THESIS SUMMARY

To the Ph.D. dissertation

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The wealth perspective of sustainability: an empirical inquiry

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1. THEME AND FOUNDATIONS OF THE THESIS

During the past half century sustainability became one of the most debated issue of science, while the empirical research of sustainability has recently been substantially spurred by broadening possibilities allowed by recent advancements in the field of informatics, the availability of data in growing amount and improving quality, as well improving statistical systems. My thesis aims at investigating the issue of systainability of the wealth perspective, or, with other words, the wealth-economy, underlined by macroeconomic theory, focused on the interlinkages between nature and human systems.

In the 19th century, western economics, founded in the philosophical thinking of the enlightenment tradition, considered the availability of natural resources unlimited. Later, along with globalization and rapidly growing population, the issue of sustainability came into view, and the limits to the availability of natural resources entered modern economic thinking. From the 1960s and 1970s sustainability became a central issue in the mainstream of many other scientific fields, and today the knowledge regarding the complexity of problems of sustainability is formed by the systhesis of the results gained from various specialized scientific fields. The issues of sustainability and especially environmental sustainability, in the narrow and broader sense, initiated research in particular directions in several areas of natural and social science, as well as in arts and philosophy.

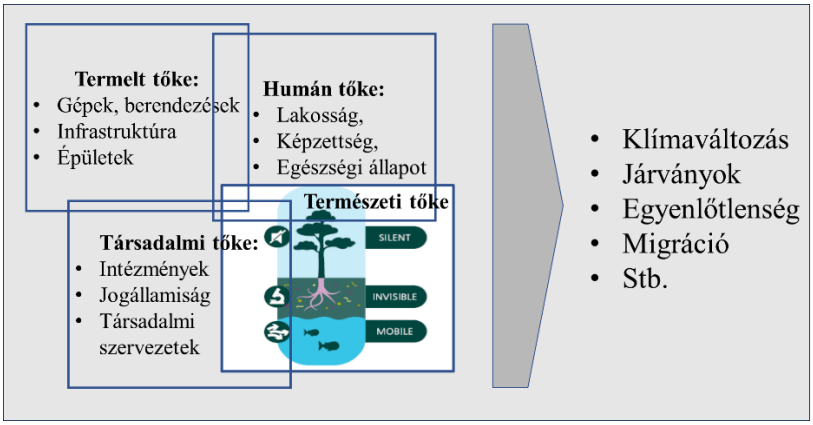
„…*During the 20th century, the complexities of the interlinkages between politics, the economy and the ecological system denoted relatively new tasks not only for politics and the economy, but for science, in particular social sciences, as well."* (Simai, 2016, p. 99).

The literature related to the subject of sustainability has been growing constantly. The number of publications with the keywords of *sustainability, sustainable development and wellbeing* have been growing rapidly over the past decaces, particularly since the 1990s. The complex problems of the interlinkages between the biosphere and the social-economic system became the focus of attention particularly in the context of economic development. The environment, the biosphere is in constant movement, its processes are invisable and cannot be heard (Dasgupta, 2021). Yet, problems in the natural systems, such as climate change

(often mixed up with the concept of sustainability, itself), became directly perceptible, which definitely affect daily lifestyle, local and international politics, as well as the growth of economies. Consequently, during the past decade, the narrative of contradiction between unlimited growth and the boundedness of the biosphery has become stronger and stronger, urging the development of novel approaches to address the complexities of the interlinkages between natural and human systems, and pursuing the unfolding of new perspectives. The *wealth approach of sustainability* can be seen as such an initiative, which is a theory underline framework that allows the elaboration of sustainability related information for policy, primarily macro-fiscal policies, as well as for industry and the public.

Figure 1 shows the concept of the interlinkages between nature and society from the wealth perspective. On the right, examples of the processess routed in these interlinkages are shown, which became directly perceptible concerning sustainability.

Figure 1. Interrelations between nature and the socio-economic system of the wealth perspective



Source: own design using (Dasgupta, 2021)

In this framework, wealth means the sum of capital elements, which are at the disposal of the socio-economic system, including natural capital. This wealth is the source of revenues and benefits over time, while its changes, being an indicator „beyond GDP", signals if, during a given period of time, the socio-economic system performed sustainably, or not. This wealth perspective of sustainability raises such questions of how to compose the list of capital assets and how to valuate the various components thereof. The thesis addresses both questions, at the same time it is

