ESG performance and economic growth in Europe

Abstract

This study evaluates ESG performance at the country level and its link to economic growth. We ask two main research questions. First, does a country's economic growth depend on its ESG performance? Second, does a country's ESG performance depend on its GDP? We consider a range of indicators to evaluate ESG performance based on alternative methodologies to check their robustness. We find that the countries that joined the EU in 2004 or later have weaker ESG performance than Western European countries have; however, the decisive factors are social and governance issues, not environmental issues. These indications are robust in various settings. Further results reveal the existence of Granger causality between ESG performance and economic growth; however, ESG performance is proven to impact economic growth only in the middle to long term.

Keywords: economic growth, GDP, sustainable development, ESG indices

JEL codes: E01, O11, Q01

1. Introduction

Studies on various aspects of environmental, social, and governance (ESG) performance have proliferated in recent years. Although the concept of ESG performance is strongly associated with observed climate change and is widely understood among governments and societies, it is still difficult to measure and evaluate ESG performance at both the micro- and macroeconomic levels. As previous studies have indicated (e.g., Walter, 2020; Abhayawansa & Tyagi, 2021; Ahmed et al., 2021; Berg et al., 2022; Erhart, 2022; Sahin et al., 2022), the ESG ratings assigned to companies may differ significantly. Few studies have evaluated ESG performance at the country level, and the approaches used also differ (e.g., Capelle-Blancard et al., 2019; Pineau et al., 2022). Therefore, there is much room for further studies and experiments, which may bring us closer to achieving a standard for ESG performance evaluation.

European countries, especially those in the EU, are highly involved at the political and regulatory levels in meeting ESG commitments, as derived from the Paris Agreement. Moreover, the level of economic development in Europe varies by country, especially between postcommunist countries and Western European countries, as well as between Northern and Southern European countries. Thus, Europe is an interesting example of a group of diverse countries implementing the same ESG policy.

In this study, we analyse EU member countries, Norway, Switzerland and the UK from 2011-2020. The objective of the study is to evaluate ESG performance and its link to economic growth. Our contribution to the literature is twofold. First, following Capelle-Blancard et al. (2019), we suggest an alternative approach to estimate ESG indices. Second, we identify the relationship patterns between ESG performance and gross domestic product (GDP)-based measures in the considered group of countries; other studies do not cover a wide range of European countries. Since we believe that the causal relationship may occur in both directions, we develop the following two research questions. (1) Does a country's economic growth depend on its ESG performance? (2) Does a country's ESG performance depend on its GDP?

The remainder of the paper is organized as follows. In the next section, a review of the literature is presented. In Section 3, we explain the data sources and methodology, while in Section 4, we present and discuss the results. The last section concludes the paper.

2. Literature review

In this section, we present a review of ESG studies conducted at the country level with special attention paid to the ESG indicators developed in the literature.

2.1. Areas of ESG studies at the country level

Sustainability is linked to the idea of a green economy, i.e., an economy that improves human well-being, reduces environmental risks, reduces ecological scarcity and improves social justice (Yang et al., 2022; An et al., 2021; Merino-Saum et al., 2018). Green finance, clean energy and the green economy should be considered important, though not primary, determinants of sustainable development, as highlighted by Qiao et al. (2021) and Ling et al. (2021) in their study. They identified primary determinants of sustainable development: government-implemented innovation strategies, competition mechanisms and regulatory measures. Countries that perform well in terms of ESG are perceived as being more credible, having less risk and providing a better environment for development. The literature indicates that ESG performance affects economic growth, debt and debt servicing costs as well as credit risk and reputation.

According to Capelle-Blancard et al. (2019), good ESG performance signals a country's commitment to sustainability and long-term orientation and provides a buffer against negative shocks, leading to smaller government bond yield spreads. Twenty countries, which are members of the Organisation for Economic Co-operation and Development (OECD) were studied between 1996 and 2014, and the results indicate that above-average ESG performance is associated with lower default risk and thus smaller government bond spreads. The results also show that the social and corporate governance dimensions have a significant negative relationship with government bond yield spreads, while the environmental dimension does not. According to Pineau et al. (2022), ESG factors affect sovereign creditworthiness in developing emerging countries. Furthermore, Reznick et al. (2019) found that ESG ratings and government bond spreads are negatively related but that this relationship is more significant for developed economies than for emerging markets.

A country's sustainable development, in terms of both social and environmental frameworks, impacts direct business financing related to debt servicing costs. A better risk profile and greater ability to repay capital at maturity are rewarded to investors with smaller spreads required from bond issuers. This finding is supported by the research of Hoepner et al. (2016), who indicated that a one-unit increase in a country's stability score is associated with an average decrease in the cost of debt of 64 basis points. The above study covered 470 loan agreements signed between 2005 and 2012 with borrowers from 28 countries worldwide operating in all major industries. Eliwa et al. (2021) investigated whether lending institutions in 15 EU countries consider ESG performance and disclosure in their lending decisions and whether these factors influence the reduction in the cost of debt capital. The above authors provided evidence that ESG performance and ESG disclosure affect the cost of debt. This situation is more pronounced in stakeholder-oriented countries (i.e., those where sustainability issues are more prevalent) than in other countries. Apergis et al. (2022) confirmed that a better ESG rating is associated with a lower cost of unsecured debt in the primary bond market. The above authors investigated whether companies in the S&P 500 between 2010 and 2019 that exhibit good ESG performance benefit from smaller bond spreads and better bond ratings compared to companies with poorer ESG performance.

According to Stellner et al. (2015), a country's ESG performance positively affects its credit risk. Better corporate social responsibility (CSR) performance results in lower credit risk, as measured by credit ratings and zero-volatility spreads (z-spreads), if the country of operation has a good ESG rating. The above study was conducted on a sample of 872 bonds of companies located in 12 eurozone countries between 2006 and 2012. The results show that entities that have aligned themselves with a country's ESG performance pay the smallest spreads. Hübel (2022), who investigated the role of countries' ESG performance in sovereign credit default swap (CDS) markets, obtained similar findings. The above research was conducted for 60 countries from 2007 to 2017. The results show that countries with better ESG scores have smaller CDS spreads and that the risk mitigation effect of ESG is more pronounced in the long run than in the short run. However, some studies have indicated that ESG performance has a neutral effect on business financing decisions. According to Vetri et al. (2023), ESG factors neither improve the efficiency of utilities nor are complementary criteria for banks when making lending decisions.

A country's sustainability performance, as measured by ESG indices, influences its economic growth, as confirmed by Diaye et al. (2022). These authors examined the economic effects of ESG performance in 29 OECD countries between 1996 and 2014. The results show that there is a positive relationship between ESG performance and GDP per capita in the long term but that no such relationship exists in the short term. Similar findings were also obtained by Ho et al. (2023), who surveyed 118 countries between 1999 and 2015, and their results show that there is bidirectional causality between environmental and social performance and economic growth.

In the literature a couple of studies have been dedicated only to a selected area of ESG performance. For example, studies on environmental factors conducted by Adams et al. (2020) and Long et al. (2015) indicated two-way impacts, i.e., a positive impact of environmental policy on economic growth through innovation and an impact of economic growth on environmental policy. The impact of governance on economic growth was studied by Huang & Ho (2017). This study covered 12 Asian countries from 1996-2014. The results show that governance effectiveness and the rule of law influence economic growth. In a study by Fayissa & Nsiah (2013), it was found that good governance contributed to differences among 39 countries in sub-Saharan Africa; thus, the authors concluded that the role of governance in economic growth depends on the income level of the countries studied. They also indicated that the importance of sustainable development in a country depends on its level of economic development. Rodriguez & Valdes (2019) studied the relationship between GDP and healthcare spending for a group of Latin American and Caribbean countries and for OECD countries from 1995 to 2014. Their study showed the absence of a causal relationship over the long term. The relationship between economic growth and social development and the ESG indices was studied by Tanjung (2021), who examined 9 Asian countries over the period 2010-2018. The above study confirmed the link between GDP and ESG indices in the countries studied but did not confirm the link between social development and sustainability.

Research on the sustainable development of countries has been conducted for different groups, usually for developed countries and emerging countries. This approach, of course, is justified, as these countries are characterized by different economic parameters, which makes them diverse. A study by Ho et al. (2023) revealed the different impacts of GDP on CO2 emissions for different income groups of countries. For emerging countries, GDP growth increases CO2 emissions due to extensive production growth, which leads to greater fossil fuel consumption and contributes to higher emissions. For developed countries, GDP growth can either increase or decrease CO2 emissions. Moreover, Yang et al. (2022) examined G7 countries from 2010 to 2018 and showed that each ESG area has an impact on the economy when analysed individually. In a study by Adams et al. (2020) on the impact of environmental factors on economic growth, countries were selected in terms of geopolitical risk proxied by greenhouse gas emissions. These countries were diverse in terms of the economic parameters that characterize their economies but similar in terms of the characteristics under study.

2.2. ESG indicators at the country level

The range of ESG indicators used to assess countries' performance varies. However, the most commonly used indicators are proprietary sets of indicators (e.g., Capelle-Blancard et al., 2019; Pineau et al., 2022; Ogundajo et al., 2022; Diaye et al., 2022) or ESG ratings (e.g., RobecoSAM and Vigeo country ESG ratings). ESG ratings are created by rating agencies based on financial and nonfinancial information from many business entities. The ways in which ESG ratings are designed vary, which makes it difficult to compare the results obtained. Berg et al. (2022) identified three sources of discrepancies in ESG ratings: scope, measurements and weights. This finding has been confirmed by studies relating to individual rating bases; e.g., Erhart (2022) identified three types of differences between ESG Refinitiv and Sustainalytics ESG. The first difference is related to the direction of the sustainability risk score scale; for Sustainalytics ESG, the lower the score is, the better, while for ESG Refinitiv, the opposite is true (i.e., the higher the score is, the better). A second important difference is that Sustainalytics calculates scores that are comparable across industries, whereas Refinitiv's scores are specific to individual sectors. The third difference is that the Sustainalytics score scale is narrower. Discrepancies between the ratings and rankings provided by different rating agencies were also identified by Abhayawansa & Tyagi (2021), who attributed these discrepancies to design (e.g., definitions of terms), measurement methods and commensurability.

Concerns regarding the methodology of ESG ratings, including the comparability of sustainability scores based on data from the same ESG providers, have also been raised in the literature (Sahin et al., 2022; Ahmed et al., 2021; Erhart, 2022; Drempetic et al., 2020; Yu & Luu, 2021; Berg et al., 2022). Authors have usually pointed to the problem of postpublication revision of the results, which is performed by ESG Refinitiv. However, this approach undermines the reliability of the assessments and their usefulness.

For example, Gyönyörová et al. (2023) investigated the consistency and convergence of ESG data from the S&P Global 1200 index and revealed significant uncertainty in terms of the extracted latent factors. Angelova et al. (2021) reviewed the credit rating methodologies of three rating agencies—Moody's, Standard and Poor's, and Fitch—in the context of ESG risk considerations. Lines of improvement were proposed for indicator selection, normalization, aggregation and weighting procedures, as well as for the use of the sovereign rating indicator in conjunction with climate change scenarios. Genc & Basar (2019) examined the economic, social and political factors used to determine the debt sustainability of countries at three rating agencies: Standard and Poor's, Moody's and Fitch. The research showed that of the three rating agencies, Moody's makes the most optimistic estimates of country ratings, while Fitch makes the most pessimistic. Hubail (2014) examined country risk ratings for 70 countries from 2006 to 2011 based on ratings provided by rating agencies and the Euromoney and Economic Intelligence Unit. The impacts and importance of economic and political factors varied significantly in predicting the risk ratings of agencies for different country groups and different periods. Hoti & McAleer (2004) analysed risk assessment methodologies for twelve countries from six geographical regions. The authors also showed methodological differences in terms of risk assessment. The largest problem, however, is the scope of baseline indicators used to measure a given ESG area.

An analysis of the literature shows that the most popular is the set of 18 indicators used by Capelle-Blancard et al. (2019). It was used in studies by Diaye et al. (2022), Pineau et al. (2022) and Hübel (2022), for example. These indicators were divided into three indices, namely, an environmental quality index (E index), a social development index (S index), a governance quality index (G index) and finally a total composite index (ESG index). The scopes of the above indices are shown in Table 1.

< Table 1 >

The ESG indices of 20 countries between 1996 and 2014 were analysed, and the results reveal relatively high scores for the G and S indices and relatively poor scores for the E index. In addition, Capelle-Blancard et al. (2019) found that there was a much greater amount of variation in social and environmental issues than in governance issues. The findings were most positive for Nordic countries, New Zealand and Canada. In contrast, Italy, Ireland and Greece were ranked lowest.

Pineau et al. (2022) used different sets of indices. These indicators are presented in Table 2.

< Table 2 >

They used ESG and non-ESG (macroeconomic) meta-variables to explore the relative importance of ESG and non-ESG factors in sovereign creditworthiness assessment. The analysis covered 110 countries between 1997 and 2018. The research showed that governance factors (G) are important causal meta-variables for advanced economies, while environmental factors (E) are the major causal meta-variables for emerging markets.

Yang et al. (2022) used three independent variables: green finance, clean energy and green economic growth. These three variables are presented in Table 3. The analysis of the findings shows that ESG practices enhance the growth of the green economy and that governments in G7 economies need to promote ESG practices by increasing their level of investment in green bonds.

< Table 3 >

Ogundajo et al. (2022) analysed only sustainability factors related to the area of governance. Six indicators, as shown in Table 4, were included.

< Table 4 >

The results for 2011–2020 showed that the rule of law is a country-level governance factor that strongly influences a country's position and development. Ogundajo et al. (2022) noted the need to improve the methodology, including both the selection and definition of indicators and the introduction of rules for data collection and updating.

All in all, we conclude there is a variety of approaches to rate or evaluate the ESG performance and no approach is treated as a widely accepted standard. Against this background, we followed Capelle-Blancard et al. (2019) whose approach has been gaining in popularity, especially as a source of ESG indices to test its possible implementation in different settings.

3. Materials and method

In this section, we explain the scope of our dataset, the methodology used for the ESG indices and the causality analysis performed.

3.1. Data

We collected country-level data from publicly available sources, i.e., Eurostat, the World Bank (WB) and the International Monetary Fund (IMF), for EU member countries plus Norway, Switzerland and the UK for 2006-2021. Due to missing values, we used 300 country-year observations and reduced the time frame to 2011–2020[1]. In the selection of variables, we followed the methods of Capelle-Blancard et al. (2019) and Pineau et al. (2022), with certain exceptions, especially for "E". The list of variables is presented in Table 5. We used fewer variables (15) than did Capelle-Blancard et al. (2019) and Pineau et al. (2022).

Regarding the "E" component, Capelle-Blancard et al. (2019) focused on air quality, wastewater, forests and renewable energy, while Pineau et al. (2022) selected CO2 emissions, natural resource depletion, forests and three variables representing the role of agriculture. We selected variables representing the sectors of the economy that play a crucial role in environmental protection. Therefore, we included (1) the construction industry and (2) agriculture, forestry and fishing. Then, we considered the country's role in (1) the

[1] Overall, 17 values of the considered variables were imputed in the 2011-2020 period. Sixteen of the imputed values were related to the school enrolment variable, which constitutes approximately 5% of its values in the sample.

environmental goods trade and (2) low-carbon technology products. Finally, we accounted for the country's expenditure on environmental protection. All these variables may be treated as proxies for a country's environmental policy.

Regarding the "S" component, we introduced "voice and accountability" as a variable reflecting societal freedom and "individuals using the internet", which plays an important role in social life quality, instead of "access to electricity", to capture a broader context.

Although two series increase over time, this does not mean that one of these series causes an increase in the other series. Even if that were the case, it is still far from obvious which of them is the cause and which is the effect, and bidirectional causality may frequently arise. Since our primary objective is to identify the pattern of the relationship between ESG performance and GDP-based measures in the considered group of countries, we believe that this causal relationship may occur in both directions.

