al. (1972) study deals with the question of technological progress in particular and in detail, with the result that, at least within the model framework, technological solutions alone, however far-reaching they may be, cannot prevent a collapse of the system. Moreover, empirical investigations concerning the projected developments with data from 1970 to 2000, later also with data beyond, reached the conclusion that the real development so far is more or less identical with the development forecasts of the basic scenario, which projects a collapse of the world economic system by the middle of the 21st century (Turner, 2008; Turner, 2014). Additionally, updates of the original study with latest data and findings on developments that occurred in the meantime (such as the effects of greenhouse gases on climate) came to similar results. Simulations based on these updates also led to an excess of growth limits and a subsequent system overshoot and collapse within the calculated standard model (Meadows et al., 1992; Meadows et al., 2004).

Accordingly, another report to the Club of Rome (Randers, 2012), forecasted growing influences on climate and nature by economic activity up to 2052. Moreover, a rising consumption of energy was expected, despite an increasingly efficient use of energy. Due to growing environmental damage and gradually scarce natural resources, it was anticipated that productivity and subsequently global economic output would grow much slower, i.e. it was expected that increasing environmental damage would limit economic growth.

World without growth: De-growth

In the recent past, new approaches to dealing with growth have been developed, such as de-growth, green growth, or post-growth. All of these concepts are in line with the explanations made so far, as all concepts follow the idea of a realised balanced development, as formulated within the study *The Limits to Growth* and its updates. However, the stipulated assumptions and consequent recommendations for action differ in many aspects diametrically from each other. Moreover, there is no self-contained theory behind the mentioned approaches; they can rather be seen as a pool for various contributions and political initiatives following a common main idea.

For example, the considerations on a decline of growth (de-growth) are manifold, varying roughly by contributions focusing on social reforms, capital criticism or resource orientation (Schmelzer, 2017). Although their emphasis differs, they all fundamentally question the possibility of decoupling economic growth and resource consumption. They rather assume that under a continuation of the traditional paradigm of growth and its linked increase in consumption and production, the global energy and resource consumption could not be reduced to a level needed for sustainable development – even if existing potentials for efficiency increases are completely exploited (see exemplarily Martinez-Alier et al., 2010; or Demaria et al., 2013). One explanation is that it would not only require a surplus of technical efficiency but also fundamental changes in consumer behaviour. However, as experience – especially within a growth economy – shows, progress made in reductions of material or energy are often cancelled by an increase in demand, so-called rebound effects. Such rebound effects can be explained by lower costs in the purchase or use of goods and services due to efficiency improvements, consequently leading to a higher demand and thus fully or partly cancelling the savings potential of efficiency improvements (e.g. higher demand for larger

vehicles due to more energy-saving car engines). Moreover, we see a permanent increase in energy demand due to an increase in world population associated with a rise in purchasing power of the global middle class.

Consequently, to get rid of the existing forces of growth, a radical change would be needed. There are different scenarios for such a change, e.g. an increased handling of economic activities outside of established markets or in fundamentally differently designed markets; a reform of the existing monetary and interest system; a reduction of the global division of work and its connected principle of external supply; a reallocation of time between paid work and leisure, as well as differently designed social relationships and gender roles. Even if such actions lead to a reduction of economic performance (measured in GDP per capita), this should not be the case for social welfare. Rather, economic growth is seen as the source for manifold undesirable social developments, such as tendencies of social acceleration, the increase of disaffected work or the decline of meaningful activities, which could be avoided by an abandonment of growth.

Green growth and post-growth

The need for a fundamental transformation of the economic system is also shared by various contributions considering the approach of green growth. However, the content and direction of this transformation process is a different one, as the dominating idea suggests that ecologically sound growth is very much possible if economic development is embedded in an ecological orientation (see e.g. Jacobs, 2013; Jacobs and Edelhofer, 2014). For this, the promotion of ecological innovation is seen as central. It is based on the concept that technical innovations in favour of greater efficiency in the use of raw materials and energy as well as an increase in existing recycling rates could decouple the tradeoff between economic growth and resource consumption. If these innovations are realised and adapted to worldwide markets, it would generate economic growth at the same time. This is of particular relevance since it is assumed that without an increase in GDP per capita, the needed investments for an ecological transformation could not be financed and the existing level of social well-being could not be sustained (German Federal Advisory Council on Global Change, 2011).

Simulations based on the concept of green growth show the possibility of a relative decoupling of economic growth and environmental consumption with a lower increase in ecological damage than economic performance. Moreover, alternatively modelled scenarios lead to an absolute decoupling, i.e. constant or even decreasing negative environmental impacts with a simultaneous increase of economic output (Giljum et al., 2008; Meyer et al., 2012). However, the results of such simulations strongly depend on the upcoming legislation framework of governments and corresponding market incentives. Measures in favour of green growth include financial incentives for ecological innovations as well as a reduction of legal barriers that prevent green innovations and business models. This approach of green growth differs from the de-growth approach, especially concerning the strong focus on technological progress as a driving force for sustainable economic growth. However, the latest research insights regarding the empirical evidence on decoupling of GDP also show that existing economic systems are still far away from green growth in terms of sufficient reductions of resource use or emissions (see Haberl et al., 2020; Hickel and Kallis, 2020; Parrique et al., 2019).

