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THE ROLE OF SUSTAINABLE FINANCE IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS: DOES IT WORK?

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Abstract. The World Bank and International Monetary Fund reported that the achievement of the 17 Sustainable Development Goals (SDGs) requires an escalation of development finance. The report Scaling Finance for the Sustainable Development Goals highlighted the urgency of the efforts to realize SDGs in encouraging financial innovation to move quickly. Even if the role of finance in achieving SDGs is unquestionable, few scientific studies have addressed these issues. We tried to fill the existing research gap. In this study, we examined the link between sustainable finance and SDGs based on European Union countries belonging to the OECD. We present a new and the original research approach. We assumed that the sustainable finance model plays a fundamental role in implementing SDGs (all SDGs were analysed except for SDG 6 and SDG14, due to lack of statistics were not analysed) and ensuring that social and environmental sustainability are reflected in SDGs. The results of this study show that the more sustainable the finance model, the better the achievement of SDGs in the group of analysed countries. We found a strong link between sustainable finance model and social sustainability (SDG1, 3, 4, 5, 10, 16); environmental sustainability (SDG11, 12, 13, 15) and economic sustainability (SDG8, 9, 17).

Keywords: sustainable development goals, SDGs, Agenda 2030, sustainable finance model, the correspondence analysis.

JEL Classification: G14, G15, G18, G21, G23, O16, O44, Q01.

Introduction

The 2030 Agenda for Sustainable Development (Agenda 2030) contains 17 Sustainable Development Goals (SDGs) that are integrated and linked together (United Nations, 2015). This means that SDGs and the effectiveness of policies implemented to achieve each of the goals are also interrelated (Collste et al., 2017). SDGs generally refer to actions and policies that aim to mitigate the negative externalities of human activity and especially referring to the scope of social inclusiveness (SDGs 1–11, 15, 16), ecological inclusiveness (SDGs: 1, 2,

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6–9, 11–15), and relational inclusiveness (SDGs: 3, 4, 10–14, 16, 17) (Gupta & Vegelin, 2016). Interactions occur among SDGs that can be both positive and negative, usually depending on key factors such as geographical context, resource endowments, time horizon, and governance (Nilsson et al., 2018).

To achieve the SDGs, financing is necessary. The International Monetary Fund [IMF] published an analysis that showed that developing countries face an average annual funding gap of some USD $2.6 trillion for investment in health, education, roads, electricity, water, and sanitation. For low-income developing countries, this means additional annual spending that can amount to as much as 15% of their gross domestic product (GDP) (United Nations, 2019). The enormous and unmet need of developing countries may lead to the conclusion that the achievement of the SDGs requires an increased funding from billions to trillions (International Monetary Fund [IMF], 2015).

In 2015 in Addis Ababa, the third Financing for Development conference was held, and at the top of the issues discussed during the event, domestic resource mobilisation (DRM) and development was identified as an effective solution to and method of financing sustainable development (Long & Miller, 2017). Besides domestic resources, the role of financial markets in financing sustainable development is crucial and has been discussed in literature, especially in the context of capital market role (United Nations Global Compact, 2019).

A broad discussion exists in literature about the relationship between finance and sustainability (Aspinall et al., 2018; Ferreira et al., 2016). The overall conclusion based on the research results is that conventional finance is inadequate and unsuitable for financing SDGs as the three-dimensional perspective of sustainable development is not considered, leaving no room for environmental and social issues (Pisano et al., 2012; Fullwiler, 2015). Some postulates have been formulated in the scope of financing sustainable development that may improve financing, such as (1) incorporating non-financial (ESG) factors into risk analysis of financial institutions (OECD, 2018); (2) developing sustainable finance roadmaps and increasing cooperation regionally, and (3) developing typology of sustainable assets and finance (Zorlu, 2018). Sustainable finance is a common part of the proposed postulates.

Sustainable finance is a developing concept and new paradigm of finance. It is well defined in the literature. The general definition of sustainable finance explains this kind of finance as finance that takes into consideration ESG factors into financial decision-making (Schoenmaker, 2017). The subcategories of sustainable finance refer to major forms of environmental degradation, and inequalities that are part of definitions of sub-disciplines of sustainable finance (Ziolo et al., 2019).