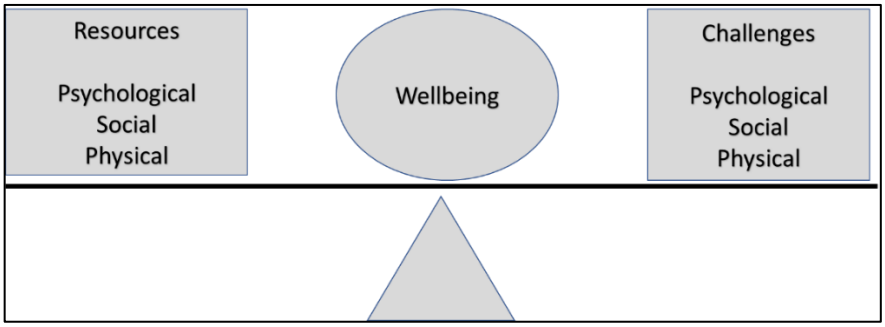
pointed out that empirical reasearch of sustainability from the wealth perspective is limited by several concerns.

The interpretation of sustainability in the context of economics and environmental economics is founded in the underlying philosophical thinking. Regarding sustainability, a philosophical inquiry addresses its essence, its goals and the means of achieving and measuring it. In this context, according to western philosophical tradition the aim of development is to achieve happiness, wellbeing and freedom. Aligned with the definition of the Brundtland report[1], it can be interpreted that western philosophy considers sustainability as the problem of justice between generations, the aim of which is wellbeing accross generations. Neo-classical economics grasps sustainability as the problem of sharing goods and services between generations. The two perspectives are connected by the abstraction of wellbeing.

Dodge et al. (2012, p. 230) defines the concept of wellbeing as follows (Figure 2):

„ …stable wellbeing is when individuals have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge. When individuals have more challenges than resources, the see-saw dips, along with their wellbeing, and vice-versa."

Figure 2. The concept of wellbeing according to Dodge



Source: own construct, based on (Dodge et al., 2012)

According to economic theory the criteria of sustainability is *non-reducing* wellbeing. (Pearce and Atkinson, 1993). Wealth, i.e. the sum of capital assets available for the socio-economic system, moves in unison with changes in

[1] The Brundtland report, prepared for the UN and published in 1987, defined sustainability as follows: *„ …Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (Brundtland, 1987).

intergenerational wellbeing, therefore, changes in wealth is an indicator of sustainability (Arrow et al., 2010). The economic theory of sustainability of the wealth perspective can provide empirically justified information for policy, integrating the scientific results of various disciplines. Such information on causal interrelations between savings, wealth accumulation and wellbeing accross generations can support decisions regarding setting the rates of macroeconomic savings and forming strategies for the utilization of savings. That is, how savings and their use is connected with the perspectives of long-term sustainability. The wealth perspective of sustainability is the means that can conceptualize the pursuit of sustainability as a problem of managing the portfolio of capital assets accross generations.

This is the most important contribution that the wealth perspective of sustainability can deliver compared with other models and indicators, which attempt to characterize sustainability along some normative concept[2].

According to literature, *comprehensive wealth* is an indicator „beyond GDP" that can characterize sustainability, underlined by solid theoretic background. It can well respond to the need for novel indicators of sustainability articulated in the mainstream scientific discourse. The concept of comprehensive wealth can, in practice, actualize the wealth perspective of sustainability. Based on the wealth perspective of sustainability the question can be raised: what is the effect of fiscal-policy decisions on the accumulation of wealth, which is the source of income and benefits in the future. There is aboundant data available to describe the changes in wealth both in terms of quantity and quality, that allows empirical research.

My research focuses on sustainability of the wealth perspective, in particular the interrelations between natural capital and economic development. The research presented in the thesis seeks direct connections between sustainability and decisions

[2] This statement refers to the fact that many „sustainability indicators" are not underlined by solid theory, based on which, sustainability could be investigated empirically. That is, there are several indicators that do not carry information concerning if progress along that indicator, means progress towards sustainability, or not, and based on which actions could be designed that would aim sustainable progress justified by causal relationship between the action and the outcome.

linked to economic activity, using indicators of the „beyond GDP" type, particularly that relates to macroeconomic savings.

A main motivation of my research is that the recently renewed Wealth Accounts database of the World Bank allows the empirical research of sustainability, backed by economic theory, which is a relatively new research area. Specifically:

- The recently renewed Wealth Accounts database of the World Bank, which is publicly accessible since 2021 (World Bank, 2018), differentiates renewable and non-renewable natural capital elements. This enables research of sustainability from the ecosystem perspective, according to the strong criteria of sustainability, in case of 146 countries of the world.;
- Using the Wealth Accounts database of the World Bank can significatly contribute to the empirical research that aims at exploring the causal relationship between changes in various components of wealth and economic performance (income);
- It is broadly agreed in the sustainability discourse that natural capital can support economic performance and income generation. My research results may contribute to confirming this statement empirically.