3.2.ESG indices

To address our research questions, a composite measure for each ESG dimension first needs to be constructed. This stage of the process is difficult because there are numerous indicators that can be considered descriptors of each dimension of ESG performance; thus, they need to be efficiently merged into a single figure. Capelle-Blancard et al. (2019) suggested that principal component analysis (PCA) is an adequate tool for addressing this issue; these authors used a total of 18 variables divided into three groups of 6 each for the three ESG dimensions and applied PCA to construct the compound E, S and G indicators (and afterwards constructed a final ESG measure as a weighted average of these three dimensions). Although this approach seems to be an attractive alternative, several problems remain unsolved. The key is that PCA extracts the common components as long as the variables of interest are highly correlated in the sense of Pearson's linear correlation. However, we claim that this approach is inadequate for determining such correlations among the candidate variables. First, high correlations among the variables that are used to measure the same dimension do not necessarily arise; for example, environmental dimension descriptors such as forest area (as a % of total area) and renewable electricity output (as a % of the total of the energy) are both clearly valid; however, they are not necessarily strongly correlated because they represent different aspects of the same environmental dimensions. Second, even if the measures are strongly related, this does not necessarily imply a linear correlation. The high correlation among the variables used to measure the same ESG dimension implies their redundancy and may also be considered a reason to reconstruct the set of measures and propose new measures that would be orthogonal to a greater extent. It is not entirely clear whether the correlation condition is met in Capelle-Blancard et al.'s (2019) analysis; while these authors mention the Kayser–Meier–Olkin (KMO) requirement that corresponds to the aforementioned correlations[2], they do not provide the KMO values. Although not clearly stated, the above authors supposedly perform the analysis with the use of time series for the considered countries rather than with the use of a single observation per country (for example, averaged over time). Since there is no mention of the verification of the stationarity assumption, there is a high risk of nonstationarity (for example, the increasing popularity of renewable energy results in its increased share in the energy mix). Given that the nonstationarity of more than one time series may result in spurious correlations, applying PCA based on time-series data requires a different approach (Hamilton & Xi, 2023). Furthermore, the above perform PCA with all 18 considered measures of all three ESG dimensions together. However, assigning particular variables to different dimensions is somewhat arbitrary and not confirmed by the data. The analysis of the PCA loadings[3] reveals that the first component loading (interpreted as the "G" group loading) on school enrolment is actually higher than the second component loading (interpreted as the "S" group loading), which casts doubt on where this variable belongs if the data-driven algorithm is applied. Conversely, the loading of the third component of political stability (the "E" group loading) is greater than the loading of the third component of wastewater treatment. Given that further analysis is based on the assumption that out of the 18 variables of interest, there are essentially 6 representatives of each ESG dimension and that each of the measures belongs to exactly one group, which is quite arbitrary, such an approach raises doubts. In contrast, one may claim that the variables that are aimed at measuring the same reaction should be related to one another. As a result, we follow the beaten track and construct indices with the use of PCA; however, we modify the work of Capelle-Blancard et al. (2019) in a few ways. First, we assign each of the considered variables to one of the groups and perform separate PCA for each of the dimensions. Second, we use averaged data from the 2011–2020 period to avoid nonstationarity problems, which can yield spurious (overoptimistic) correlations. Third, we replace the level data with first differences if the KMO statistics benefit from such an approach. Table 5 provides the set of variables used in PCA, their form

[2] Please refer to Capelle-Blancard et al. (2019), Appendix, note to Table A.1.3. (p. 166).
[3] Please refer to Capelle-Blancard et al. (2019), Appendix, Table A.1.5. (p. 166).

(level/difference), their division between the three dimensions and the respective KMO statistics.

< Table 5 >

This step of the procedure may be viewed as model selection. We decide upon the final set of the E, S and G indicators used and their final forms based on the KMO statistics for the 2011–2020 averaged data: the initial candidate variables are selected/rejected in the level/difference form in the way that maximizes the KMOs in each dimension. As shown in Table 5, the KMO values are quite high for the G dimension, acceptable for the S dimension and at the edge of being acceptable for the E dimension. This finding seems understandable and typical given the different levels of heterogeneity among these dimensions, with the environmental indicators being the most heterogeneous: while the governance indices are consequently higher for some countries and lower for other countries, the different environmental aspects may place the same country at the top of the ranking in the case of one measure and far down in the ranking in the case of another measure. Obviously, these values would be substantially greater when nonstationary series are used (not averaged across countries). However, this approach would likely yield spurious correlations and thus should be avoided. The final step of this part of the procedure is to reperform PCA for the above-selected shape for each year between 2011 and 2020. Then, for each year and country, we obtain the three main PCA components[4] (as the sum of products of the particular PCA loading factors and the corresponding values of the variables for the given country in the considered year). The attained three components (within the given country and year) are then weighted based on the total variance in the given factor explained by the particular components. As a result, we obtain three indicators (E, S and G) for each country in each year from 2011–2020:

$$PC_{i,d,t} = l1_{i,d,t}x1_{d,t} + \cdots + l5_{i,d,t}x5_{d,t} \qquad [1]$$

where i=1,2,3 is the number of principal components, d={E,S,G} is the considered ESG dimension, $lj_{i,d,t}$ are the factor loadings for the jth factor (j=1,…,5) of dimension d for the ith principal component computed for year t (t=2011,…,2020) and $xj_{i,d,t}$ is the jth factor (descriptor) of dimension d in year t. Furthermore, the PCA-based index of dimension d is obtained as

[4] The number of principal components is selected basing on Kaiser's criterion.

$$I_{d,t,PCA} = \sum_{i=1}^{3} PC_{i,d,t} \cdot E_{i,d,t}/(E_{1,d,t} + E_{2,d,t} + E_{3,d,t}) \qquad [2]$$

where $E_{i,d,t}$ is the eigenvalue for the *i*th principal component in the analysis of dimension *d* computed on the data from year *t*.

The low values of the KMO statistics raise doubts about the usefulness of the ESG indicators obtained via PCA. As a consequence, we also compute different types of ESG indicators. To ensure the comparability of the results, we continue the analysis using the same variables as those in the PCA procedure. However, we consider two functional forms: (a) variables always in levels (as in the mainstream literature) and (b) variables converted to differences if the same cases as those in the PCA are used (as shown in Table 5). For the two aforementioned cases, we provide two types of ESG indicators based on the (1) rankings and (2) standardized values of the measures used. The ranking-based indicators are constructed in the following way. For each of the considered descriptors of dimension *d* in year *t,* we rank the countries based on the value of the given descriptor, assigning values of 1,…,30 to represent the position of the country in the ranking for the given descriptor[5]. Let $rj_{d,t}$ be the position of considered country *c* in the ranking based on factor *j* (*j*=1,…,5) of dimension *d* (*d*={E,S,G}) computed for year *t* (*t*=2011,…,2020); as long as the values of the considered factors are untied, $rj_{d,t}$ is ranked from 1 to 30. The overall ranking-based index of dimension *d* in year *t* for a given country is obtained as

$$I_{d,t,RANK} = \sum_{j=1}^{5} rj_{d,t} \qquad [3]$$

The main advantage of the ranking-based indicators is that they are not affected by the atypical values of any variables; regardless of whether the distance in the considered variable is small or large, this value is converted to the same difference in the ranking. Conversely, this situation also means that the given difference in the rankings may imply large and small differences in the values of the descriptors. Thus, an alternative approach based on the values of the considered ESG factors is employed. Using the same variables and the same two variants based on levels and differences[6] as in the case of the ranking-based indicators, the value-based indicators are

[5] Except for the unemployment rate, an increase in the value of the given descriptor increases the value of the considered ESG indicator. As a consequence, countries are ranked ascendingly in all the descriptors and descending in the case of the unemployment rate. This procedure is the same in the case of the descriptors given in levels and in that after the transformations described in Table 5.

[6] See Table 5.

constructed. The overall value-based index of dimension *d* in year *t* for a given country is obtained as the sum of the standardized descriptors of dimension *d* in year *t* for a given country.[7]

$$I_{d,t,VALUE} = \sum_{j=1}^{5} xsj_{d,t} \qquad [4]$$

Standardization solves the scale problem (different scales for different variables may result in inadequate treatment if the absolute values are considered). However, the outstanding performance of a country in one category may result in the whole index being excessively optimistic, despite its possibly poor performance in other components of the same dimension.

3.3.Causality analysis

We use the concept of Granger causality to address the concerns of causality. The aforementioned procedures provide a set of ESG indicators for each country and year; thus, a panel dataset is obtained. We use the half-panel jackknife (HPJ) Wald-type test, developed by Juodis et al. (2021), for Granger noncausality. Importantly, while under the null hypothesis, the Granger-type tests for panel data state that there is no causality in the Granger sense for any of the series that constitute the panel data, rejecting the null hypothesis does not necessarily mean that causal relationships occur for all the series.

We consider three noncausality hypotheses: (H1) the considered ESG indicator is not Granger caused by GDP, (H2) the annual real GDP change is not Granger caused by the considered ESG indicator, and (H3) a 5-year real GDP change is not Granger caused by the considered ESG indicator (averaged in the considered 5-year period). Hypothesis H2 is provided mostly for completion. The nature of the GDP dynamics with short-term incidental fluctuations suggests the use of medium-term horizons and 5-year differences rather than annual differences.

4. Results and discussion

4.1. ESG indices at the country level

First, we present the results based on the average values obtained through the use of the PCA approach (Figure 1) and then consider ESG value-based and ranking-based indicators (Figure

[7] Like the case of the ranking based indicators, a minor amendment is required in the case of the unemployment rate: its values are subtracted instead of added to reflect the opposite influence of the unemployment rate on the value of the indicator.

2). We also present the value-based and ranking-based indicators for each component in Figure 3. The results for each country are presented in Appendix A.1.

< Figure 1 >

Indices based on the PCA approach show that, on average, the best (top 5, i.e., the highest value of the indices) ESG performance was achieved by Switzerland, Norway, the Netherlands, Denmark and Luxemburg, while Italy, Greece, Croatia, Romania and Bulgaria had the worst performance. These results are largely consistent with the "S" and "G" indices, while for the "E" component, the results deviate somewhat. The top 5 performers in the "E" dimension were Slovakia, Czechia, Spain, Italy and Greece, while the bottom 5 performers were Estonia, Norway, Sweden, Finland and Denmark. These results are counterintuitive because Nordic countries are generally considered leaders in environmental protection. A tentative explanation may be provided by the use of raw data for these countries (Appendix A.2). Among the top performers, this result represents the downturn of construction in industry starting from the time of the global financial crisis. A lower construction value added (as a percentage of GDP) is overall environmentally friendly. In the case of Slovakia and, to some extent, Czechia, the main driver of "E" top performance is the increased role of countries as exporters of the environmental good trade balance (as a percentage of GDP) and the trade balance in low-carbon technology products (as a percentage of GDP). The main industrial sector in both Slovakia and Czechia is the automotive industry, which includes the production of both electric cars and special-purpose electric batteries. Thus, the development of electromobility and changes in the automotive market have contributed to improvements in the environmental indicators in these countries. Notably, the top 5 performers in the "E" dimension include countries that have well-developed tourism sectors. Therefore, a large share of agriculture, forestry and fishing in GDP was recorded. These countries also increased their expenditures on environmental protection (% of GDP) at a slightly greater level than did other countries.

For the five countries with the lowest performance in the "E" dimension, first, the situation in the construction industry was stable; however, in most of the cases, these countries, especially Norway and Denmark, reduced their role as exporters of the trade balance of environmental goods and trade balance in low-carbon technology products. Overall, expenditures on environmental protection (as a percentage of GDP) have been stable over time, except for Belgium, which faced an increase from 0.8% to 1.5%.

In the case of value-based indicators, the higher the value is, the better the situation in terms of ESG overall or for each component, namely, “E”, “S” or “G”. For rank-based indicators, the lower the value is, the better the ranking.

< Figure 2 >

The value-based and rank-based measures, in which we used variables defined in the same way as were those in the PCA approach, provided almost the same results for the top and bottom performers. The best ESG performance was achieved by the Netherlands, Norway, Finland, Denmark and Switzerland (Luxembourg was the sixth in terms of value-based measures and fifth in terms of rank-based measures in exchange for Switzerland). Italy, Croatia, Romania, Greece and Bulgaria were among the worst performers. These results are also comparable to those of the PCA.

Scandinavian countries and Switzerland are recognized as leaders in the implementation of ESG practices, largely due to their high levels of economic development. This finding may confirm the link between the level of economic development and ESG performance. An analogous conclusion follows for the countries considered the worst performers; i.e., Romania and Bulgaria are the least developed European countries.

However, when we used only the levels of variables (marked by _R), the list of countries differed. Romania, Lithuania, France, Norway, and Czechia (Austria being in 6^{th} place) are recognized as top performers, while Finland, Malta, Croatia, Deutschland and Latvia are recognized as bottom performers. These differences in results confirm that the selection of variables and their form may have a considerable impact on final ESG rankings.

After these results were combined with the value-based assessment, it was found that only Finland and Romania scored in line; i.e., they were placed in two groups. Finland is the leading country in terms of the implementation of ESG practices, and Romania is the least committed country in terms of the implementation of sustainability practices. Finland is a highly industrialized economy with a GDP per capita that is slightly greater than that of Germany and Belgium. Moreover, Finland is considered an innovative country with a dominant share of exports in machinery, mechanical and electrical equipment, and their parts. Romania is a country with a large shadow economy and a great degree of regional disparities in education, health and transport. The ESG scores of the countries indicated are therefore in line with their levels of economic development.

Figure 3 shows the ranking results for each ESG component.

< Figure 3 >

However, for the "E" dimension, indices based on transformed and raw data (on the levels of variables) provide similar results, often different for those for the "S" and "G" dimensions, which shows that how data are treated may generate different results, even in the case of variables used in the academic literature for a long time.

Against the background of the results of Capelle-Blancard et al. (2019), only those countries that were included in both studies could be compared. Thus, our bottom performers, such as Croatia, Romania and Bulgaria, are excluded. Greece and Italy also performed poorly in Capelle-Blancard et al. (2019), while our top 5 countries were included in the top 10 countries in Capelle-Blancard et al. (2019); however, the period of their analysis ended in 2014.

< Table 6 >

Additionally, we compared the ESG results for "new" (i.e., joining the EU beginning in 2004, mostly postcommunist countries) and "old" European countries, as well as for Southern and Northern European countries. In all the settings, the ESG indices for "old" countries were better than those for "new" countries (see Table 6). Although "new" countries obtain better results in the "E" category, their achievements are worse in the "S" and "G" categories. This finding may be treated as a sign that it is easier to adjust the economy to market rules than to change societal and political landscapes. The situation in the countries in Northern Europe is better than that in the countries in Southern Europe, which is in line with the findings of D'Orazio & Thole (2022) for climate-related financial policy.

4.2. Causality link between ESG performance and economic growth

The results of the causality analysis are provided in Table 7. The *p* values refer to the hypothesis that there is no causality; i.e., values below the preassumed level of significance indicate that, at least in some of the countries, the Granger causality relationship exists. In the discussion below, wherever we refer to the significance of a variable, for brevity, we assume significance at the 10% level. Three blocks correspond to three types of considered noncausality hypotheses: (H1) the considered ESG indicator is not Granger caused by GDP, (H2) the annual real GDP change is not Granger caused by the considered ESG indicator, and (H3) a 5-year real GDP change is not Granger caused by the considered ESG indicator (averaged in the considered 5-year period).

