How Well Green Variables Affiliate to Green Growth Perspective: Evidence from Europe

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Abstract The problem of suitable green growth oriented policies entails direct and indirect welfare costs on a country that chooses to subsidize or protect natural resources as its principal (cornerstone) approach for achieving sustainable economic development. Growing awareness of a (possible) ecological disaster and (necessary) environmental preservation has become a philosophical, social, economic, and even cultural force in support of the seemingly utopian notion that environmental conservation and economic expansion may coexist. Not only does the prevalent economic discourse see green growth as a solution for many environmental issues, but also other social participants (such as media, academia and politics) are now beginning to assert that economic expansion and environmental preservation are compatible. The aim of this paper is to consider different aspects of green growth by evaluating its cyclical behaviour in comparison to relevant green variables. By using the HP filter for extracting cyclical characteristics of the variables we will try to evaluate how well green variables affiliate to the green growth perspective of several European countries.

Keywords: green growth, green GDP, sustainability, natural resources, Europe

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1 Introduction

Economic progress has always been one of the most interesting and prevalent themes in social discourse, both in specialized scientific disciplines and political ideologies, as well as in the ordinary lives of people. The primary objective has always been to recognize the significance and influence of economic progress on all spheres of life including ecological questions, climate change, political dilemmas, urban development, social sustainability and etc. The balance between economic, ecological and social sustainability can be detected within the UN Agenda 2030, i.e. the Sustainable Development Goals as eradication of poverty and hunger, which guarantees a healthy life; ensuring access to basic services such as water, sanitation and sustainable energy; support for the creation of development opportunities through inclusive education and decent work; encouraging innovation and building infrastructure, creating communities and cities that are able to produce and consume sustainably; reduction of inequality in the world, especially external inequality; care for the environment and the fight against climate change, protection of oceans and terrestrial ecosystems; promoting cooperation between different social agents to create an environment of peace and sustainable development (Beg, 2018). It is exactly the coordinated mix of economic, environmental, and social elements that provides the backbone of sustainable development and green growth models that utilize natural, energy, and other resources responsibly for future generations!

The problem of suitable green growth-oriented policies imposes direct and indirect welfare costs on a nation that chooses to subsidize or preserve natural resources as its principal (cornerstone) approach for achieving sustainable economic development. Growing awareness of a (possible) ecological disaster and (necessary) environmental preservation has become a philosophical, social, economic, and even cultural force in support of the seemingly utopian notion that environmental conservation and economic expansion may coexist. Not only does the prevailing economic discourse see green growth as a solution to several environmental problems, but other social players (such as the media, academia, and politics) are now beginning to assert that economic expansion and environmental preservation are compatible. The purpose of this research is to examine various aspects of green growth by comparing its cyclical behaviour to pertinent green factors. Using the HP filter to extract the cyclical aspects of the variables, we will attempt to determine how well green variables align with the green growth viewpoint of a number of European nations.

2 The story behind Green economy – Green Growth – Green GDP nexus

There are various economic metrics that gross domestic product (GDP) does not reveal. Important aspects of the perception and evaluation of quality of life include living circumstances, health and social protection, education quality, a feeling of safety, and the level of environmental protection. Even if their level of living and national riches are not exceptionally great, the happiness and contentment with life of the overwhelming majority of a country's residents are based on their perception of the fairness of the distribution of national resources and the product achieved. The sense of satisfaction and pleasure is controlled by a multitude of elements, ranging from the home environment, social circle, and friendship, to work satisfaction and the possibilities of professional advancement and social advancement, as well as the strength of our social links with everyone (Beg, 2018).

Green growth is a concept used to represent economic development that makes sustainable use of natural resources. Globally, it is used to define an alternative to conventional industrial economic development. That path would lead to what is known as a green economy. On the other side, *Green economy* is defined as an economy that aims to raise issues related to the reduction of environmental risks and ecological deficiencies and that aims to achieve sustainable development without environmental degradation. It is closely connected to ecological economics, but its emphasis is more political. How therefore will we define green economic growth? The most effective method is to identify the causes of a single diagnostic indication that will aid in analyzing economic sustainability and green viewpoint. Motivation ranges from *economic* (GDP measure is a dangerously inadequate measure of quality of life because it counts what we produce and consume but ignores social costs, environmental outcomes, and income inequality), *ecological* (public is getting increasingly concerned with depleted natural resources and polluted environment, and other ecological issues), *philosophical* (human appetites and the population growth render non-market wellbeing measures to confront it with the society's material standard of living), *political* (green growth is generating diversity in positions, from enthusiastic to cautious, for it can be an opportunity, but also a risk that disfavours one country on international level) to even *methodological* questions (the lack of recognized methodological principles that would be the basis for reliable statistical data, thus an accurate accounting and valuation system of economic growth and development) (Stjepanović, Tomić and Škare, 2019).