The research results presented in the thesis may contribute to the scientific research of sustainability with new knowledge, primarily by establishing link between the policy decision of today (macro-level savings) and changes in intergenerational wellbeing, i.e. sustainability. My research would demonstrate in practice the possibilities of research of sustainability at the territorial (national) and global levels, using new environmental data provided by the national and international statistical systems. The limitations of the research can highlight the necessary further directions of improvement, primarily concerning the methodology of data generation and data harmonization. The literature review and the selection of referenced articles attempt to demonstrate the relevance of my research questions and hypotheses, as well as how they fit with published research results. Within this context investigating causality between wealth, or capital assets, as well as savings and the performace of the economy (income generation) would be considered as new approaches. The research results would be seen to broaden the discipline with new knowledge.

The results of the research and testing the hypotheses are foreseen to deliver value-added contribution primarily in three areas:

1. Utilization of the Wealth Accounts database of the World Bank for regression analysis:

   The literature of empirical research based on the advanced version of the Wealth Accounts database, which is accessible since 2021, in particular regarding regression analysis, is constantly growing. The publications are backed by more-or-less the the same theoretical foundation, for example (Krevel, 2021). Several of these theoretical resources are thought to support the research concept presented in my thesis, as well. Therefore, the results of my research can be compared with those of other research, additionally, the longer time series data available today can amend the results of earlier research.

2. Regression analysis of the Cobb-Douglas type production function of the growth modell offered by Dasgupta:

   My research highlights the opportunities of research enabled by macroeconomic growth models, which include natural capital, as factor of production (growth regression). Literature on the application of the Cobb-Douglas type production function is rich, but traditionally in microeconomics, it is aimed at the investigation of dinamics of various industries, in particular agriculture. Empirical research related to the Kuznets-curve using Cobb-Douglas type functions is a major step towards investigating sustainability. In addition to researching economic and environmental convergence, functions of the Cobb-Douglas type, which are expanded with natural capital as factor of production offers novel approach regarding the methodology of the empirical research of sustainability.

3. Applying indicators of the „beyond GDP" type:

   In the literature, several references can be found concering indicators of the „beyond GDP" type, however, their application, including politics, is not yet widespread, This has justified the call worded by Target 17.19 of the Goal 17 of the UN Sustainable Development Goals, that essencially spurs

shaping and applying new indicators of sustainability. My research reflects on these needs.

In general, regarding the interlinkages between the environment, natural capital, economic development and growth, the main focus of concern is GDP and the research is usually limited to the statistical analysis of the available data at the national, or industry level. For example, the recent report of the World Bank on global wealth (World Bank, 2021) addresses in details the utilization of income from the export of natural resources from the perspective of the Hartwick-rule (Hartwick and Hamilton, 2014; Hartwick, 1977). In the report, the study by Cust és Ballesteros is focused on the linkages between wealth accumulation and income generation, measured in GDP (2021c), primarily in resource rich, developing countries. The authors pointed out strong causal relationship between wealth accumulation and income generation, essentially, providing empirical justification to the Hartwick-rule, according to which in these countries income should be used to finance investments focused on human and natural capital, as well as technological innovations, in order to reinforce sustainable growth. As a further example, the Dasgupta Review (Dasgupta, 2021) discusses the impact of inequality and fertility on economic growth, measured by GDP. My research, linked to these and other results published in the literature, also seeks causality between changes in natural capital and changes in income, however, applying sustainability indicators, „beyond GDP".

With my research, my aim is to highlight the value-added character of indicators of the „beyond GDP" type, which are approved in the international statistical system and which concern the perspectives of sustainability. I intend to emphasize the importance of the methodologies how the data of these indicators are compiled, in concrete terms, how well the available data are aligned with the concept of variables defined by macroeconomic theory. The sustainability indicators used in my research are the Gross National Income (GNI), Adjusted Net National Income (ANNI) an Adjusted Net Savings (ANS).