< Table 7 >

Based on these results, H1 and H3 are rejected. A change in GDP impacts ESG performance (H1), while ESG performance impacts GDP in the medium term (H3) but not in the short term (H2). The role of GDP change in ESG performance, regardless of the time horizon, may be motivated by the government and private sector's attitudes towards investments in new priorities, such as ESG. When economic performance and perspectives are positive, various entities are inclined to invest in new priorities. However, such an investment does not immediately lead to positive results. Conversely, when economic performance or perspectives are poor, the government and private sectors may stop such investments and readjust their interest towards activities that may offer immediate results. Why does ESG performance impact GDP only in the medium term? Changes in each of the three components take time to adjust to new requirements. As our study shows, for postcommunist countries, such adjustments in the "S" and "G" dimensions are difficult. Even more than 30 years after the collapse of communism, these countries performed worse than their Western counterparts did. We claim that the economy may benefit from "E" performance in the medium to long term, as such performance requires structural changes in, e.g., industry, agriculture and society. The results of pro-environmental investments are not immediate; in fact, in the short run, such investments may reduce profitability.

These results are in line with those of Diaye et al. (2022) and Ho et al. (2023), who analysed different sets of countries for different periods. However, the above authors used only the indicators developed by Capelle-Blancard et al. (2019), while in this study, we applied a wide set of indicators based on various methodologies. As the results hold, regardless of the type of indicator considered, their robustness has been confirmed.

5. Conclusions

In this study, we aimed to evaluate the ESG performance of European countries and its link to economic growth for the period 2011-2020. Inspired by Capelle-Blancard et al. (2019), we followed their approach and suggested alternative solutions for estimating ESG indices. Our estimations showed that ESG performance in postcommunist countries and new EU entrants is lower than that in "old" European market economy countries. However, the differences are assigned to the "S" and "G" dimensions, not the "E" dimension, which may demonstrate that societal and political changes are more difficult to achieve than economic change is.

Additionally, the differences between Northern and Southern Europe were explored, and we found that ESG performance in Northern Europe was better than that in Southern Europe. Our results for the top and bottom performers are robust, regardless of the approach used to calculate the ESG indicators. The exceptions, however, are indicators estimated for the levels of different variables (marked as _R). We identified the Netherlands, Norway, Finland, Denmark and Switzerland (all from Northern Europe) as the top performers, while the bottom performers were Italy, Croatia, Romania, Greece and Bulgaria (all from Southern Europe).

We explored the causal link between ESG performance and GDP-based measures in European countries for all ESG indicators applied in our study. We found that a change in GDP is meaningful for ESG performance, while ESG performance is meaningful for economic growth only in the medium term (i.e., 5 years). These findings are in line with those of previous studies by Diaye et al. (2022) and Ho et al. (2023) and serve as a confirmation that ESG performance may improve economic growth prospects with some time lag.

Our study has several limitations. First, one should note the limited availability of long-term series of variables falling within the scope of an ESG. To ensure comparability among countries, researchers may not include variables that could explain ESG activities well due to gaps. Therefore, the inclusion of ESG performance in economic growth models is still limited. Second, measuring ESG performance at the country level is a relatively new concept with no well-grounded theoretical background. On the one hand, ESG regulations may be analysed at the country level, as many countries have pronounced their commitment to ESG (see, e.g., D'Orazio & Thole 2022). On the other hand, actual ESG commitment should be evaluated through the use of activities and changes in policy rather than through words and declarations. We claim that the impact of activities undertaken to meet ESG commitments is still difficult to measure. Thus, the implementation of the EU taxonomy can help overcome this obstacle in the future.

Future research should focus further on the selection of ESG variables in empirical studies for the purpose of evaluating ESG performance to build a widely accepted standard and reduce the degree of divergence.

For policy making in the EU, we postulate that the divergence of countries' economic and social situations should be considered when designing EU-wide ESG policies. Again, the one-size-fits-all approach seems to not be an optimal solution and may not yield the required results.

References

Abhayawansa, S., & Tyagi, S. (2021). Sustainable investing: the black box of environmental, social, and governance (ESG) ratings. *The Journal of Wealth Management*, 24(1), 49-54. https://doi.org/10.3905/jwm.2021.1.130

Adams, S., Adedoyin, F., Olaniran, E., & Bekun, F. V. (2020). Energy consumption, economic policy uncertainty and carbon emissions; causality evidence from resource rich economies. *Economic Analysis and Policy,* 68, 179-190. https://doi.org/10.1016/j.eap.2020.09.012

Ahmed, M., Gao, Y., & Satchell, S. (2021). Modeling demand for ESG. *European Journal of Finance,* 27(16), 1669-1683.1. https://doi.org/0.1080/1351847X.2021.1924216

An, H., Razzaq, A., Nawaz, A., Noman, S., & Khan, S. (2021). Nexus between green logistic operations and triple bottom line: evidence from infrastructure-led Chinese outward foreign direct investment in Belt and Road host countries. *Environmental Science and Pollution Research,* 28(37), 51022-51045. https://doi.org/10.1007/s11356-021-12470-3

Angelova, D., Bosello, F., Bigano, A., & Giove, S. (2021). Sovereign rating methodologies, ESG and climate change risk: an overview. *Working Papers Series*, Department of Economics, Ca' Foscari University of Venice, 15/WP/2021. http://dx.doi.org/10.2139/ssrn.3841948

Apergis, N., Poufinas, T., & Antonopoulos, A. (2022). ESG scores and cost of debt. *Energy Economics,* 112, 106186. https://doi.org/10.1016/j.eneco.2022.106186

Berg, F., Koelbel, J., & Rigobon, R. (2022). Aggregate confusion: the divergence of ESG ratings. *Review of Finance*, 26(6), 1315–1344. https://doi.org/10.1093/rof/rfac033

Capelle-Blancard, G., Crifo, P., Diaye, M. A., Oueghlissi, R., & Scholtens, B. (2019). Sovereign bond yield spreads and sustainability: an empirical analysis of OECD countries. *Journal of Banking and Finance,* 98, 156-169. https://doi.org/10.1016/j.jbankfin.2018.11.011

Diaye, M. A., Ho, S. H., & Oueghlissi, R. (2022). ESG performance and economic growth: a panel co-integration analysis. *Empirica,* 49, 99–122 (2022). https://doi.org/10.1007/s10663-021-09508-7

D'Orazio, P., & Thole, S. (2022). Climate-related financial policy index: a composite index to compare the engagement in green financial policymaking at the global level. *Ecological Indicators*, 141, 109065, https://doi.org/10.1016/j.ecolind.2022.109065

Drempetic, S., Klein, C., & Zwergel, B. (2020). The influence of firm size on the ESG score: corporate sustainability ratings under review. *Journal of Business Ethics*, 167, 333-360. https://doi.org/10.1007/s10551-019-04164-1

Eliwa, Y., Aboud, A., & Saleh, A. (2021). ESG practices and the cost of debt: evidence from EU countries. *Critical Perspectives on Accounting*, 79, 102097. https://doi.org/10.1016/j.cpa.2019.102097

Erhart, S. (2022). Take it with a pinch of salt—ESG rating of stocks and stock indices. *International Review of Financial Analysis*, 83, 102308. https://doi.org/10.1016/j.irfa.2022.102308

Fayissa, B., & Nsiah, Ch. (2013). The impact of governance on economic growth in Africa. *The Journal of Developing Areas*, 47(1), 91-108. https://doi.org/10.1353/jda.2013.0009

Genc, E. G., & Basar, O. D. (2019). Comparison of country ratings of credit rating agencies with MOORA method. *Business and Economics Research Journal,* 10(2), 391-404. https://doi.org/10.20409/berj.2019.175

Gyönyörová, L., Stachoň, M., & Stašek, D. (2023). ESG ratings: relevant information or misleading clue? Evidence from the S&P Global 1200. *Journal of Sustainable Finance & Investment*, 13(2), 1075-1109. https://doi.org/10.1080/20430795.2021.1922062

Hamilton, J. D., & Xi, J. (2023). Principal component analysis for nonstationary series. *Working Paper*, University of California at San Diego. https://econweb.ucsd.edu/~jhamilto/HX.pdf

Ho, S. J., Oueghlissi, R., & Ferktaji, R. I. (2023). Testing for causality between economic growth and environmental, social, and governance performance: new evidence from a global sample. *Journal of the Knowledge Economy*, 14 (2). https://doi.org/10.1007/s13132-023-01406-6

Hoepner, A., Oikonomou, I., Scholtens, B., & Schröder, M. (2016). The effects of corporate and country sustainability characteristics on the cost of debt: an international investigation. *Journal of Business Finance & Accounting*, 43 (1-2), 158-190. https://doi.org/10.1111/jbfa.12183

Hoti, S., & McAleer, M. (2004). An empirical assessment of country risk ratings and associated models. *Journal of Economic Survey*, 18(4), 539-588. https://doi.org/10.1111/j.0950-0804.2004.00230.x

Huang, Ch. J., & Ho, J. H. (2017). Governance and economic growth in Asia. *The North American Journal of Economics and Finance,* 39, 260-272. https://doi.org/10.1016/j.najef.2016.10.010

Hubail, R. A. (2014). An empirical analysis of country risk ratings. *Journal of Business Studies Quarterly,* 5(4), 52-67.

Hübel, B. (2022). Do markets value ESG risks in sovereign credit curves?. *The Quarterly Review of Economics and Finance*, 85, 134-148. https://doi.org/10.1016/j.qref.2020.11.003

Juodis, A., Karavias, Y., & Sarafidis, V. (2021). A homogeneous approach to testing for Granger non-causality in heterogeneous panels. *Empirical Economics*, 60, 93–112.

Ling, J., Germain, E., Murphy, R., & Saroj, D. (2021). Designing a sustainability assessment framework for selecting sustainable wastewater treatment technologies in corporate asset decisions. *Sustainability*, 13(7), 31-38. https://doi.org/10.3390/su13073831

Long, X., Naminse, E. Y., Du, J., & Zhuang, J. (2015). Nonrenewable energy, renewable energy, carbon dioxide emissions and economic growth in China from 1952 to 2012. *Renewable and Sustainable Energy Reviews*, 52, 680-688. https://doi.org/10.1016/j.rser.2015.07.176

Merino-Saum, A., Baldi, M. G., Gunderson, I., & Oberle, B. (2018). Articulating natural resources and sustainable development goals through green economy indicators: a systematic analysis. *Resources, Conservation and Recycling*, 139, 90-103. https://doi.org/10.1016/j.resconrec.2018.07.007

Qiao, S., Shen, T., Zhang, R. R., & Chen, H. H. (2021). The impact of various factor market distortions and innovation efficiencies on profit sustainable growth: From the view of China's renewable energy industry. *Energy Strategy Reviews*, 38. https://doi.org/10.1016/j.esr.2021.100746

Ogundajo, G. O, Akintoye, R. I., Abiola, O., Ajibade, A., Olayinka, M. I., & Akintola, A. (2022). Influence of country governance factors and national culture on corporate sustainability practice: an inter-country study. *Cogent Business & Management*, 9(1), 2130149. https://doi.org/10.1080/23311975.2022.2130149

Pineau, E., Le, P., & Estran, R. (2022). Importance of ESG factors in sovereign credit ratings. *Finance Research Letters,* 49, 102966. https://doi.org/10.1016/j.frl.2022.102966

Reznick, M., Viehs, M., Chockalingam, N., Panesar, T., Lizarazu, G. A., & Moussavi, J. (2019). *Pricing ESG risk in sovereign credit.* Hermes Investment Management and Beyond Ratings.

Rodriguez, A., & Valdes, N. (2019). Health care expenditures and GDP in Latin American and OECD countries: a comparison using a panel cointegration approach. *International Journal of Health Economics and Management*, 19, 115–153. https://doi.org/10.1007/s10754-018-9250-3

Sahin, Ö., Bax, K., Paterlini, S., & Czado, M. (2022). The pitfalls of (non-definitive) environmental, social, and governance scoring methodology. *Global Finance Journal,* Forthcoming. http://dx.doi.org/10.2139/ssrn.4020354

Stellner, Ch., Klein, Ch., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: the moderating role of country sustainability. *Journal of Banking & Finance*, 59, 538-549. https://doi.org/10.1016/j.jbankfin.2015.04.032

Tanjung, M. (2021). Can we expect contribution from environmental, social, governance performance to sustainable development?. *Business Strategy and Development,* 4(4), 386-398. https://doi.org/10.1002/bsd2.165

Walter, I., (2020). Sense and nonsense in ESG ratings. *Journal of Law, Finance and Accounting*, 5(2), 273-305.

Vetri, S., Bruni, M. E., Iazzolino, G., Morea, D., & Baldissarro, G. (2023). Do ESG factors improve utilities corporate efficiency and reduce the risk perceived by credit lending institutions? An empirical analysis. *Utilities Policy*, 81, 101520. https://doi.org/10.1016/j.jup.2023.101520

Yang, Q., Du, Q., Razzaq, A., & Shang, Y. (2022). How volatility in green financing, clean energy, and green economic practices derive sustainable performance through ESG indicators? A sectoral study of G7 countries. *Resources Policy*, 75, 105-126. https://doi.org/10.1016/j.resourpol.2021.102526

Yu, E. P. Y., & Van Luu, B. (2021). International variations in ESG disclosure–do cross-listed companies care more?. *International Review of Financial Analysis*, 75, 101731. https://doi.org/10.1016/j.irfa.2021.101731

Table 1. Components of ESG indices by Capelle-Blancard, Crifo, Diaye, Oueghlissi and Scholtens

Index	Measuring items	Interpretation of the results
E index	Air quality - control air pollution Water and sanitation - wastewater treatment Forests - forest area (% of land area) Renewable energy - combustible renewable energy (% of total energy), renewable electricity output (% of total electricity), renewable energy consumption (% of total energy)	High scores signal strong environmental performance
S index	Human capital - school enrolment secondary (% gross) Demography - life expectancy Health - health expenditure, public (% of total health expenditure) Gender equality - ratio of female to male labour force participation rate (%), gender parity index Employment - nonvulnerable employment (% of total employment)	It includes measures of the level of social development of countries
G index	Democratic institution - control of corruption, rule of law, voice and accountability Safety policy - country effectiveness, political stability, regulatory quality	High scores signal a high degree of legal quality
ESG index (total index)	Consists of subindices by aggregating detailed indicators using weights estimated by means of factor analysis	This measures a country's sustainability performance and is the result of a factor analysis of ESG indices

Source: Author’s own compilation based on Capelle-Blancard et al. (2019).

Table 2. Components of ESG indices by Pineau, Le and Estran

Category	Factor
Environmental (E)	CO_2 emissions (metric tons per capita)
	Agricultural land (% of land area)
	Food production index
	Agriculture, value added (% of GDP)
	Forest area (% of land area)
	Adjusted savings: natural resource depletion (% of GNI)
Social (S)	Access to electricity (% of population)
	Life expectancy at birth, total (years)
	Population aged 65 years and above (% of total population)
	Mortality rate, under 5 (per 1,000 live births)
	Unemployment, total (% of total labour force)
Governance (G)	GDP growth (annual %)
	Proportion of seats held by women in national parliaments (%)
	Ratio of female to male labour force participation rate (%)
	Patent applications
	Regulatory quality (meta-variable)

Source: Author's own compilation based on Pineau et al. (2022).

Table 3. Components of ESG indices by Yang, Du, Razzaq and Shang

Category	Factors	Measurement
Environmental (E)	Clean energy	Renewable energy consumption
Social (S)	Growth of the green economy	Green growth
Governance (G)	Green financing	Green bonds

Source: Author's own compilation based on Yang et al. (2022).

Table 4. Country-level governance factors

Factors	Measurement
Voice and accountability	Score ranges from 1 (low) to 100 (high); has positive polarity
Political stability and lack of violence	Score ranges from 1 (low) to 100 (high); has positive polarity
Government effectiveness	Score ranges from 1 (low) to 100 (high); has positive polarity
Regulatory quality	Score ranges from 1 (low) to 100 (high); has positive polarity
Rule of law	Score ranges from 1 (low) to 100 (high); has positive polarity
Control of corruption	Score ranges from 1 (low control of corruption) to 100 (high control of corruption)

Source: Author's own compilation based on Ogundajo et al. (2022).