In 2017, Stjepanović, Tomić and Škare (2017) introduced an alternative approach to sustainability and green development, which marks a significant step toward the reform of world economic thought by giving a practical technique and reliable statistics for evaluating economic success. Consequently, practical curiosity compels us to pose the following question: Can the concept of Green GDP support an ostensibly virtual growth model so that economic development can go hand-in-hand with greater improvements in physical, human, and natural capital, taking into account the dynamic process of globalization of economic dependence?! Green viewpoint is a politically and internationally significant idea, thus its operationalization and mitigation at the local level provide the greatest obstacle. There is often a high level of aspiration and political support for a green economy and green growth policies, particularly if they can improve social welfare and do not impede economic development (Menegaki, 2021). Global economic growth patterns, sustainability issues, stances on the distribution of wealth, questions on the degradation of environmental capital, and the lack of international environmental negotiations are now fundamental elements for policy actors and the political community to comprehend the green growth perspective (Stjepanović, Tomić and Škare, 2022).

3 Short review of related empirical literature

The overall evaluation of the literature reveals encouraging as it illuminates real ambition towards a green growth economy. Numerous international platforms have developed their own indexes to evaluate the performance of the green economy in order to assist policymakers, international organizations, civil societies, and the private sector, among others, in developing a common understanding of green growth and indicators that can operationalize its concept (Hussain et al., 2022). For example, the Global green economy index (GGEI), Green growth index (GGI), Green economy progress (GEP), Environmental indicator report, Nasdaq's OMX green economy index, System of National Accounts (SNA) and UN System of

Environmental-Economic Accounting (SEEA standards) (Stjepanović, Tomić and Škare, 2019).

Hongxian (2018) analyzed direct and indirect impacts of the growth rate of green GDP, which affects several ratios of energy consumption as well as the relationship between different energy sources. Likewise, (Al-mulali, 2014) describes the relationship between GDP growth and energy consumption. Vimochana (2017 examined the importance of environmental accounting and the policy alternatives accessible to economic decision makers by analyzing the methodologies of natural resource valuation used by several industrialized and developing nations. The findings imply that the implementation of the fundamental features of green accounting will illustrate the role of the environment in the economy, facilitate the study of macroeconomic issues with the aid of an accounting information system, and therefore set the economy on a sound course. Interesting papers on the Green GDP and related topic are systemized by Stjepanović, Tomić and Škare (2022): for example see: Islam and Asad (2021), Kalantaripor and Alamdario (2021), Qi, Huang, and Ji (2021), Wang, Wang, and Wang (2020), Veklych and Shlapak (2013), Rauch and Chi (2010), Jiang (2007), Alfsen et al. (2006) and etc.

4 Methodology

The ideal approach for decomposing a data series into two components (long-term trend and stationary cycle) is still the subject of much discussion. This issue is even more significant in the context of business cycle analysis if the whole subsequent analysis is dependent on the findings of this filtering procedure. Taking into consideration fairly large literature that is criticizing HP filter, Ravn and Uhlig (2002) emphasised that this filtering method withstood the test of time and the intensity of discussion and criticism remarkably well, so it appear it will most likely remain the popular method for detrending in theoretically oriented researches for a long time to come. The prevalence of the HP filter in detrending time series is undoubtedly due to its simplicity in estimation and comprehension. Hodrick and Prescott's (1997) analysis was based on the assumption that time series are consisted of cyclical and growth components, so if growth accounting can provide estimates of growth components with errors that are small relative to the cyclical component, computing the cyclical component is just a matter of calculating the difference between the observed value and the growth component. It resulted in the creation of the filter that became the most popular method for removing long-run movements from the time series within the business cycle analyses. The HP filter focuses on removing a smooth trend τ_t from some given data y_t by solving next equation:

$$\min_t \sum_{t=1} ((y_t - \tau_t)^2 + \lambda((\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}))^2) \quad (1)$$