2. RESEARCH QUESTIONS AND HYPOTHESES

My research questions address some focused segments of the broad and complex problem areas of sustainability:

A. What interdependences and causal linkages can be articulated regarding the perspectives of economic growth and changes in renewable natural capital? Would reducing ecosystems worsen the outlook of economic growth, and, alternatively, would a healthy, more valuable renewable natural wealth induce economic growth?
B. Do the impact of wealth and that of renewable natural capital depend on demography?
C. Does the environmental perspective of savings offer appropriate means to pursue an improved perspective of economic growth within the framework of macro-finance policy? Does the utilization of savings with an environmental concern, primarily to finance investments with an aim to protect and regenerate renewable natural capital, have an impact on sustainability? Is the effect of investments aimed at increasing the value of renewable natural capital comparable with those of other types of investments, for example aiming at produced, or human capital?
D. Do sustainability indicators provide information regarding sustainability „beyond GDP"? If so, what are these information?

The hypotheses articulate certain aspects of the research questions in a way that can be confirmed, or rejected based on the research results.

Hypotheses linked to research question ***A***:

1. Hypothesis (H1): There is causal inference between changes in renewable natural capital and changes in income generation.

Justification: intuitively, increasing renewable natural capital would induce growth in income generation.

2. Hypothesis (H2): The proportion of the effect of changes in renewable capital on income generation exceeds the proportion of renewable natural capital within comprehensive wealth, compared with other types of capital (e.g. produced, or human capital).

Justification: the proportion of renewable natural capital within comprehensive wealth is usually far smaller than that of other types of capital, e.g. produced, or human capital. H2 intuitively states that growth in even a proportionally small renewable natural capital component of comprehensive wealth can induce significant growth.

Hypotheses linked to research question ***B***:

3. Hypothesis (H3): the effect of changes in comprehensive wealth on income generation depends on the ratio of comprehensive wealth to population.

Justification: intuitively, it is foreseen that the factor that affects income generation is the per capita comprehensive wealth, as opposed to the total amount of comprehensive wealth of a nation. That regards wealth, taking into account the size of the population is similar to accounting for „effective labor" in the production function of the classical growth model.

4. Hypothesis (H4): the effect of changes in the renewble component of natural capital on income generation depends on the ratio of renewable natural capital to population.

Justification: it is foreseen that it is the per capita comprehensive wealth that is statistically significant, likewise the argument regarding H3.

Hypotheses linked to research question ***C***:

5. Hypothesis (H5): There is positive causal relationship between income generation and the absolute value of environmentally adjusted savings per capita.

Justification: the saving rates can be equal in countries of different development level, depending on how the absolute value of the environmentally adjusted savings is set. Intuitively, savings of higher absolute value would induce higher generation of income.

6. Hypothesis (H6): There is positive causal relationship between income generation and environmentally adjusted saving rate.

Justification: in the case two countries at similar levels of development economic growth can differ depending on the rate of enveronmentally

adjusted savings. Intuitively, higher saving rate would result in, *ceteris paribus*, higher income.

Hypotheses linked to research question ***D:***

7. Hypothesis (H7): using sustainability indicators, the perspective of the strong sustainability criteria can be actualized.

Justification: This hypothesis implies that investigating the joint effect of the renewable and non-renewable components of natural capital would reflect the perspective of the weak criteria of sustainability. The perspective of the strong criteria of sustainability would focus on the changes of the renewable component of natural capital, only. This kind of research is enabled by applying renewable and non-renewable natural capital in the production function as separate factors.

8. Hypothesis (H8): ANNI and GNI are indicators of sustainability that carry information „beyond GDP".

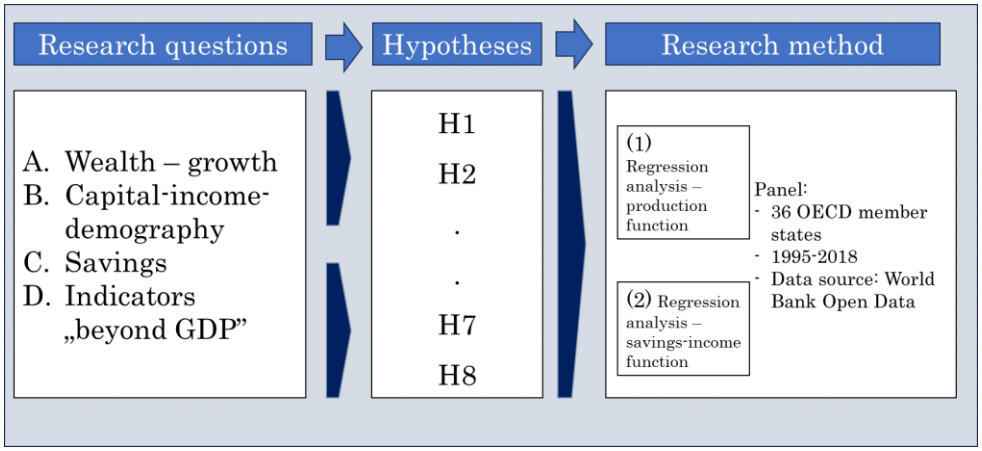
Justification: GNI and ANNI are indicators that are relevant to produce information that cannot be produced using GDP.