In order to be able to analyse how realistic the assumptions and statements of both approaches are, knowledge about the relationship between resource consumption, ecological burdens and economic development is needed. However, reliable models are not yet available (Petschow et al., 2018). Another recent position has been formulated under the paradigm of a precautionary post-growth strategy, which sees the dependency of relevant societal areas and institutions on growth as a central obstacle for political measures adressing a sufficient reduction of ecological burdens, in particular in industrial countries (Seidl and Zahrnt, 2012). This position is also known as “a growth” or “new economics of prosperity” (see e.g. van den Bergh, 2011). The question of whether in the future, for the compliance of the planetary boundaries, growth must either be compelled or restricted to environmentally compatible innovations is not central anymore. It is yet uncertain which of these two developmental paths is ecologically sound, as the current state of knowledge does not allow a clear theoretical or empirical statement on this. The main challenge, especially in the case of declining economic output, is to keep central social institutions such as social security systems as resilient as possible, so that their ability to function no longer depends on constant economic growth. To do this, for example, it is recommendable to increase the statutory pension age, implement a supplementary funded provision or switch to a public guaranteed standard pension in order to decrease the dependency of old-age security systems on growth. To forward with another proposal, it is advisable to establish a citizen insurance and abolish the existing income thresholds in order to address health insurance.

Generally, it has been noted within the previous explained growth concepts that GDP per capita is not a compre-

hensive or reliable indicator considering the relationship between economic growth and social well-being. Accordingly, this indicator should not have a central role in the legitimation of political measures concerning the design of sustainability policies, or should always be considered in the context of other well-being indicators (Petschow et al., 2020).

Economic growth and measuring well-being

From an economic point of view, GDP only measures a part of societal well-being, as welfare is not only determined by material well-being but also by the social situation as well as an intact environment. In operationalising the latter two components, there are different possibilities. Hence, it is not surprising that there are currently a large number of measurement methods for prosperity, which differ greatly considering their definition (see for an overview German Federal Parliament, 2013). For some approaches, only material well-being is measured, for others non-material aspects such as the existing level of knowledge or education, aspects of health, social relationships, environmental quality or political participation are taken into account. The basis for this is not only objective but also subjective assessments and surveys, investigating e.g. individual life satisfaction or perceived economic insecurity.

Welfare can be expressed in monetary terms (e.g. expenditures on private consumption, education, health or environmental protection) or non-monetary terms (e.g. infant mortality or unemployment). Depending on the method, the result is depicted as a singular number or a series of collocated numbers. In the first case, aggregated welfare indices are used, which has the advantage of reducing the complexity of the different facets of welfare. Accordingly, the results are not only simple and comprehensible, but allow for interpretations about whether the overall welfare of a country has risen or fallen. One disadvantage of this approach is its more or less arbitrary weighting of individual welfare components. Moreover, problems in interpreting the results may arise, if singular components within the overall index develop in the opposite direction, not being reflected in the aggregated result.

Well-known examples are the National Welfare Index, which includes, contrary to GDP, data on private consumption, income distribution, ecological damage and public debt; the Human Development Index, which contains, in addition to GDP per capita, life expectancy at birth and school attendance (but no ecological data); the Weighted Index of Social Progress, which comprises economic, ecological and demographic indicators as well as measures on the status of women, the extent of "social chaos" and cultural diversity. Other, newer well-being indicators also consider environmental quality by including variables such as healthy life expectancy (Bloom et al., 2019).

The counterpart to these aggregated welfare indices are clusters of economic, social and ecological indicators. The individual indicators stand on an equal footing for different sub-aspects of wealth, their results not being offset against each other. Such indicator sets have the advantage of being useable for specific political decisions due to their attention to detail. A disadvantage is that they often do not allow for a definite statement if the well-being of a country has generally risen or fallen. Moreover, they can be confusing and lead to problems of understanding. In order to avoid this, it is common to define specific sets of indicators. An example is the indicator set developed by the German Council of Economic Experts and the French Conseil d'Analyse Économique, which – based on the recommendations of the Stiglitz-Sen-Fitoussi Commission (Stiglitz et al., 2010) – includes different measures on economic performance and environmental and fiscal sustainability, as well as objective data on quality of life and subjective assessments of well-being. Comparable is the Better Life Index of the OECD, which is complimented by green growth indicators, if the progress in ecological sustainable growth is in focus.

Finally, when considering *The Limits to Growth*, the calculation of specific sustainability indices should also be mentioned, which differ from the approaches presented so far, as they measure primarily stock variables (such as capital or natural assets) and their change over time in relation to investments and natural regeneration. The question in focus is, whether a society is depleting its economic, social and/or natural resources and endangers its future level of well-being. The best-known example might be the Ecological Footprint, calculated annually by the Global Footprint Network. One result of its calculation is the Earth Overshoot Day, which was reached in 2021 on the 29 July, much earlier than when it was calculated for the first time 40 years ago – it then fell on the 19 December.

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