Table 5. Variables used in the analysis and their transformations

Descriptor	Source	Form	KMO[a]
Environmental			0.5575
Expenditure on environment protection (% of GDP)	IMF	level	0.5015
Agriculture, forestry, and fishing, value added (% of GDP)	WB	difference	0.5341
Environmental goods trade balance (% of GDP)	IMF	difference	0.5331
Trade balance in low-carbon technology products (% of GDP)	IMF	difference	0.5308
Construction, value added (% of GDP)	Eurostat	difference	0.7444
Social			0.6312
Unemployment, total (% of total labour force)	WB	level	0.8876
Individuals using the Internet (% of population)	WB	level	0.5899
Population aged 65 years and above (% of total population)	WB	difference	0.7154

School enrolment, secondary (% gross)	WB	difference	0.691
Voice and accountability (estimate)	WB	level	0.6001
Governance			0.8722
Control of corruption (estimate)	WB	level	0.8668
Regulatory quality (estimate)	WB	level	0.8851
Rule of law (estimate)	WB	level	0.8453
Government effectiveness (estimate)	WB	level	0.8519
Political stability and absence of violence /terrorism (estimate)	WB	level	0.9556

Source: Author's own calculations; [1]KMO statistics provided for the PCA performed on the averaged 2011–2020 data.

Table 6. PCA and value- and rank-based ESG indicators for different country settings

Group of countries	ESG_INDEX	total_STD_ESG	total_STD_ESG_R	total_rank_ESG	total_rank_ESG_R
New	-1.53	-0.24	-0.05	17.79	15.81
Old	1.17	0.18	0.04	13.75	15.27
North	0.98	0.21	0.08	13.82	14.71
South	-2.18	-0.42	-0.16	18.86	17.07

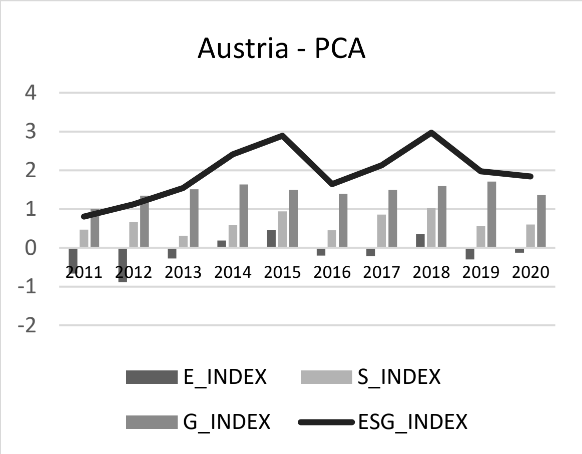
Note: average indices; Index - PCA based; rank – ranking-based indicators; STD – value-based indicators; and R – analysis based on the levels of the variables.

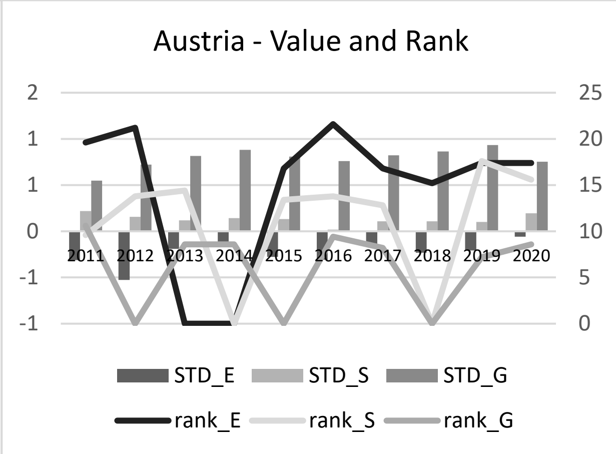
Table 7. Results of the HPJ Granger-type tests of the (delta) GDP–ESG causality

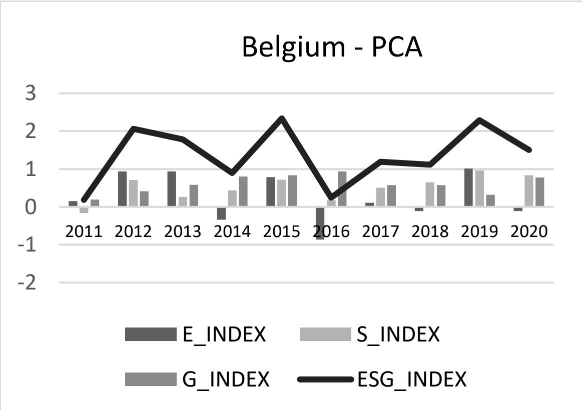
ESG indicator type	Variable treatment[a]	$GDP \rightarrow ESG$	$ESG \rightarrow \Delta GDP$ (annual)	$ESG \rightarrow \Delta GDP$ (5-year-change)
$I_{E,t,PCA}$	level/difference	0.199	0.040	0.203
$I_{S,t,PCA}$	level/difference	0.000	0.416	0.046
$I_{G,t,PCA}$	level/difference	0.000	0.103	0.000
$I_{E,t,RANK}$	level/difference	0.002	0.728	0.068
$I_{E,t,RANK}$	level	0.000	0.701	0.006
$I_{S,t,RANK}$	level/difference	0.577	0.105	0.426
$I_{S,t,RANK}$	level	0.003	0.736	0.000
$I_{G,t,RANK}$	level	0.024	0.953	0.001
$I_{E,t,VALUE}$	level/difference	0.000	0.582	0.000
$I_{E,t,VALUE}$	level	0.002	0.056	0.039
$I_{S,t,VALUE}$	level/difference	0.000	0.106	0.081
$I_{S,t,VALUE}$	level	0.058	0.233	0.000
$I_{G,t,VALUE}$	level	0.000	0.001	0.000

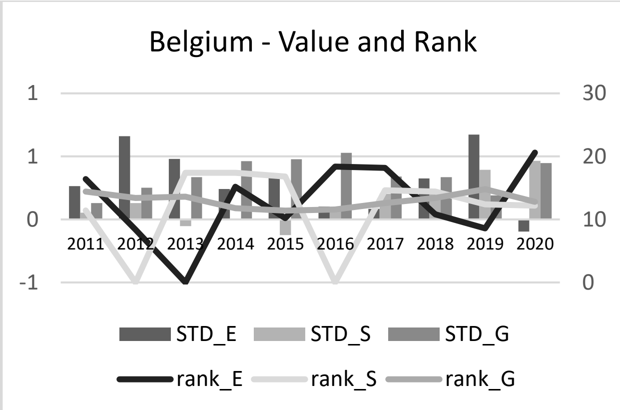
Source: Author's own calculations; [a]level = analysis based on the levels of variables; level/difference = analysis based on the form of the variables that maximized KMO in the averaged PCA; for each of the variables, its form is provided in the third column of Table 5; [b]all variables in the PCA were considered levels; thus, the level and level/difference results are the same; thus, we do not include a separate level/difference row for the I_G indicators.

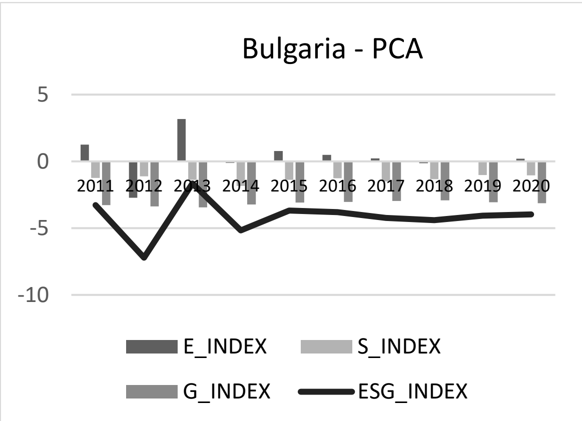
Appendix A.1. ESG indices

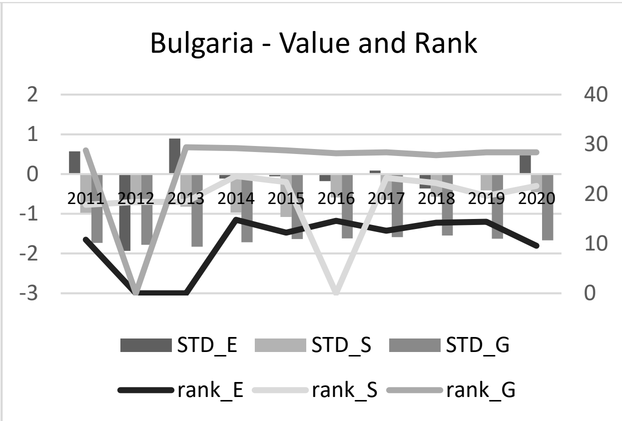


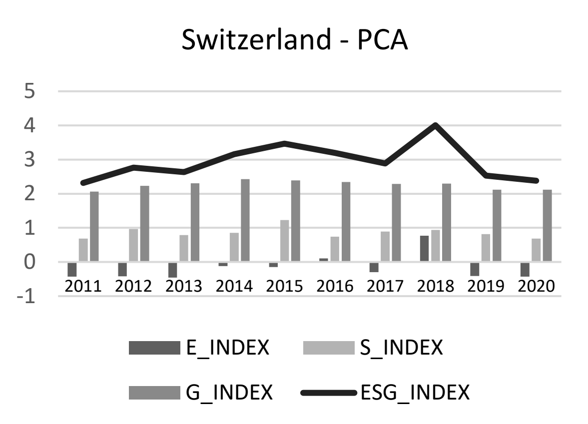


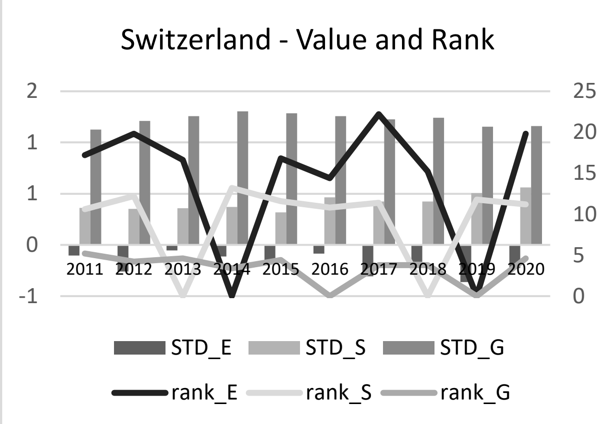


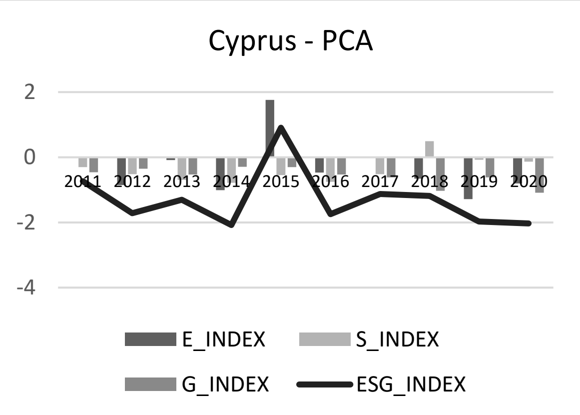


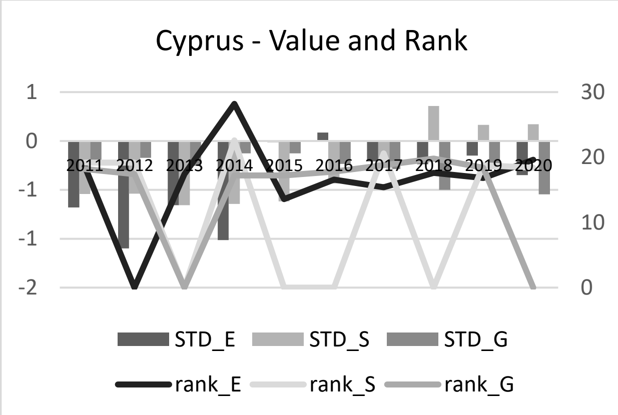


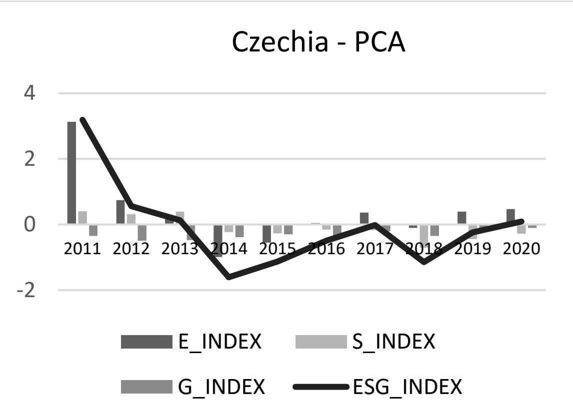


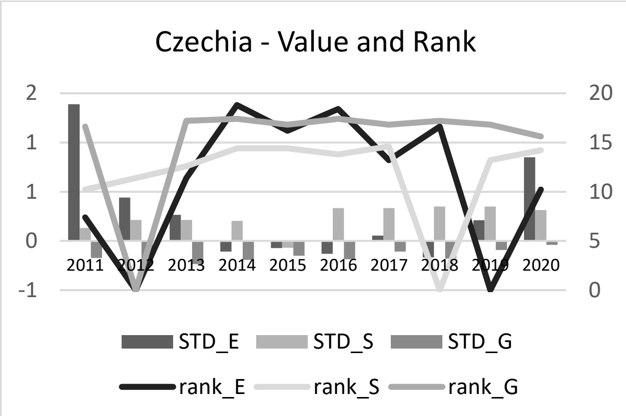

Switzerland - PCA
5
4
3
2
1
0
-1
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

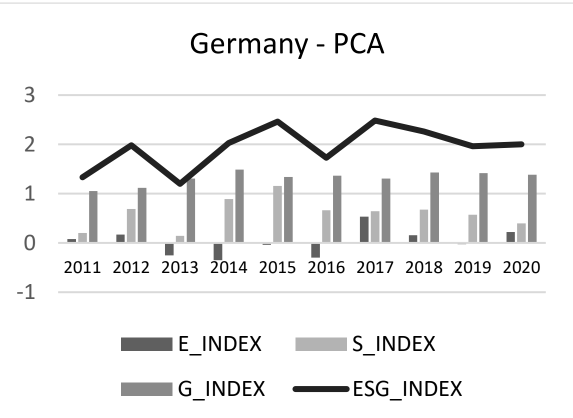

Switzerland - Value and Rank
2
1
1
0
-1
25
20
15
10
5
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

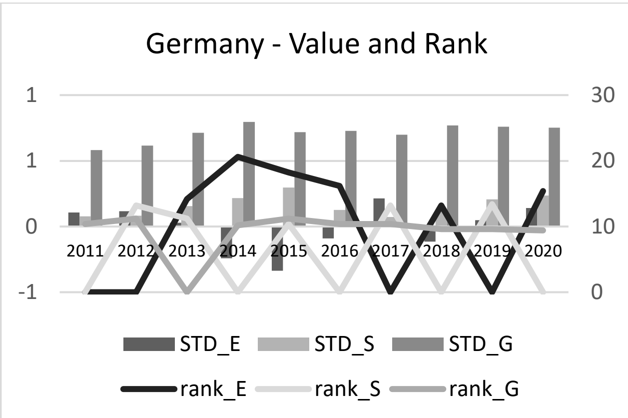

Cyprus - PCA
2
0
-2
-4
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

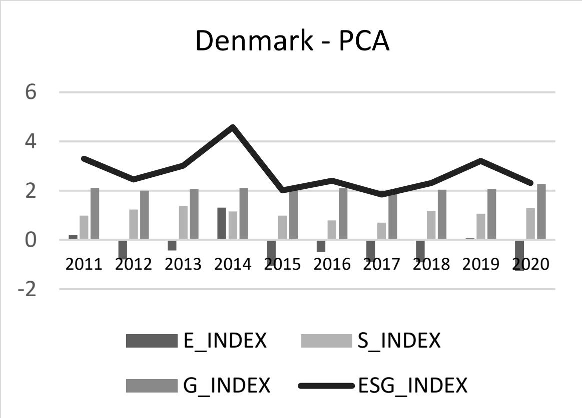

Cyprus - Value and Rank
1
0
-1
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