3. RESEARCH CONSTRUCT, METHODOLOGY, DATA

The methodology of research is empirical, regression analysis, based on neo-classical growth theory. The economic model of the research is composed of two parts: (1) regression analysis based on the neo-classical macroeconomic production function amended with natural capital, as production factor, as proposed by Dasgupta; (2) regression analysis of the income – savings equation of the macroeconomic growth model. The estimations of the regression functions were carried out using panel data of 36 OECD member states over the 1995-2018 period. The source of data is the World Bank Open Data database.

The logic of the research is shown in Figure 3. Linked to the research questions (A-D), the hypotheses (H1-H8) are confirmed, or rejected based on the testing carried out using regression analysis (methods (1), (2)).

Figure 3. Research construct



Source: own construct

The method of analysis of (1) and (2) are as follows:

(1) analysis of the partial elasticities of income related to the factors of production (produced, human and natural capital), that is how much and to what extent each factor of production contributes to inducing changes in income. The economic model of the analysis, based on the production function of neo-classical growth theory is the following:

$$+ \quad + \quad + \quad +$$

$$\boldsymbol{Y = f(R, K, H, N)},$$

i.e., revenue is a function of renewable natural capital (R), produced capital (K), human capital (H) and non-renewable natural capital (N). According tot he hypotheses, there is a positive causal relationship between changes in income

and the changes of renewable natural capital, signalled by the + sign above the variable, similarly the other variables. This analysis is carried out by the estimation of the linear regression model of the Cobb-Douglas form, proposed by Dasgupta, using logarithmic transformation.

$$\boldsymbol{y = A * s^{\gamma} * c_P^{\alpha} * c_H^{\beta} * c_R^{1-\alpha-\beta}}.$$

(2) The impact of adjusted net saving on income is analyzed with linear regression, using the savings – income equation of the neo-classical growth model.

$$y = f(S, Sr, TW, R)$$

(+ + + +)

According to the above equation, intuitively, there is positive causal linkage between income generation and environmentally adjusted savings (S), saving rate (Sr), the absolute value of comprehensive wealth (TW), as well as the absolute value of the renewable component of natural capital (R).

It is emphasized that (1) relates to analyzing the impact of environmental factors on the elasticities of income, while (2) analyzes the impact of environmental factor on changes in income.

In the two analyses both the simple, and multiple variables versions of the regression model are used: in (1) four versions of the regression model (D1-D4), in case of (2) three model versions (F1-F3) are used. Analysis of the model versions are carried out using GDP, GNI and ANNI, as explained variables.

4. RESEARCH RESULTS

The analysis of hypotheses (H1, H2, …H8), i.e. discussions on the arguments to confirm, or reject the hypotheses are based on the results of the regression analyses (1) and (2). In both regression analyses GDP, GNI and ANNI are applied, as indicators of income, which allows a comparative assessment, i.e. to what extent the results differ differ, concerning the causality between income, as the explained variable and the various explanatory variables. Is there any difference in this repect between using GDP, GNI, or ANNI, i.e. do sustainability indicators carry information, additional to GDP?

The results of the regression analyses (1), with the model versions D1-D4, i.e. the coefficient estimates in log-diff. form, are shown in Table 1, Table 2 and Table 3, with the explanatory variables GDP, GNI and ANNI, respectively.

Table 1. (1) Estimated regression coefficients, GDP

dlGDPpC	D1	D2	D3	D4
β0	-	-	-	0,000
β1	1,420	0,834	0,821	0,836
β2	-	0,320	0,320	0,308
β3	-	-	-	0,000
βN	-	-	0,000	-
összesen	1,420	1,154	1,141	1,144

Source: own analysis

Table 2. (1) Estimated regression coefficients, GNI

dlGNIpC	D1	D2	D3	D4
β0	-	-	-	0,000
β1	1,301	0,881	0,861	0,908
β2	-	0,261	0,264	0,250
β3	-	-	-	0,000
βN	-	-	0,057	-
összesen	1,301	1,142	1,125	1,158

Source: own analysis

Table 3. (1) Estimated regression coefficients, ANNI

dlANNIpC	D1	D2	D3	D4
β0	-	-	-	0,078
β1	1,282	0,794	0,782	0,841
β2	-	0,300	0,305	0,292
β3	-	-	-	0,000
βN	-	-	0,057	-
összesen	1,282	1,094	1,144	1,211

Source: own analysis

βi stand for the partial elasticities of GDP, GNI and ANNI, i.e. the coefficients of the explanatory variables in the respective regression model: β1, β2 and β3 (the coefficients of produced, human and non-renewable natural capital. β0 is the coefficient of renewable natural capital, βN is the coefficient of natural capital (jointly the renewable and non-renewable components of natural capital). The sign „-„ means that the variable does not appear in the model. Zero means that the coefficient is statistically not significant.