so the residual $y_t - \tau_t$ is then commonly referred to as the business cycle component. This is actually a linear filter that requires previous specification of a parameter known as lambda (λ). Giving the form of the observation (annually, quarterly or monthly) this parameter tunes the smoothness of the trend i.e. penalizes the acceleration in the trend component relative to the cycle component. Many point that the parameter λ does not have an intuitive interpretation for the user and that its choice is consider the main weakness of the HP filter. Non-the-less, HP filter has been applied in a number of relevant studies so far. According to Stock and Watson (1998) and Napoletano, Roventini and Sapio (2005), co-movements between variables are revealed through the cross-correlation of the cyclical component of each series with the cyclical component of Green GDP as a benchmark variable. This is the correlation between x_t and y_{t+k}, where x_t is the filtered series and y_{t+k} is the k-quarter lead of the filtered Green GDP. A large positive correlation at $k = 0$ (i.e. around lag zero) indicates the pro-cyclical behaviour of the series; a large negative correlation at $k = 0$ indicates counter-cyclical behaviour; and no correlation indicates acyclical behaviour of the series. A maximum correlation at, for example, $k = -1$ indicates that the cyclical component of the variable tends to lag the aggregate business cycle by one quarter. In other words, if the absolute maximum (or minimum) is achieved at some Green GDP lead, then the variable is denoted as *leading*, whereas it is called *lagging* in the opposite case. Finally, *coincident* variables are those displaying the bulk of their cross-correlation with real Green GDP at lag zero.

Quarterly data on green variables were collected from the World Bank statistics, World Inequality database and database offered by Stjepanović, Tomić and Škare (2022) for the period 1990 – 2019 To extract the business cycle component that represents the stationary cycle of the variable, we utilized the conventional value of 100 for the smoothing parameter, which corresponds to yearly frequencies. To test the integration properties we analyzed graphical displays of the variables and conducted three unit root tests; Augmented Dickey Fuller test, Phillips-Perron test and Kwiatkowski-Phillips-Schmidt-Shin test. Graphs and tests confirmed in general, the absence of a unit root in the observed variables which is an important property of detrended variables (results available upon request). Therefore, we introduced several green variables in our research. First, *Green GDP* variable (nominal value) as a baseline indicator, balancing the quantitative (standard methodological algorithm) and qualitative components of the green economy (opportunity costs). Next, the *Green gap* variable represents the gap between the Green GDP and standard GDP indicator. Variable CO_2 indicates carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring (expressed as kilotons). Next, the CO_2 *footprint* variable presents national footprint of total population with per-capita emissions, all ages, individual in purchasing power parity. Variable *Waste* includes total (commercial and industrial) waste (expressed in tonnes). Variable *Resource depletion* expresses adjusted savings of natural resource depletion as a percentage of the GNI per country, presents natural resource depletion as a sum of net forest depletion, energy depletion, and mineral depletion. Variable *Natural capital* includes the valuation of renewable and non-renewable natural capital. Renewable natural capital includes agricultural land (cropland and pastureland), forests (timber, and three ecosystem services: water, recretion and non-wood forest products), protected areas, mangroves and fisheries. Non-renewable natural capital includes fossil fuel energy (oil, gas, hard and soft coal) and minerals (bauxite, copper, gold, iron ore, lead, nickel, silver, tin, and zinc).

5 The results

First, we will evaluate basic properties and cyclical features of Green GDP dynamics by analyzing (graphical) relation between the basic variable and related green variables (available upon request). Next, through tables we will presents extracted cyclical components (variables denoted as *c_*) whereat we simply completed cross-correlations with lags/leads between the Green GDP and the variables with green affiliation, In addition to current correlation coefficients (*t-0*), lag/lead analysis was also introduced in order to determine if some variables lag, lead or coincide with fluctuations in Green GDP.

The graphical representation (available upon request) of all variables reveals a high degree of similarity in their oscillations; nevertheless, the severity of these fluctuations was not fairly distributed among variables when seen across nations. These findings are consistent with those indicated by the cross-correlation study. If we observe cross-correlation coefficients among all countries (Tables from 1 to 6), we can notice relatively weak (but statistically significant) relationship between the green variables and Green GDP, with resource depletion being only variable that has shown continuous weak correlations across countries. Variables CO_2 and CO_2 footprint are shown to be mostly pro-cyclical and leading variables, together with Green gap variable which revealed strong pro-cyclical tendencies with statistically significant cross-correlation coefficients in leading, current and lagging patterns. Variables Natural capital, Resource depletion and Waste revealed counter-cyclical characteristics, however with mostly lagging indices.