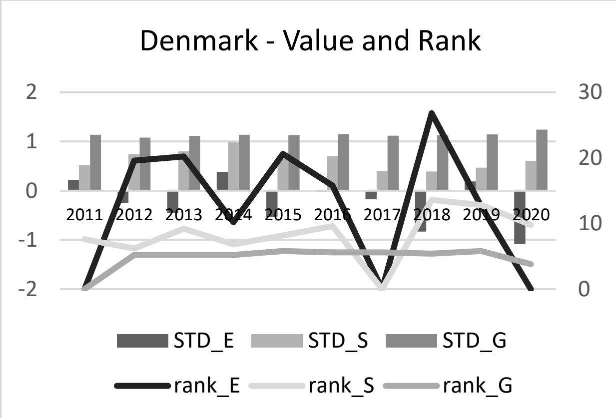

Czechia - PCA
4
2
0
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

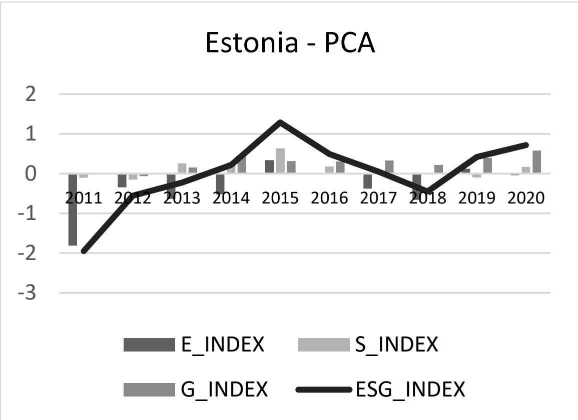

Czechia - Value and Rank
2
1
1
0
-1
20
15
10
5
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

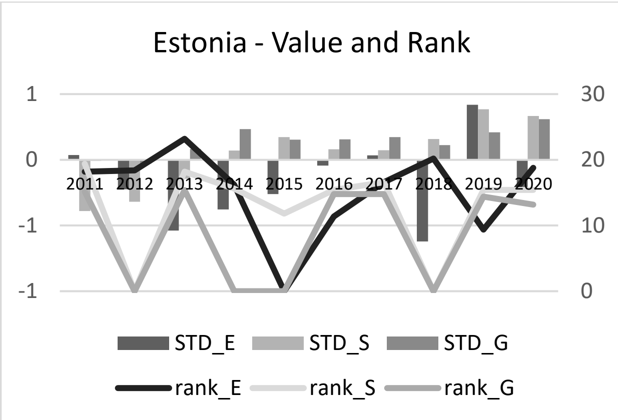

Germany - PCA
3
2
1
0
-1
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

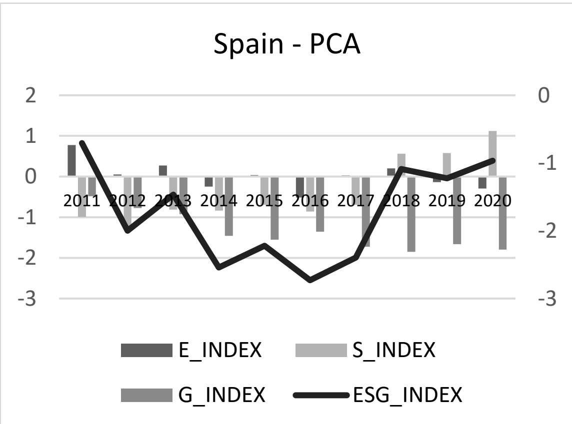

Germany - Value and Rank
1
1
0
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

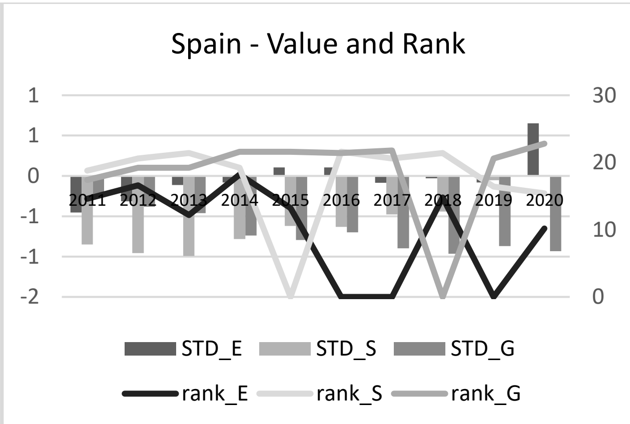

Denmark - PCA
6
4
2
0
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

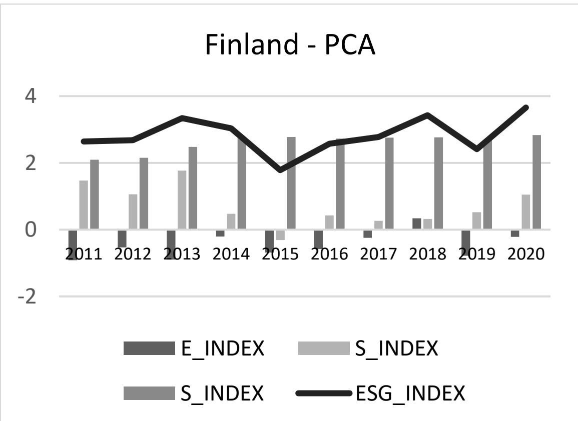

Denmark - Value and Rank
2
1
0
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

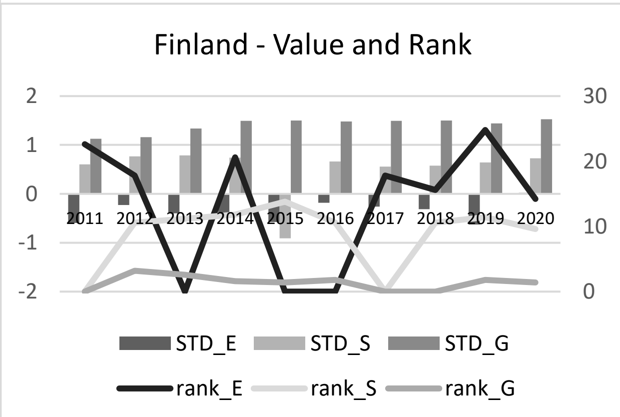

Estonia - PCA
2
1
0
-1
-2
-3
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

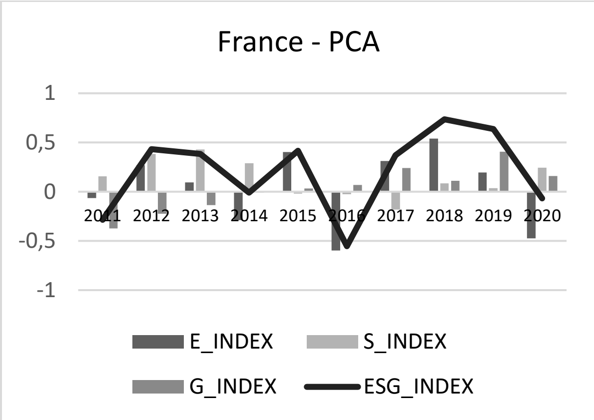

Estonia - Value and Rank
1
0
-1
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

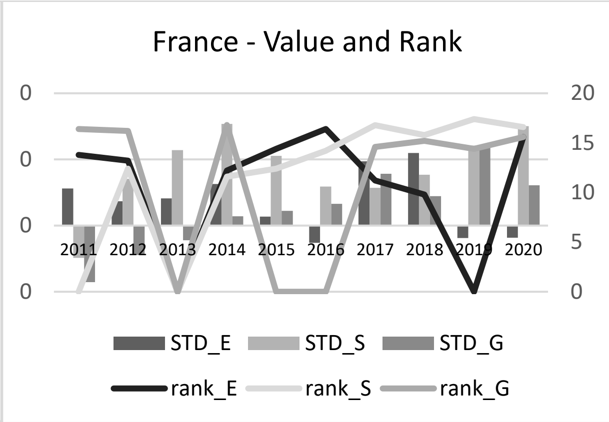

Spain - PCA
2
1
0
-1
-2
-3
0
-1
-2
-3
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

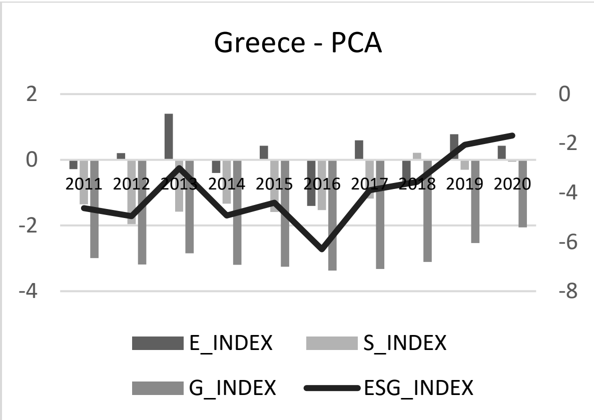

Spain - Value and Rank
1
1
0
-1
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

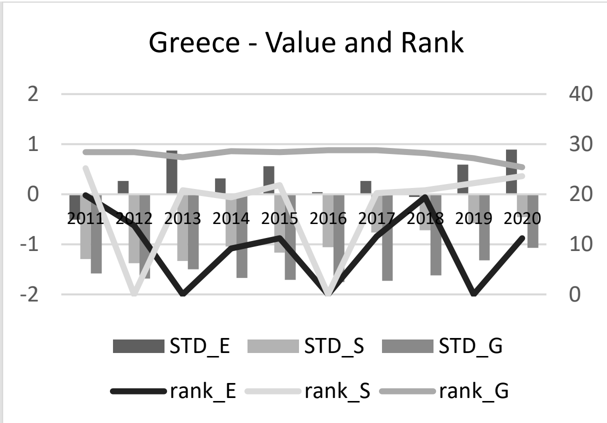

Finland - PCA
4
2
0
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
S_INDEX
ESG_INDEX

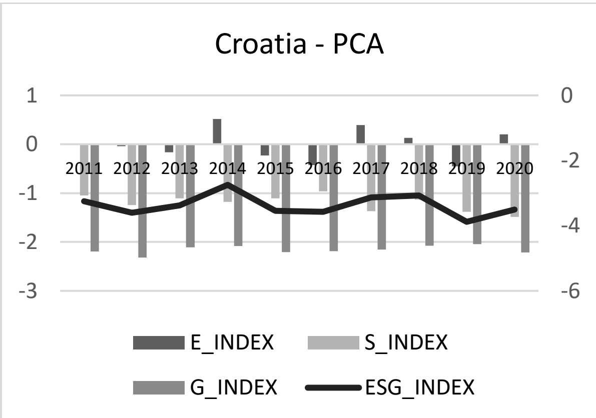

Finland - Value and Rank
2
1
0
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

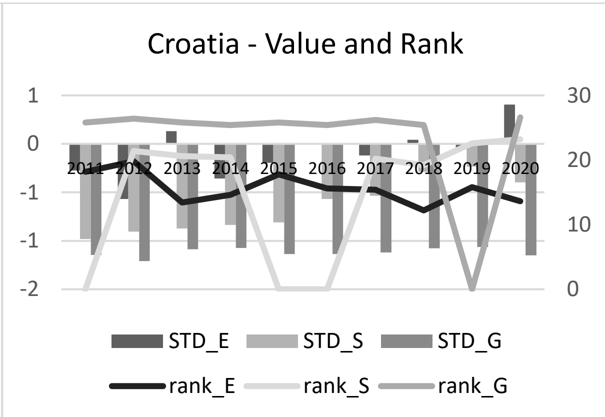

France - PCA
1
0,5
0
-0,5
-1
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

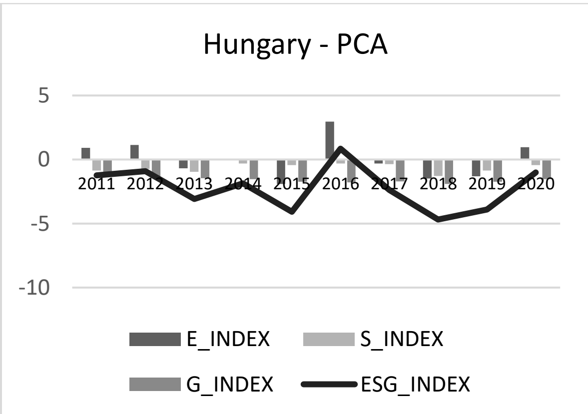

France - Value and Rank
0
0
0
0
20
15
10
5
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

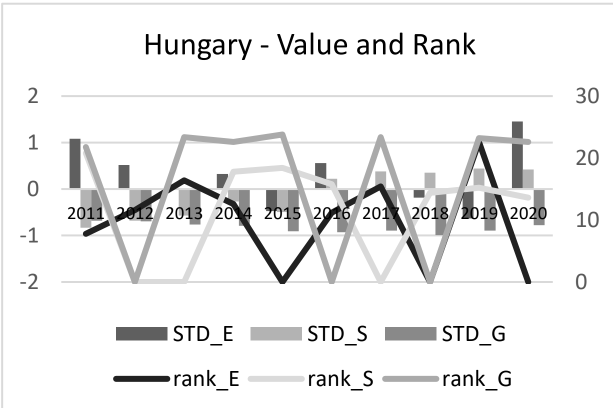

Greece - PCA
2
0
-2
-4
0
-2
-4
-6
-8
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

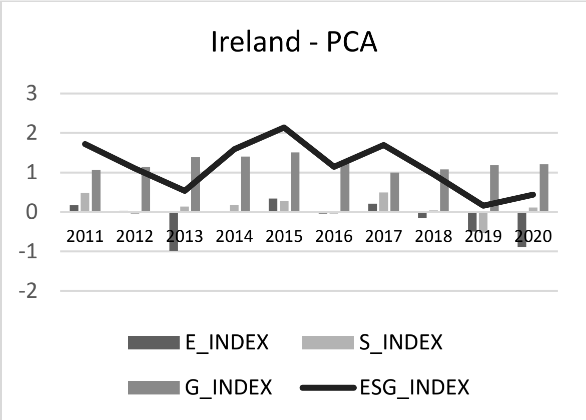

Greece - Value and Rank
2
1
0
-1
-2
40
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

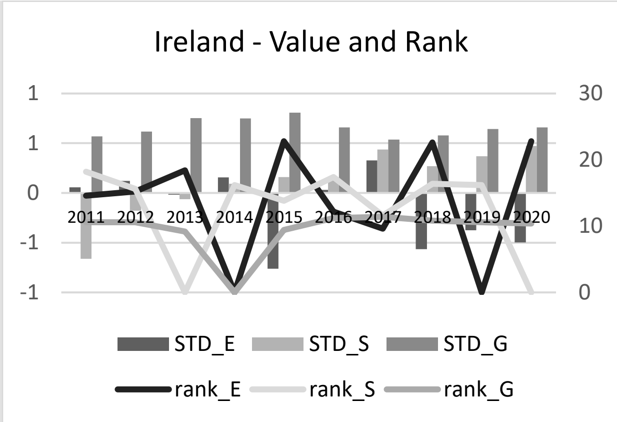

Croatia - PCA
1
0
-1
-2
-3
0
-2
-4
-6
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

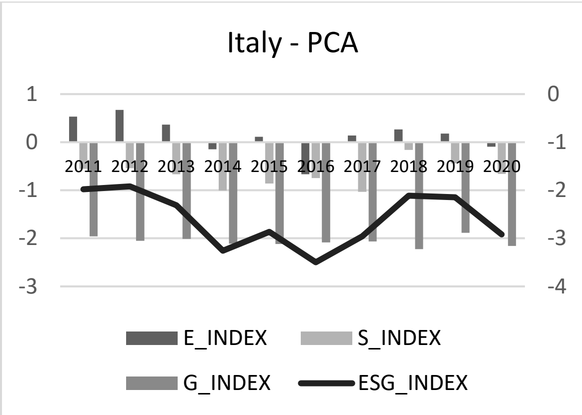

Croatia - Value and Rank
1
0
-1
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