That regards testing the hypotheses, the results of analysis (1) imply the followings:

Hypothesis H1: there is positive causal relationship between changes in income generation and changes in renewable natural capital, considering the following:

- the statement in H1 can be confirmed using ANNI, the sustainability indicator. Accordingly, the positive causal effect between changes in renewable natural capital and changes in income can be demonstrated in case of the renewable component of natural capital, but cannot be demonstrated in case of the non-renewable component of natural capital;
- the statement in H1 cannot be confirmed in case of using GDP, as explained variable;
- the statement in H1 can be confirmed if GNI is used as explained variable, however, the confirmation concerns the effect of the sum of natural capital, and the separated effects of the renewable component of natual capital and the non-renewable component of natural capital cannot be demonstrated.

Hypothesis H2: *The proportion of the effect of changes in renewable capital on income generation exceeds the proportion of renewable natural capital within comprehensive wealth, compared with other types of capital (e.g. produced, or human capital).*

With every income indicator (GDP, GNI, ANNI), in case of model version D4 the partial elasticity of income regarding the renewable component of natural capital (β0) amounts to approx. 9% of that of produced capital and 27% of that of human capital. Comparatively, the per capita renewable environmental capital amounts to approximately 6-7% of produced capital, while only 4% of that of human capital. Consequently, it can be stated that renewable natural capital contributes to income generation proportionally to far larger extent than other capital types. This result is a strong indication to confirming H2.

Results of the F1, F2 and F3 models of regression analysis (2), i.e. the coefficient estimates of the models are shown in Table 4, Table 5 and Table 6. the per capita GDP, GNI and ANNI, in the logarithmic form. β1, β2, β3 and β4 are the coefficients of per capita environmentally adjusted savings, the rate of environmentally amended savings, as well as total (comprehensive) wealth and the renewable component of natural capital per capita. Zero means that the economic significance of the coefficient of the variable in the model is very small, but statistically significant[3]. „-„ signals that the variable is not used in the model.

Table 4. (2) Estimated regression coefficients, GDP

lGDPpC	F1	F2	F3
β1	0,151	0,199	0,150
β2	-	-0,017	-0,012
β3	-	-	0,000…
β4	-	-	0,000…

Source: own analysis

Table 5. (2) Estimated regression coefficients, GNI

lGNIpC	F1	F2	F3
β1	0,165	0,212	0,135
β2	-	-0,016	-0,008
β3	-	-	0,000…
β4	-	-	0,000…

Source: own analysis

Table 6. (2) Estimated regression coefficients, ANNI

lANNIpC	F1	F2	F3
β1	0,175	0,217	0,145
β2	-	-0,014	-
β3	-	-	0,000…
β4	-	-	0,000…

Source: own analysis

Hypotheses H3 and H4 concern research question ***B*** and relate to the linkages between wealth and demography, i.e. indicate that it is the absolute value of wealth in proportion of the population that affects the generation of revenue.

According to the results of analysis (2), the coefficient of Total Wealth (β3) is statistically significant in case of all explained variable. Also, it is positive and

[3] The economic significance is very low, because it expresses the impact of the unit change in the given capital variable (US$) on the % change in the explained variable.

statistically significant with model F3, that confirms H3. Likewise, the coefficient of the per capita renewable natural capital (β4) is positive and statistically significant that confirms H4.

Hypotheses H5 és H6 state that there is positive causal inference between both the absolute volume and the rate of environmentally adjusted savings. These hypotheses are confirmed by the results of analysis (2).

In addition the results of the analysis imply that savings of equal volume generate higher income in more developed countries (i.e. in countries of higher revenues). In such cases, with equal savings, the rate of savings is higher in the country of lower income level.