Table 1: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Slovenia)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO₂	-0.30	-0.00	0.29	0.56	**0.64**	0.41	0.04	-0.13	-0.30
c_CO₂_footprint	-0.33	0.16	0.22	0.38	**0.43**	0.05	0.27	0.31	0.02
c_Green_gap	-0.21	-0.24	-0.25	-0.19	0.09	0.15	0.18	0.35	**0.51**
c_Natural_capital	-0.32	-0.11	0.12	0.39	**0.51**	0.40	0.33	0.34	0.21
c_Resource_depletion	-0.04	0.38	0.12	0.14	**0.44**	0.14	0.12	0.17	-0.07
c_Waste	0.02	0.07	-0.20	-0.33	**-0.39**	0.01	0.34	0.24	0.28

Source: Authors' calculation (in EViews 11)

Table 2: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Austria)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO₂	-0.10	0.07	-0.10	0.22	**0.36**	-0.08	-0.07	-0.25	-0.08
c_CO₂_footprint	**-0.17**	-0.04	0.01	0.09	0.14	-0.01	0.09	-0.15	-0.04
c_Green_gap	-0.16	-0.12	-0.07	-0.09	**0.90**	-0.16	-0.12	-0.01	-0.14
c_Natural_capital	-0.13	-0.13	0.10	-0.01	-0.07	**0.17**	0.06	0.11	0.05
c_Resource_depletion	-0.14	-0.10	-0.08	-0.01	**0.32**	0.02	0.08	0.14	-0.05
c_Waste	-0.10	-0.05	0.01	0.17	-0.01	-0.05	**0.30**	-0.03	0.02

Source: Authors' calculation (in EViews 11)

Table 3: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Hungary)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO2	-0.01	0.09	0.32	0.40	**0.44**	0.35	0.07	-0.09	-0.18
c_CO2_footprint	0.35	0.50	0.58	**0.61**	0.51	0.04	-0.22	-0.23	-0.34
c_Green_gap	-0.56	-0.36	-0.01	0.10	0.38	0.55	0.43	0.56	**0.63**
c_Natural_capital	-0.33	**-0.35**	-0.32	-0.28	-0.18	-0.08	-0.01	0.11	0.19
c_Resource_depletion	-0.25	**-0.32**	-0.16	0.04	0.04	0.16	0.20	0.12	**0.32**
c_Waste	-0.22	-0.35	-0.42	**-0.46**	-0.35	-0.43	-0.35	0.16	0.43

Source: Authors' calculation (in EViews 11).

Table 4: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Germany)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO2	-0.19	0.14	-0.13	**0.20**	-0.03	-0.17	0.09	-0.08	0.10
c_CO2_footprint	**0.17**	-0.09	-0.03	0.00	-0.07	-0.05	0.05	-0.01	-0.02
c_Green_gap	-0.14	-0.11	-0.14	-0.08	**0.96**	-0.12	-0.11	-0.06	-0.16
c_Natural_capital	**-0.24**	-0.20	0.11	-0.03	-0.05	0.23	0.09	0.06	0.02
c_Resource_depletion	-0.15	**0.20**	0.07	0.05	0.13	-0.07	-0.07	-0.02	0.11
c_Waste	**0.26**	-0.13	-0.25	-0.04	-0.04	0.09	0.06	0.17	-0.00

Source: Authors' calculation (in EViews 11).

Table 5: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Italy)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO2	0.07	**0.26**	0.15	0.21	0.20	-0.12	-0.19	0.23	-0.14
c_CO2_footprint	0.05	0.11	**0.17**	0.13	0.11	-0.10	-0.15	-0.08	-0.08
c_Green_gap	0.09	0.11	-0.05	**0.91**	0.35	0.07	0.04	0.12	0.12
c_Natural_capital	-0.12	-0.10	0.23	0.02	**-0.12**	0.14	0.02	0.06	0.01
c_Resource_depletion	**-0.23**	-0.20	-0.15	-0.03	0.19	0.10	0.15	0.20	-0.01
c_Waste	0.10	0.20	0.13	0.16	**-0.25**	0.01	0.02	-0.10	0.07

Source: Authors' calculation (in EViews 11).