In the relationship between sustainable finance and negative externalities (Ziolo et al., 2019) we aimed to examine the link between SDGs, and the finance model. First, relationships between sustainable finance, sustainable development and SDGs were analyzed in the context of negative externalities (Principles for Responsible Investment, 2017; Schoenmaker, 2017; United Nations, 2016; IMF, 2019; Ziolo et al., 2019). Then, a risk analysis was made in terms of the strength of its impact to justify which types of risk and the negative externalities that accompany them are the most relevant from the point of view of economy and finance and global challenges. For this purpose Global Risk Report 2020 was analyzed. At the top of the list of 10 risks in terms of impact according to Global Risk Report 2020 was Climate action failure. The group of environmental risk in top 10 is the most representatives

by environmental risk (5 among 10) two risks are societal (social), two technological and one geopolitical. In sum, environmental risk is the most important one taking in terms of impact (World Economic Forum, 2020). This is also confirmed for leading global challenges defined as climate change, poverty, inequalities. The same is a truth for sustainable finance, according to IMF 2019 "Losses from climate- related risks affect the financial system directly, through price impairment, reduced collateral values, and underwriting losses, and indirectly, through lower economic growth and tighter financial conditions" (IMF, 2019). Based on the analysis of risks and challenges environmental damage is a crucial among negative externalities (Centemeri, 2009), it's also one of an effect of climate change (Kahn et al., 2019) and climate change is a major example of an integrated approach spanning a range of goals (Elder & Olsen, 2019). Finally we analysed availability and comparability of data set and data sources for period of time and countries. With the exception of SDG6 and SDG14, data set is comparable and available. SDG6 is represented by 6 variables (indicators), but none of them is available for all EU countries. In some case the missing data concern over 10 countries. The missing data is observed in the case of countries without access to the sea i.e. Czechia, Luxembourg, Hungary, Austria, and Slovakia. It is the main reason that according to this goal the EU countries could not to be compared.

This approach is original and novel. To the best of our knowledge, this is one of the first publications assuming a link between the sustainable finance model and achievement of SDGs. All publications have been published so far focused on funding sources, not models of finance. The original approach is therefore based on the assumption that the sustainable finance model determines the achievement of SDGs. To date, the literature on the subject has focused on analyzing only amounts necessary to finance SDGs or sources of funds (public/private), while the financing model has not been studied at all. An innovative approach also lies in the fact that the study includes sustainable finance, while previous studies have not made a distinction at all between conventional and sustainable finance based only on conventional financing.

The main research hypothesis is that the more sustainable the finance model, the better the link with achievement of SDGs. The specific research questions were defined as follows:

(1) For which SDGs is the link to the sustainable finance model the strongest?
(2) For what groups of countries are the strongest relationships observed between SDGs and the sustainable finance model?
(3) What factors determine the differences between countries?

The remainder of this manuscript is organized as follows: Section II presents theoretical framework. Section III describes the data, variables assigned to describe the SDGs; Section IV explains research method. Section V provides the research results and discussion. Section VI outlines our conclusion and recommendations.

1. Literature review

Scholtens (2006) emphasizes finance as a driver of sustainability, especially through socially responsible investments (Waring & Edwards, 2008). In the last decades many institutions point out the need for financial institutions to integrate environmental, social and corporate governance factors (ESG factors) into the decision-making process to mitigate ESG risk.

According to Pisano et al. (2012), a vast gap remains between sustainable development and the actions of most financial markets. Vandekerckhove and Leys (2012) identify especially issues that must be revised to cover the gap between sustainable development and finance among them: better indicators for analysing sustainable development goals (SDGs); recommendations for sustainable financing strategies and investments (Ziolo et al., 2019). Sustainable finance is developing concept and a kind of response to financial markets to sustainable development challenges related to its financing. Gerster (2011) points out that sustainable finance is defined as a kind of financing addressing environmental, social, and governance (ESG) impacts of financial services. Schoenmaker (2017) propose framework for Sustainable Finance based on sustainable finance models (SFM). Schoenmaker (2017) distinguishes SF 1.0 – Profit maximisation, while avoiding "sin" stocks; SF 2.0 – Internalisation of externalities to avoid risk; SF 3.0 – Contributing to sustainable development, while observing financial viability. Interdependencies between finance and sustainable development are the most commonly analysed in the context of: ESG risk and integrating non-financial factors into business practices (Nikolakis et al., 2012); ESG risk and financial performance (Edmans, 2011; Gompers et al., 2003); financial markets versus global warming and civil libertie (Alm & Sievänen, 2013); impact investment (Hebb, 2013) and socially responsible investment (Vandekerckhove & Leys, 2012). Ferreira et al. (2016) present a systematic review of literature about finance and sustainability in accordance to the thematic fields as follows: investors in general; SRI; governance over impact investment; institutional investors; climate change and human rights; non-renewable extractive industry; and sustainable development. Based on systematic literature review Ferreira et al. (2016) argue there is the research gap which should be filling by new research referring the scopes of sustainable finance. Waygood (2011) states that financial institutions may impact on corporate sustainability in two ways: via financial performance and investor advocacy influence. Jeucken (2004) declares financial institutions are often significant actor in a society's progress toward sustainable development. Besides social impact of finance on society also environmental impact is reported in literature review. Chen (2013) states green finance is the key of low carbon economy and the development of low carbon economy is not possible without the green finance. Interdependencies and impact of finance on society and environment is a scope of interest of research globally. Environment and society are also a research subject in the field related to SDGs.