Regarding H7, the results of the regression analyses concerning income generation highlight the difference between the weak and strong criteria of sustainability. It is expressed with analysis (1) where in case of GNI, as explained variable, in model D3 βN, the coefficient of natural capital (jointly renewable and non-renewable capital), is statistically significant, as opposed to D4, in which case significance cannot be demonstrated for either the renewable, or the non-renewable component of natural capital. According to growth theory, the sum of the coefficients of produced, human and natural capital assets ($\alpha + \beta + (1 - \alpha - \beta N) = 1$)[4], while $\beta 0$, the coefficient of renewable natural capital is statistically not significant. This, according to the weak criteria of sustainability, expresses that in equilibrium steady state, the sum of the coefficients of the factors of production is one, also expressing that natural capital can be substituted by produced, or human capital. As opposed to this reasoning, applying ANNI in the model as explained variable, in model D4 $\beta 0$ is statistically significant ($\beta 0 \neq 0$) therefore the equation $\alpha + \beta + (1 - \alpha - \beta) + \gamma = 1$ can be applied, where γ is the power of the renewable component of natural capital. According to this equation, changes in the renewable component of natural capital cannot be compensated by growth in other types of capital.

Consequently:

[4] in this reasoning, α, β and $(1 - \alpha - \beta)$ are the powers of produced, human and natural capital, i.e. the sum of renewable and non-renewable capital, respectively.

GNI is a sustainability indicator, which conforms to the weak criteria of sustainability, and ANNI is a sustainability indicator, which conforms tot he strong criteria of sustainability. These results confirm H7.

Regarding H8, the following can be stated:

According to analysis (1), the effect of the changes in the renewable component of natural capital can be demonstrated using ANNI, which effect cannot be demonstrated in case GDP, or GNI is used as explained variable in the regression analysis. Accordingly:

ANNI, a sustainability indicator carries information concerning sustainability, in addition to GDP. This confirms H8.

The results of analysis (1) allow additional conclusions to be made:

The last rows of Table 1, Table 2 and Table 3 show the sum of the respective coefficients ($\beta 0+\beta 1+\beta 2+\beta 3+\beta N$, as applicable [5]). Each sum is larger than 1 ($\beta 0+\beta 1+\beta 2+\beta 3+\beta N>1$), which means that the economies of OECD countries (altogether) are progressing towards the growth equilibrium (steady-state). This statement is to be interpreted according to theory that growth of the economies progress towards an equilibrium state and when achieving it (the steady state) growth becomes permanent. (Abel and Bernanke, 1995; Piketty, 2018). As opposed to theory, Groom és Turk (2021) in their reflection on the Dasgupta Review state that due to the boundedness of the biosphere, i.e. due to limited natural resources economic growth is, *per definicionem*, limited, and acknowledging current trends, the slowing of economic growth are foreseen within a few decades.

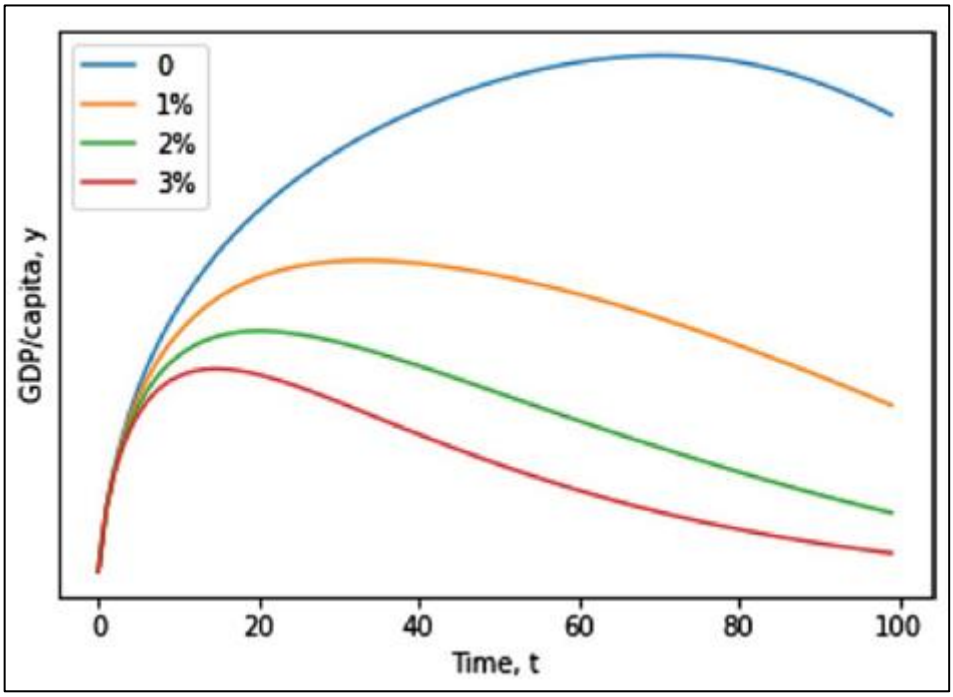
Figure 4 shows foreseen trends in economic growth conceptually, depending on the idiosinsrecies of each economy. Growth trends of economices embedded in the biosphere may differ significantly, depending on demographic growth and speed of technological change, which are indicated by colored curves.