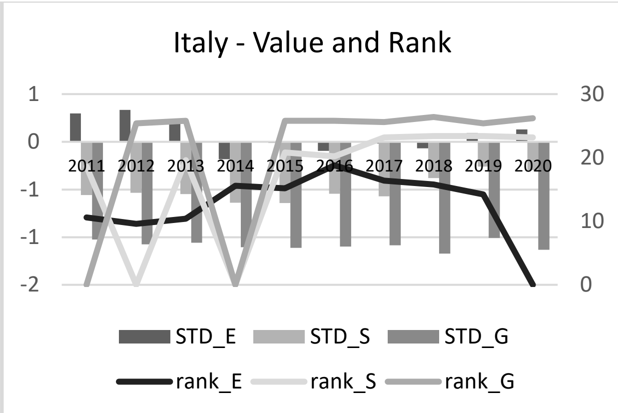

Hungary - PCA
5
0
-5
-10
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

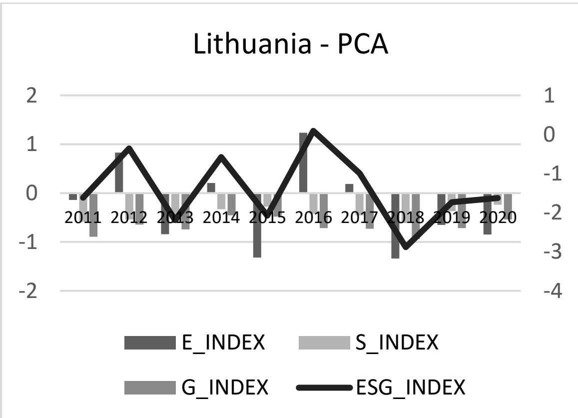

Hungary - Value and Rank
2
1
0
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

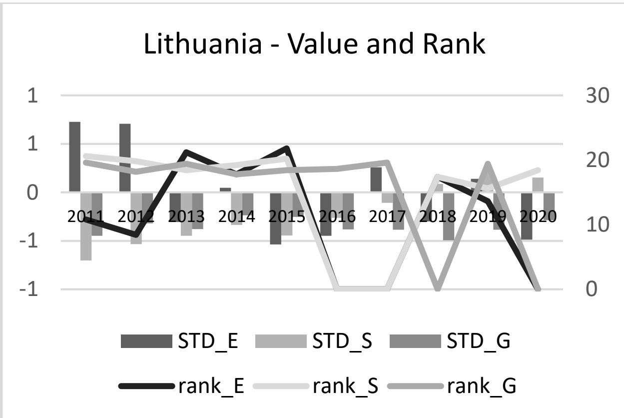

Ireland - PCA
3
2
1
0
-1
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

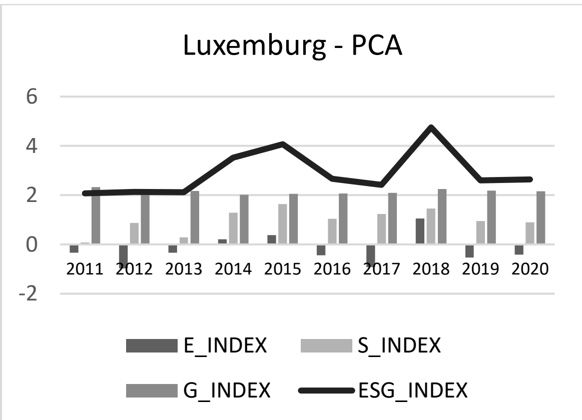

Ireland - Value and Rank
1
1
0
-1
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

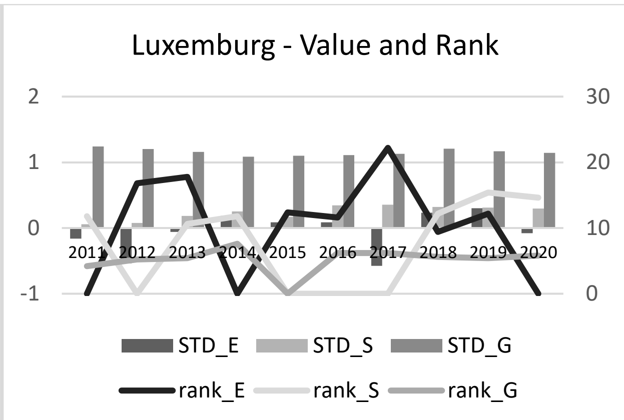

Italy - PCA
1
0
-1
-2
-3
0
-1
-2
-3
-4
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

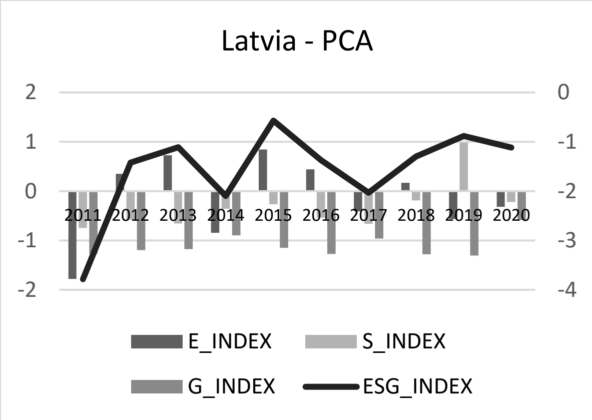

Italy - Value and Rank
1
0
-1
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

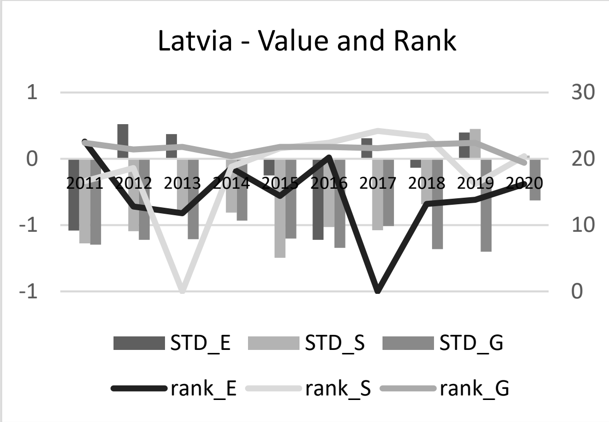

Lithuania - PCA
2
1
0
-1
-2
1
0
-1
-2
-3
-4
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

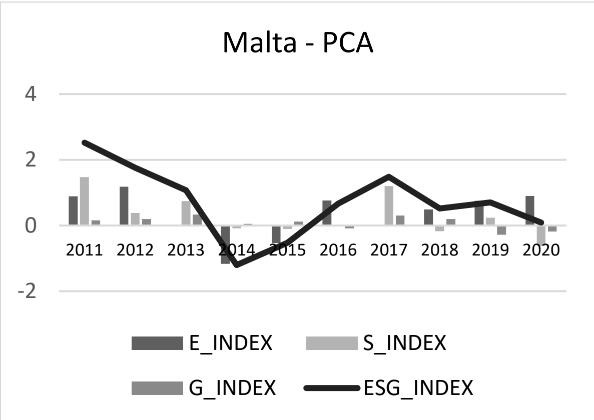

Lithuania - Value and Rank
1
1
0
-1
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

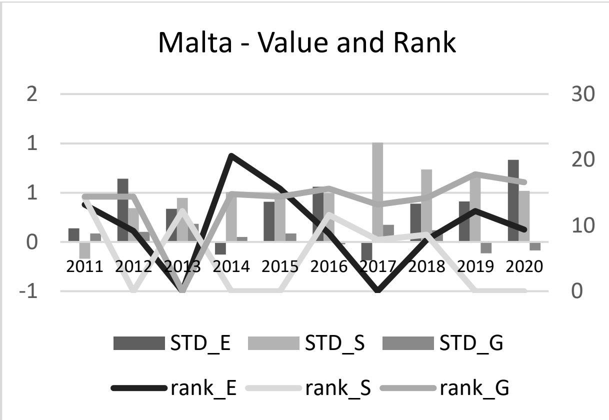

Luxemburg - PCA
6
4
2
0
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

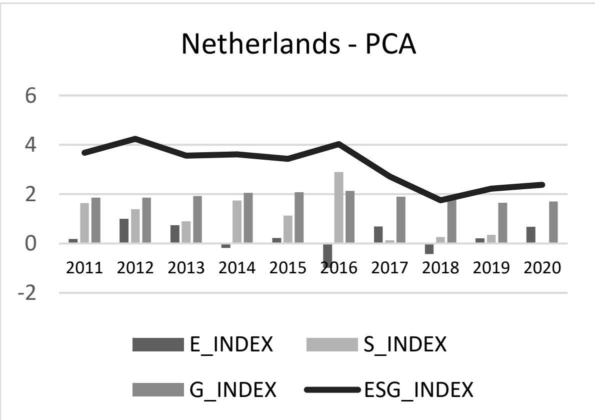

Luxemburg - Value and Rank
2
1
0
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

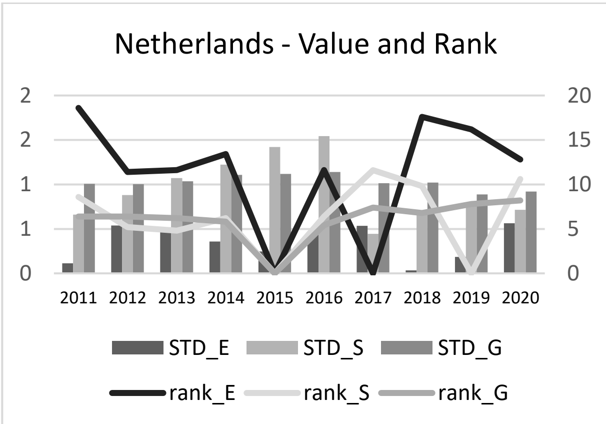

Latvia - PCA
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

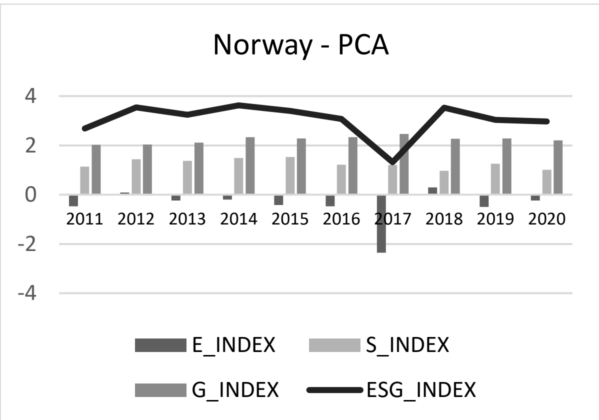

Latvia - Value and Rank
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

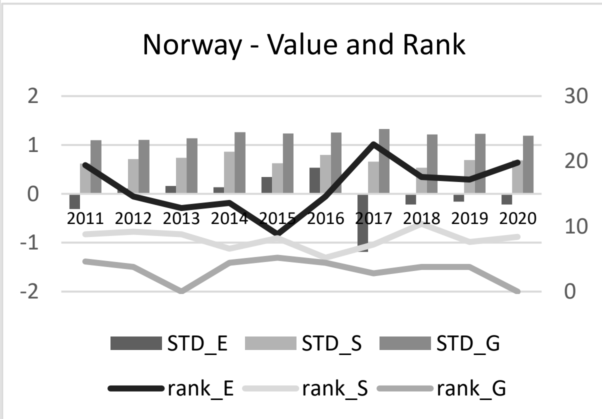

Malta - PCA
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

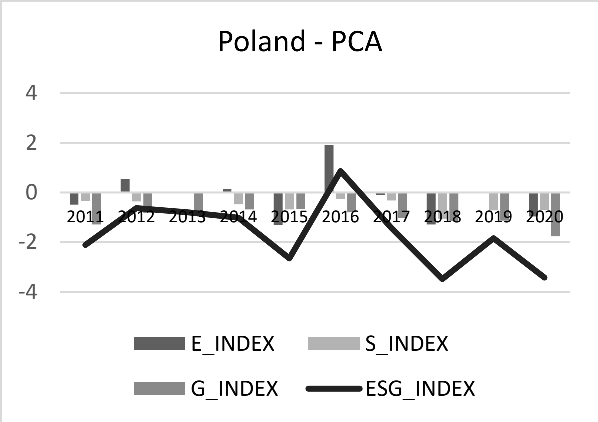

Malta - Value and Rank
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

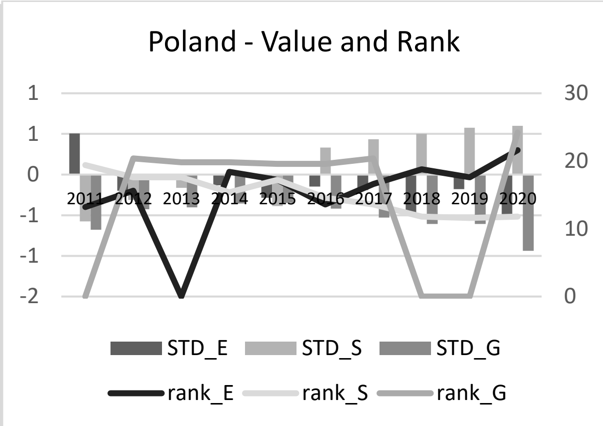

Netherlands - PCA
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

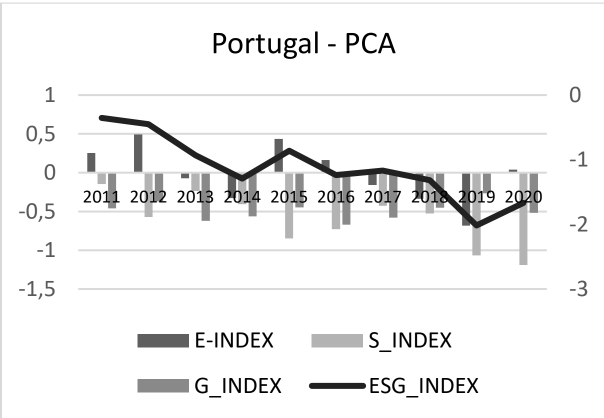

Netherlands - Value and Rank
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