Table 6: Cross-correlation to *c_GreenGDP* with lags and leads up to 4 periods (Croatia)

Variables	*t-4*	*t-3*	*t-2*	*t-1*	*t-0*	*t+1*	*t+2*	*t+3*	*t+4*
c_CO2	0.16	0.13	0.11	0.18	0.23	-0.15	**-0.25**	-0.20	-0.03
c_CO2_footprint	0.18	0.08	0.13	0.03	0.17	**-0.18**	-0.07	-0.10	-0.02
c_Green_gap	0.14	0.11	0.14	0.08	**0.97**	0.12	0.11	0.06	0.17
c_Natural_capital	**-0.22**	-0.15	0.18	0.12	-0.07	0.18	0.00	0.06	0.00
c_Resource_depletion	**-**0.16	-0.10	0.06	0.26	**0.26**	-0.19	0.07	0.14	-0.11
c_Waste	**-0.44**	-0.19	-0.10	0.30	0.08	0.15	0.17	-0.19	-0.10

Source: Authors' calculation (in EViews 11).

If we observe cross-correlation coefficients by countries, we can notice relatively strong pro-cyclical behaviour of almost all variables in *t-0* for Slovenia suggesting compatibility in trends between green variables (Table 1). A similar conclusion can be met for Austria, with relatively low pro-cyclical nexus in current time as well as in leading manner, suggesting that changes in some of the green variables could lead to a change in Green GDP (Table 2). In accordance to general results, Hungary provides evidence of relatively strong pro-cyclical behaviour of Green gap, CO_2 and CO_2 footprint variables and relatively modest counter-cyclical behaviour of Natural capital, Resource depletion and Waste variables (Table 3). For Germany, Italy and Croatia, we detect weak correlation coefficient with mixed indices, except for the variable Green gap suggesting unreliable positions for comparison (Tables from 4 to 6).

The majority of correlation coefficients are low to moderate in strength, indicating that the cyclical behaviour of the green economy does not have to be precisely tied to current developments (hence Green GDP within this research). Therefore, the usage of these variables does not need to represent the current state of green economy aspirations in the observed countries. Notwithstanding, the comparison of Green GDP as a more vague (and maybe accurate) metric of welfare with these or possibly others green variables could be interesting from the theoretical (macroeconomic modelling) and practical (predictive) perspective. In addition, a view that economic development and growth would eventually lead to environmental sustainability, the fact that developed countries consume more resources per capita than developing countries and the fact that ecological/economic impacts are felt elsewhere suggest that (comparability to) Green GDP has the potential to serve as a metric for sustainable progress policy and measure the efficacy of the means of implementation (policies or programmes) for pro-environmental initiatives (Stjepanović, Tomić and Škare, 2019). Most of the studies in this field of research are in compliance that extensive output growth coupled with increasing population leads to more fossil fuel, natural gas and oil and petroleum consumption that contributes towards higher levels of greenhouse gas emissions (suggesting that an increase in most of these activities made by human actions negatively affects green aspirations), hence it calls for a set of policies that would promote energy efficiency and security as well as decrease CO_2 emission on a global scale (for example, renewable energy plays an interesting, but still limited, role in promoting the green economy) without adversely affecting economic growth and green development prospects. Thus, it could encourage a shift in the risk-adjusted returns from investments that cause environmental harm to those that promote environmentally sustainable development.

6 Concluding remarks

Today, more than ever, the issue of whether fair and sustainable development can coexist with existing patterns of economic expansion is at the forefront. One notion stands out among the multitude of definitions that attempt to combine various dimensions of well-being in the aforementioned conceptual conflict. This is the notion of the Green GDP, or, in a larger sense, the effort towards green growth. By analyzing cross-correlation coefficients among six European countries (Slovenia, Austria, Hungary, Germany, Italy and Croatia) we detected weak correlation coefficient with mixed indices, except for the variable Green gap suggesting unreliable positions for comparison and evaluation of ongoing trends in each economy. However, from a modelling or forecasting viewpoint, the use of Green GDP (in contrast to other green variables) as a more accurate measure of wellbeing might be intriguing.

Separate environmental laws and investments in environmental protection in the studied nations are entirely independent; yet, a comprehensive environmental strategy is required to have a distinct economic and environmental effect Our findings show a necessity for environmental policies and strategies on the part of a country's government, but implementing this plan or achieving success needs the collaboration of all economic actors (Stjepanović, Tomić and Škare, 2022). This study has other limitations, such as the number of observed years. Although this time period shows a distinct dynamics, we would get much better results if we could analyze much broader time period Standard GDP as a measure of economic success and growth has several flaws, one of which is the environmental component. To strengthen monitoring and provide a more accurate picture of the country's economic position, it is important to add additional components to the present measure. However, in our study, we have emphasized the ecological aspect that we deem crucial for the continuation of civilization. In addition to these limitations, it will be essential for future and prospective study to pick a few more significant indicators of environmental policies in the observed nations and examine their trends and potential direct – causal influence on the Green GDP.

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