Per capita GDP is shown in the vertical axis, the horizontal axis is time. According to the implications of the figure, the question can be raised: in which phase of

[5] The sum of the coefficients in case of models D2 equals $\beta 1+\beta 2$, in case of models D3 equals $\beta 1+\beta 2+\beta N$, in case of models D4 equals $\beta 1+\beta 2+\beta 0+\beta 3$.

growth the partial elasticities of income, identified by the results of the research, are valid and relevant. This question may be the subject of further research.

Figure 4. Slowing trends of economic growth



Source: (Groom and Turk, 2021)

5. SUMMARY

5.1. NOVELTY OF THE RESEARCH

The results of the research confirmed that the framework of the wealth perspective of sustainability, as well as the application of sustainability indicators can serve, additional to GDP, as an alternative view that regards the long term outlook of the functioning of the socio-economic system. It was demonstrated empirically that the wealth perspective can complement the discourse on economic growth and development, traditionally focused on GDP, and that this way it can gain ground in political and public thinking.

The research results confirmed particularly the following:

- There is positive causal inference between changes in renewable natural capital and economic growth, i.e. increasing renewable natural capital induces growing income;
- Regarding the causal effect of the changes in renewable natural capital and growing income, the application of GNI allows the interpretation of the research results from the perspective of the weak criteria of sustainability, the application of ANNI allows the interpretation of the research results from the perspective of the strong criteria of sustainability;
- The impact of environmentally adjusted savings on income generation is statistically significant and positive, however, this effect can be confirmed for the application of each income indicator, GDP, GNI and ANNI;
- GNI and ANNI carry information concerning sustainability, in addition to GDP.

5.2. LIMITATIONS OF THE RESEARCH

The limitations of my research can be grouped in three topic areas:

Data methodology

The regression panel analysis was based on the time serieses of 36 OECD member states over the 1995-2018 period. It is questionable to what extent the results of the research can be considered valid for the rest of the countries in the world. It is also a question mark so as to what extent the data available in the World Bank database can fit with the concept of the theoretical shadow price.

Another problematic issue is data harmonization, i.e. the constructs of the various data applied to the variables in the economic model, as the basis of the regression

model, follow different concepts. For example, the environmental elements considered in the construct of the ANNI variable do not fit that of ANS.

Regression analysis

Beyond data statistics an diagnosis, econometric, regression analysis is challenged by several other methodological issues. In the context of the research, these problems concern the description of the growth model in a functional form that can be analyzed empirically, in practice, that is the economic model can be translated into regression model in several ways. Therefore, the results of the analysis relate to the applied regression model and, obviously, cannot be valid universally. Further problems of the regression analysis is the biasedness of the coefficient estimates due to endogeneity, multicollinearity, reversed causality between the explanatory and explained variables etc.

Short-term vs. long-term

It is assumed that changes in the value of renewable natural capital, i.e. its extent and quality, would impact economic growth lagged in time. Intuitively, the degradation of an ecosystem would have affect economic performance right away, or after several years, nevertheless, the impact would sustain on a long term. The empirical research presented in the dissertation used long time series in the data panel, however, the lagged effect of changes in natural capital have not been taken into account. It could be comprehended that the results of the research are valid concerning effects on the short term. The long-term effects could be investigated using time series data of countries individually that can be the subject of future research.

5.3. FUTURE DIRECTIONS OF RESEARCH

The investigation presented in the thesis is an initial step regarding the empirical reaserch of sustainability of the wealth perspective that can lay out several further paths of research:

- The panel regression based on the data of 36 OECD countries can be extended to other country groups and countries, including the investigation of the sustainability of individual countries based on their time series data;

- The future development and improvement of the available data regarding both construct and content would, in the future, allow further clarification and actualization of the results of the analysis presented;
- The research with the national focus can be narrowed to smaller geographic regions, cities, that could provide further detailed relevance to the results of the higher level, as well as that of regional and local policies;
- The research methodology presented in the dissertation can be applied to investigating the sustainability of smaller actors of the economy, institution and companies, and also, it can be relevant regarding the research of the sustainability of the financial system;
- Linear regression, also applied in this research, is the most popular method of econometric research. However, it would be reasonable to study the applicability of other methods to the investigation of interrelations between various factors of sustainability.

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