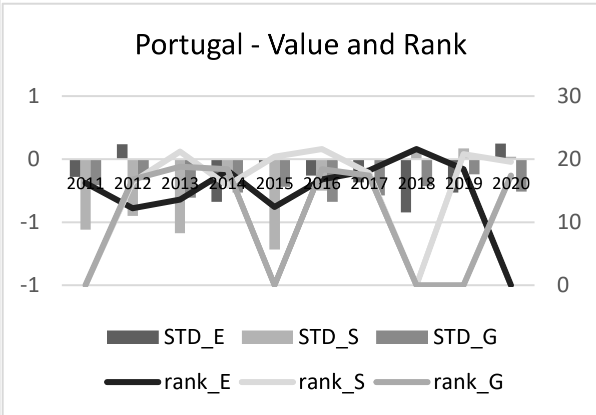

Norway - PCA
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

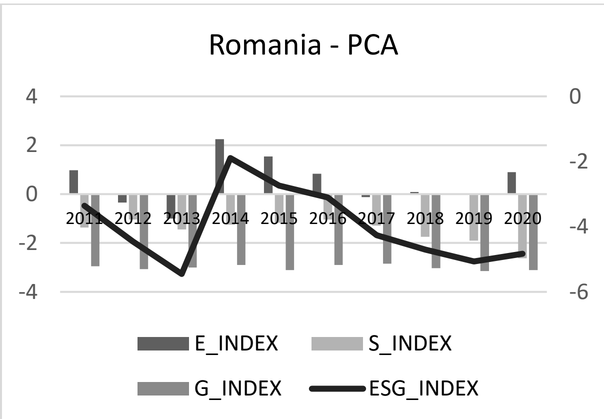

Norway - Value and Rank
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

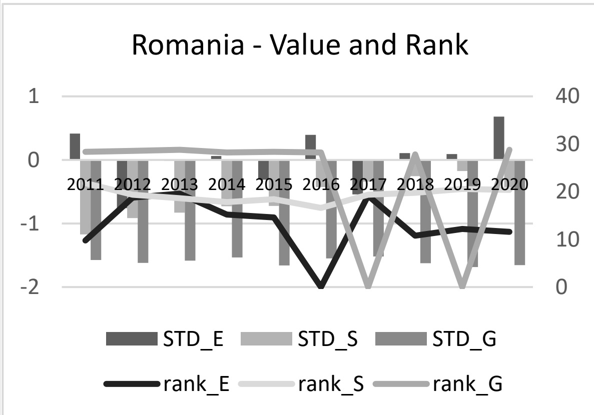

Poland - PCA
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

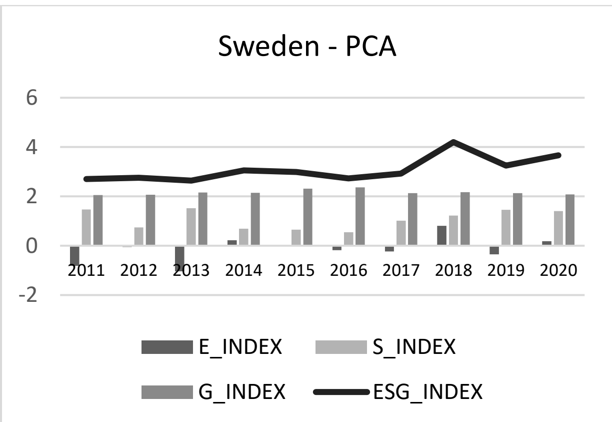

Poland - Value and Rank
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

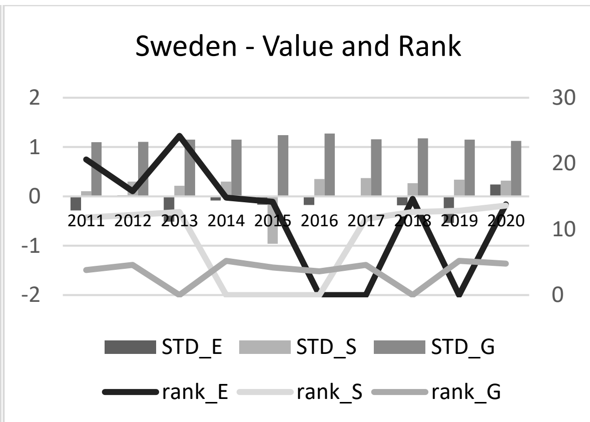

Portugal - PCA
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E-INDEX
S_INDEX
G_INDEX
ESG_INDEX

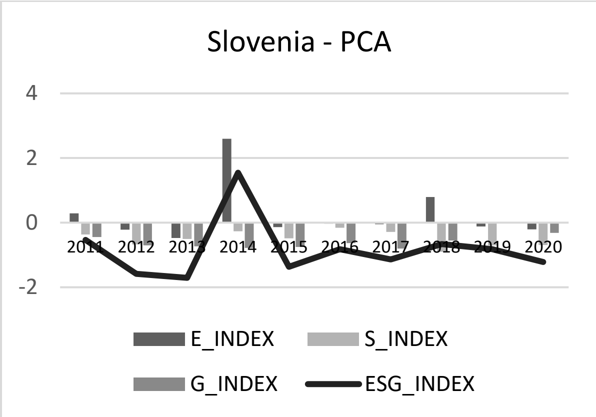

Portugal - Value and Rank
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

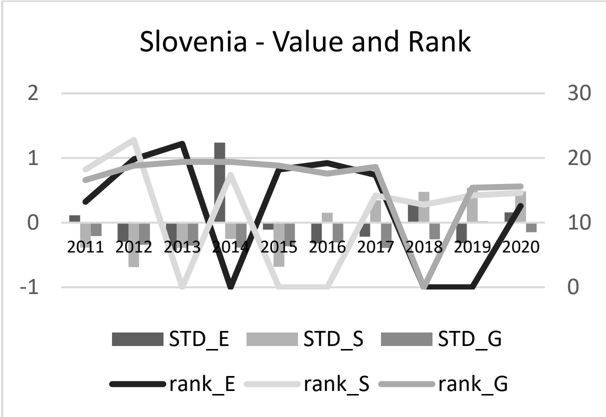

Romania - PCA
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

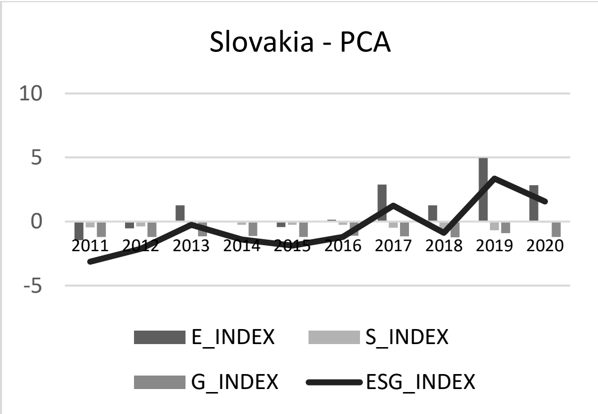

Romania - Value and Rank
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

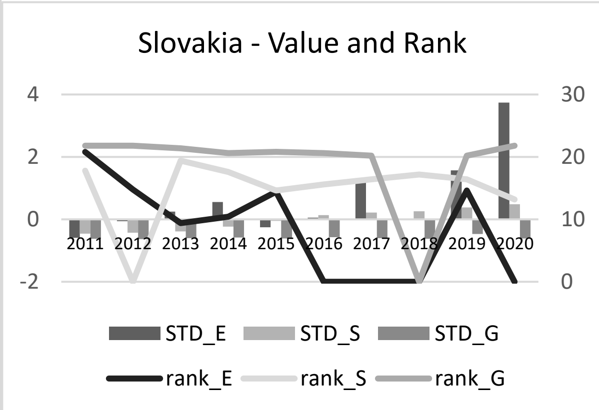

Sweden - PCA
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

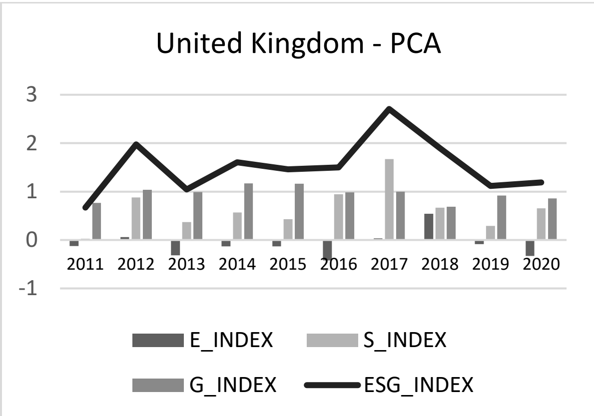

Sweden - Value and Rank
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

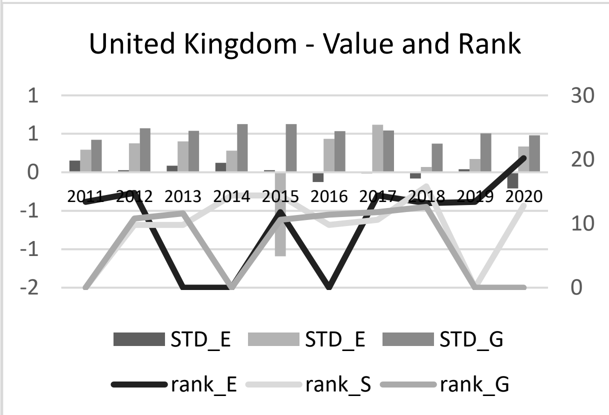

Slovenia - PCA
4
2
0
-2
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX


Slovenia - Value and Rank
2
1
0
-1
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

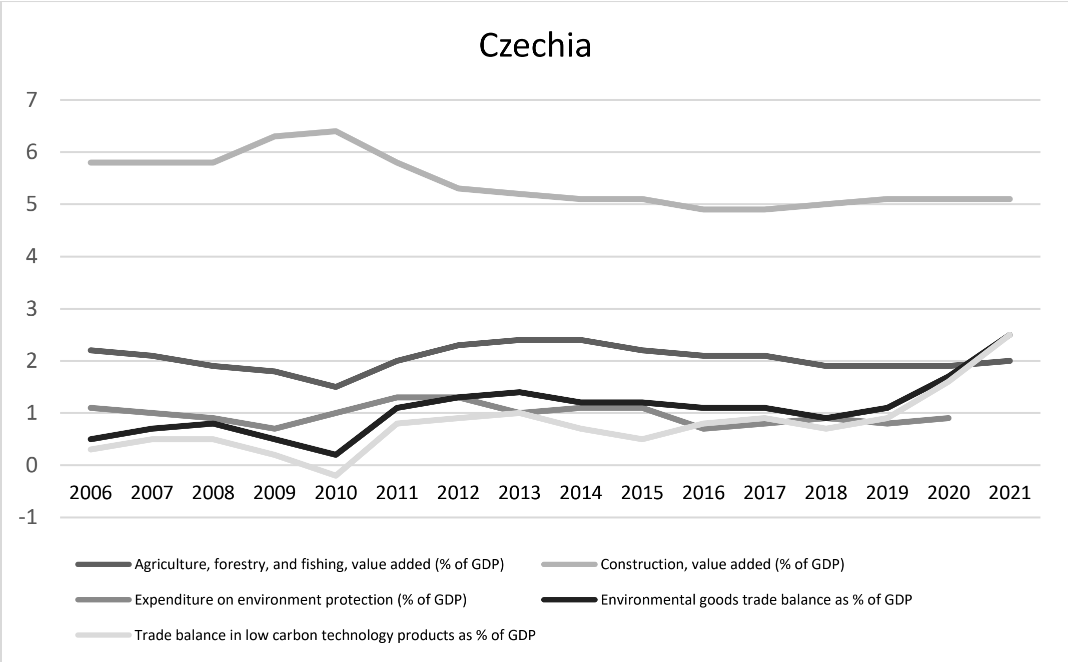

Slovakia - PCA
10
5
0
-5
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

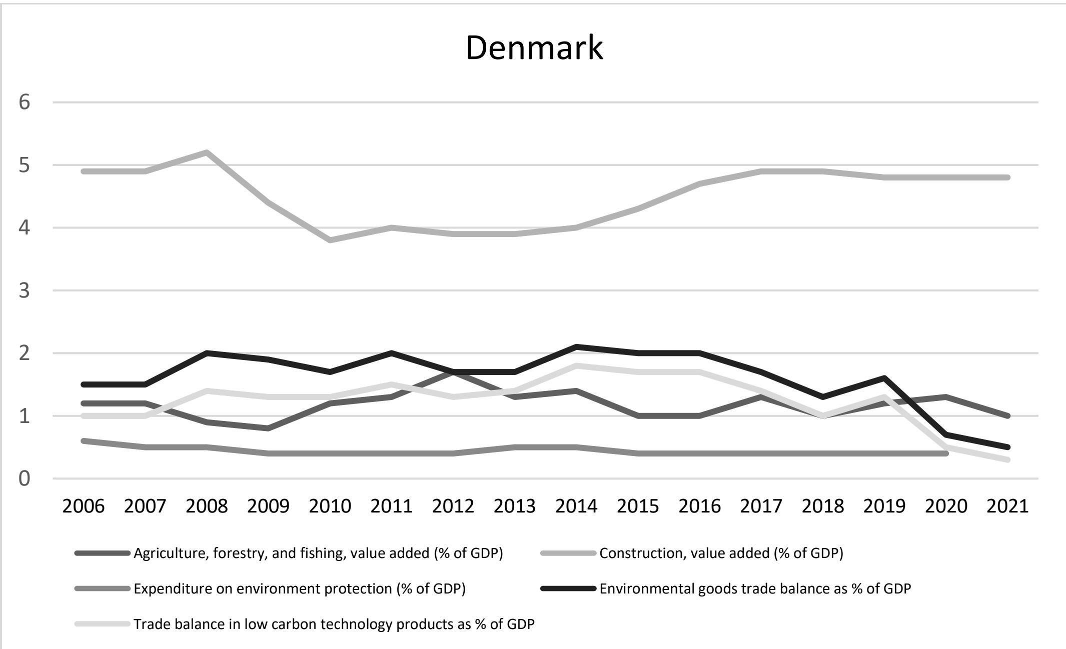

Slovakia - Value and Rank
4
2
0
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_S
STD_G
rank_E
rank_S
rank_G

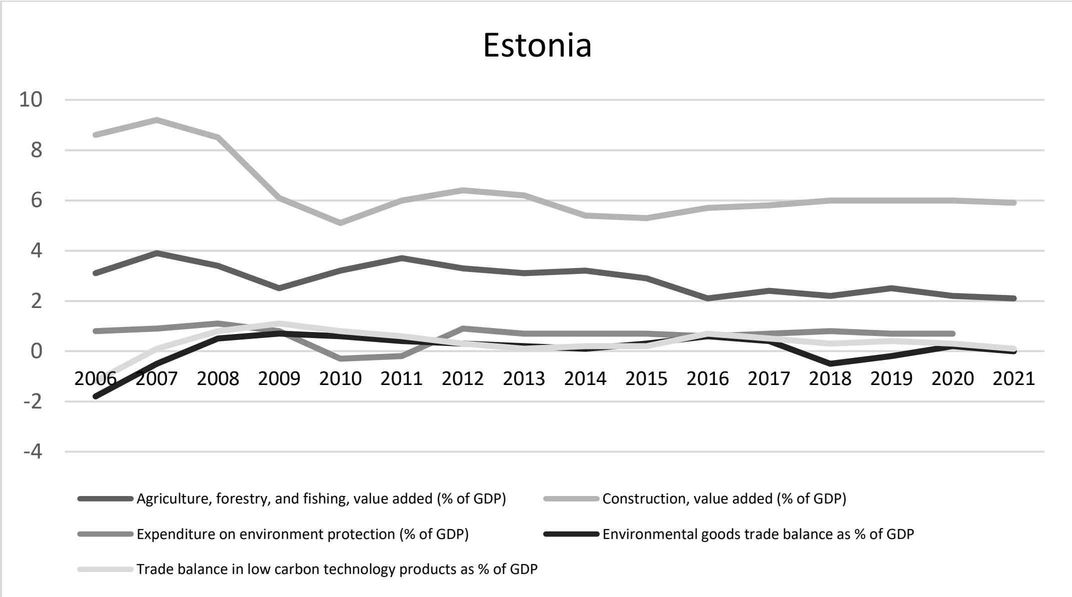

United Kingdom - PCA
3
2
1
0
-1
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
E_INDEX
S_INDEX
G_INDEX
ESG_INDEX

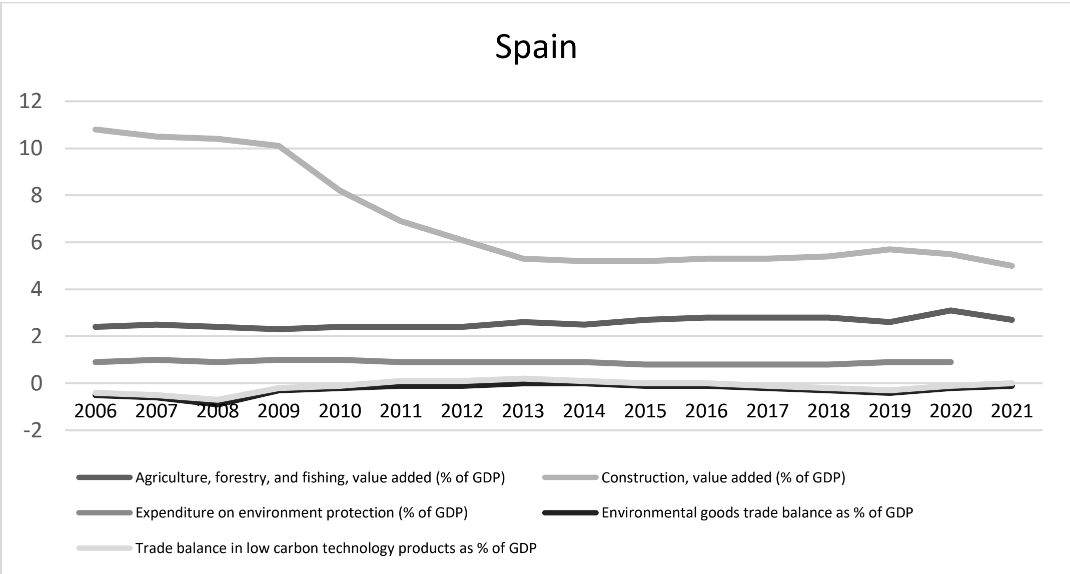

United Kingdom - Value and Rank
1
1
0
-1
-1
-2
30
20
10
0
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
STD_E
STD_E
STD_G
rank_E
rank_S
rank_G

Appendix A.2. Raw data on "E" variables for top- and low-performers






Estonia
10
8
6
4
2
0
-2
-4
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Agriculture, forestry, and fishing, value added (% of GDP)
Construction, value added (% of GDP)
Expenditure on environment protection (% of GDP)
Environmental goods trade balance as % of GDP
Trade balance in low carbon technology products as % of GDP


Spain
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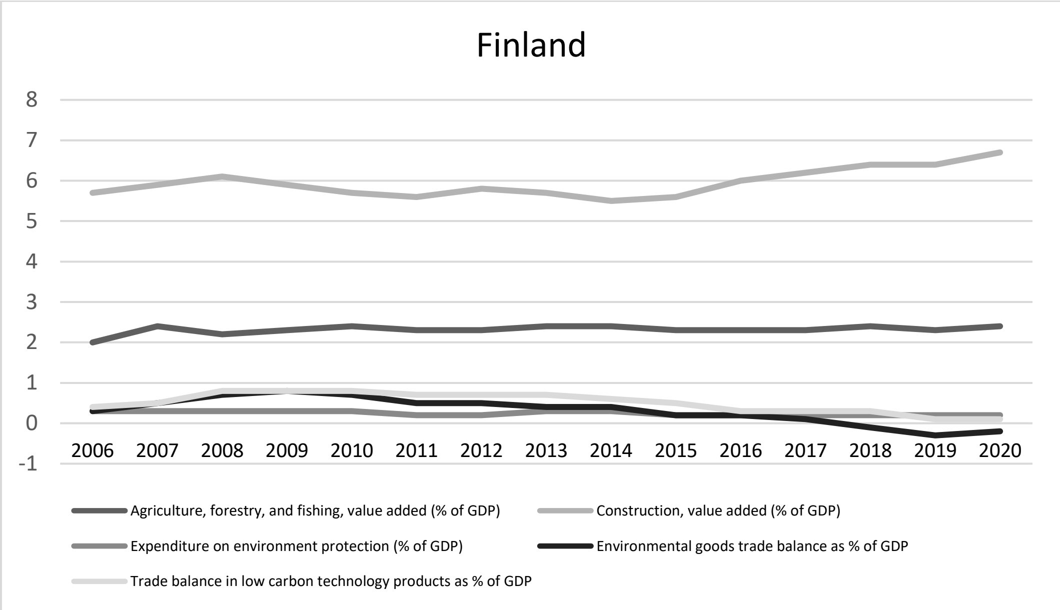
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Agriculture, forestry, and fishing, value added (% of GDP)
Construction, value added (% of GDP)
Expenditure on environment protection (% of GDP)
Environmental goods trade balance as % of GDP
Trade balance in low carbon technology products as % of GDP


Finland
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Agriculture, forestry, and fishing, value added (% of GDP)
Construction, value added (% of GDP)
Expenditure on environment protection (% of GDP)
Environmental goods trade balance as % of GDP
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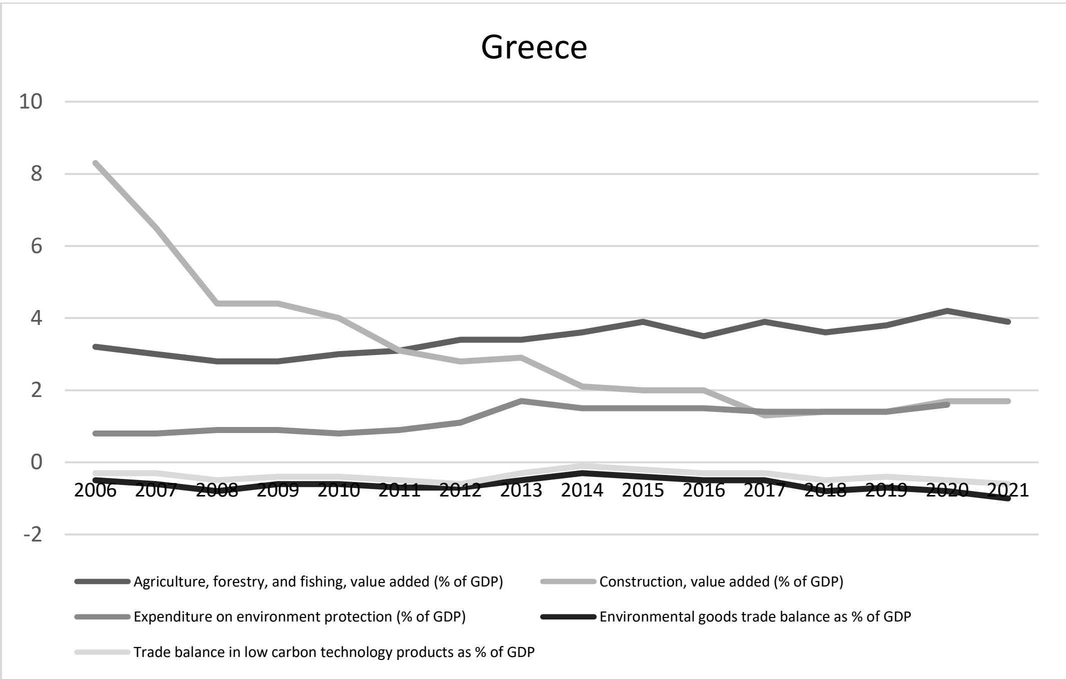
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Agriculture, forestry, and fishing, value added (% of GDP)
Construction, value added (% of GDP)
Expenditure on environment protection (% of GDP)
Environmental goods trade balance as % of GDP
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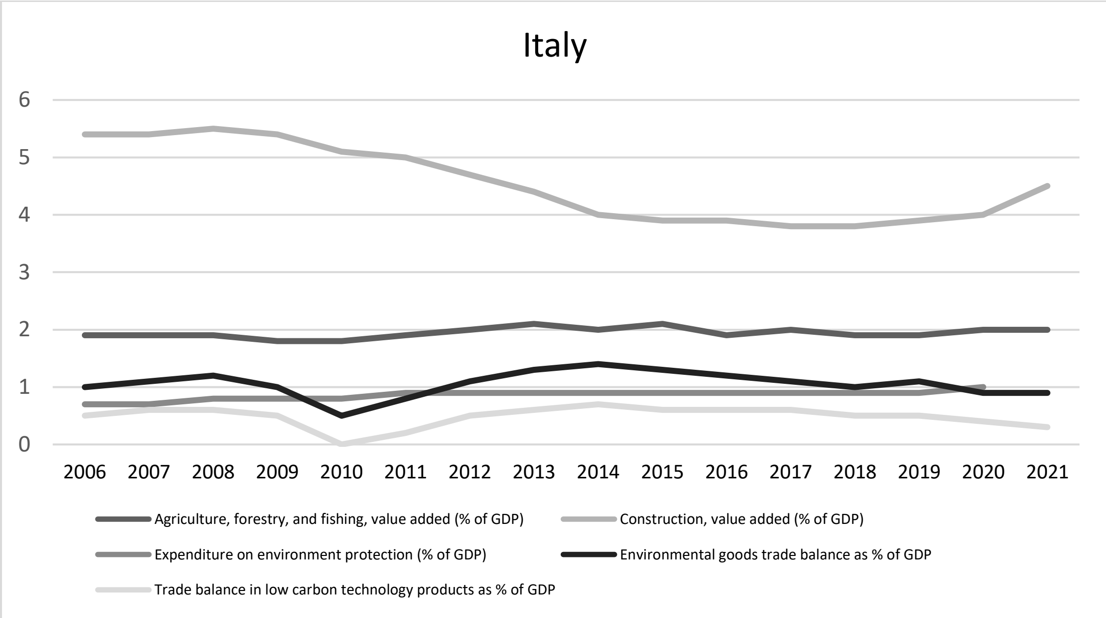
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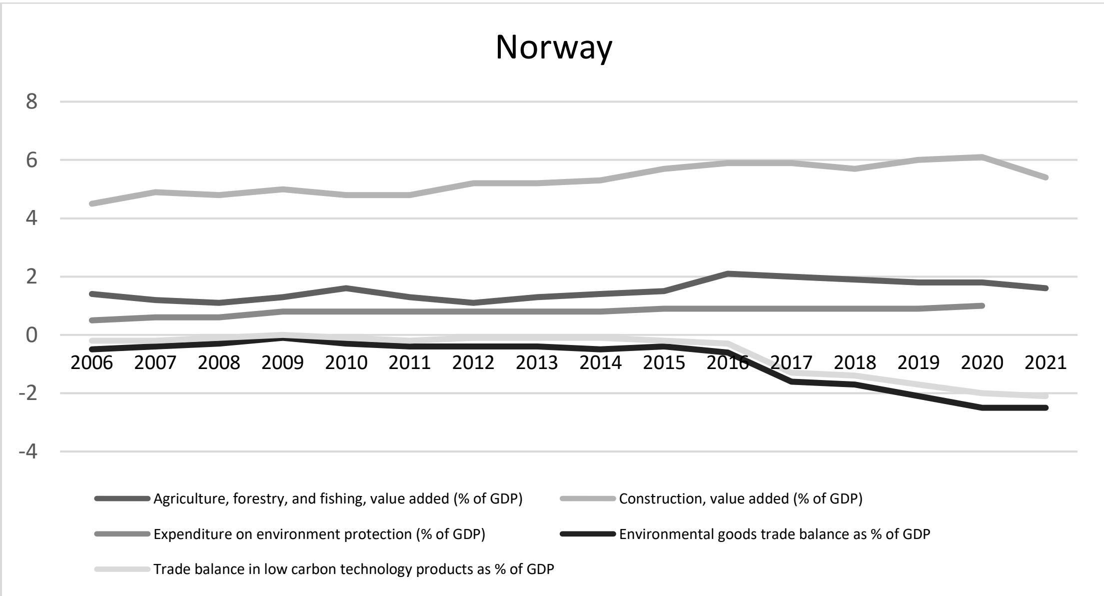
Norway
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Construction, value added (% of GDP)
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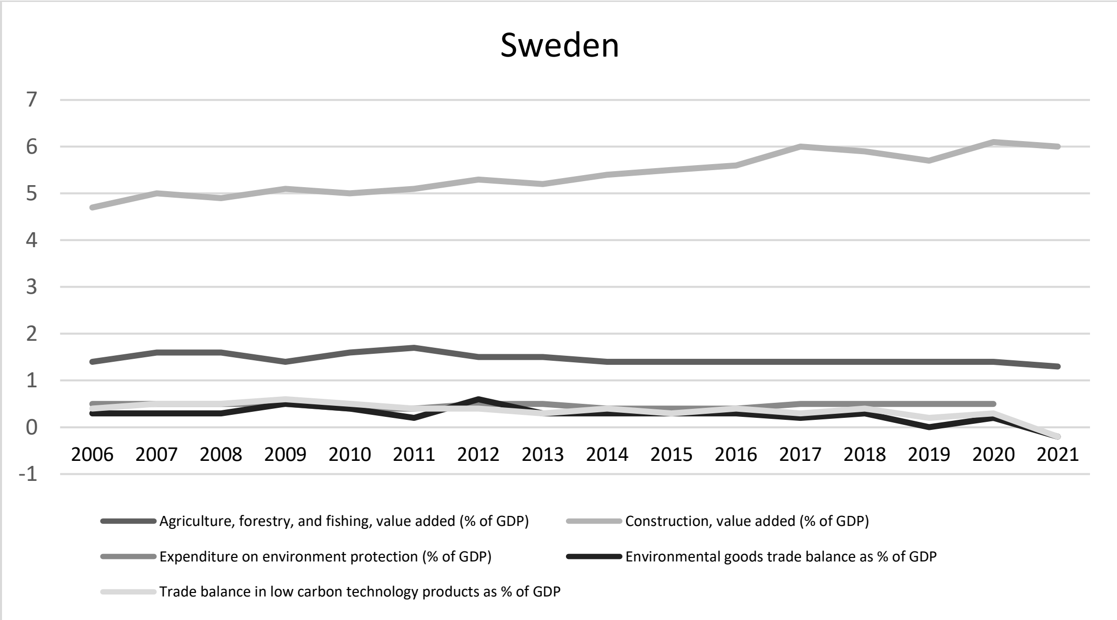
Sweden
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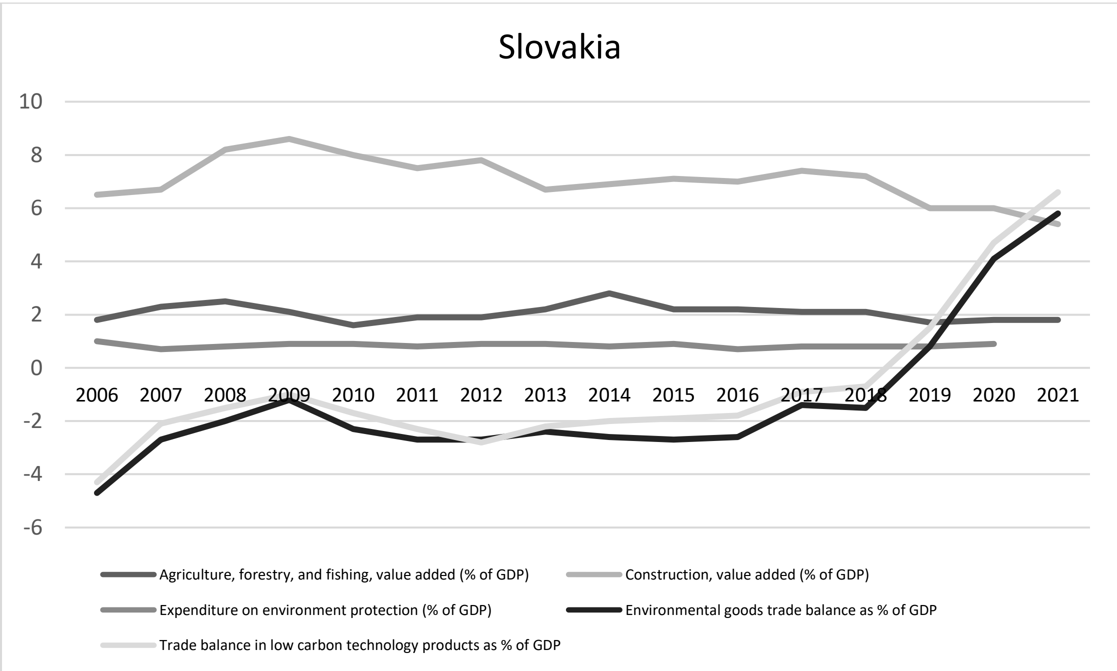
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