Literature review related to SDG analyse SDG in two ways – separately based on selected SDGs or as a SDGs network. The most common discussed among SDGs is health and environment for example Buse and Hawkes (2015) focused on health in the sustainable development goals and emphasized that his will require a paradigm shift in global health. Nerini et al. (2018) concentrate on SDG7 (energy) and characterize synergies and trade-offs between efforts to achieve SDG7. Gain et al. (2016) discuss water security in global context analyzing SDG6. Many studies focused on analysing the achievement and financing of SDGs in selected economy sectors like health (Barroy et al., 2018) or education (Rambla & Langthaler, 2016) or analysing the results considering the geographical location, especially Africa (The Sustainable Development Goals Center for Africa, 2017).

The network approach shows that some thematic areas covered by the SDGs are well connected with one another, hence other scopes of the network have weaker connections with

the rest of the network (Le Blanc, 2015). Nilsson et al. (2016) demonstrate a simple way of rating relationships between the SDG using Goals scoring. Hajer et al. (2015) proposed more general approach to SDGs based on four connected perspectives: "planetary boundaries", "the safe and just operating space", "the energetic society", "green competition". Gupta and Vegelin (2016) researched interactions between inclusive development and SDG and they argue there is a risk that theory (text about SDGs) and implementation processes focus more on social inclusiveness rather than on ecological and relational inclusiveness. Stafford-Smith et al. (2017) claim that there must be greater attention on interdependencies in three scopes: across sectors (e.g., finance, agriculture, energy, and transport), across societal actors (local authorities, government agencies, private sector, and civil society), and between and among low, medium and high income countries. Financial aspect related to SDGs is usually focused on investment or development finance context. Kedir et al. (2017) calculate the additional investment required to meet SDGs, with a focus on SDG 1. Schmidt-Traub and Sachs (2015) analyse private and public financing needs for the SDGs and formulate recommendations.

Publications on the relationship between finance and SDG focused on several threads, discussed public and private sources of SDG financing on a macro scale (Kharas et al., 2015), and the methods and instruments of financing selected SDGs on a micro scale (Gambetta et al., 2019). However, no researcher has examined the effectiveness and efficiency of SDGs financing depending on the financial model.

One of the few publications that identified the relationship between the SDG and fiscal policy instruments was Fiscal Policies and the SDGs in the Green Economy (UNEP, 2016). The report indicates fiscal instruments, such as taxes, fees, and public expenditure, and their role in stimulating and supporting the implementation of SDGs 6–14 and 17. The report raises the issue of the role of governments in shaping fiscal policy for sustainable development with sustainable fiscal policy instruments.

Sachs (2015) considered the financing mechanism for SDGs and discussed the financing of SDGs in the context of public (SDGs 3–7) and private mechanisms of financing (SDG13). Sachs raised the question of how we will ensure the required scale of flows and effective policies and institutional structures to manage the flows. Sachs emphasized that much of the necessary finance will flow through private markets, some will come from philanthropy and not-for-profit businesses, and much of it will need to come through the public sector, but no particular recommendations were provided about how to organize the systems, only general statements were outlined (Sachs, 2015).

The recommendations for financing sustainable development were considered in Financing the Sustainable Development Goals: Lessons from government spending on the SDGs. The report suggests doubling tax revenue, overhauling global tax rules, doubling concessional development cooperation, and improving the allocation and effectiveness of financing (Development Finance International & Oxfam, 2015). Kumar et al. (2016) recognized challenges related to achievement of SDGs, including: the huge cost of achieving the SDGs, the indicators for measuring SDG progress have not yet been identified, and a lack of accountability for inputs into SDGs at all levels. Klees (2017) stated that global taxation must replace the charity model.

2. Statistical data

To analyse the relationships between the area of sustainable development and finance, we used two data sets. The basis for analyses in the first area of this research was the indicators used by European Commission to monitor progress in the implementation of the latest strategy for sustainable development (Agenda 2030)[1]. In accordance with the assumptions presented in the introduction, we used the indicators describing the fifteen SDGs of this strategy in the second area of this research. Due to the availability of data, we analysed 2016 data. The following provides a detailed list of these indicators[2]:

- Goal 1: End poverty in all its forms everywhere (SDG1). SDG_01_10: *D*; SDG_01_20: *D*; SDG_01_30: *D*; SDG_01_40: *D*; SDG_01_50: *D*; SDG_01_60: *D*;
- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture (SDG2). SDG_02_10: *D*; SDG_02_20: (source: EC services), *S*; SDG_02_30: *S*; SDG_02_40: *S*; SDG_02_60: *D* (source: EEA);
- Goal 3: Ensure healthy lives and promote well-being for all at all ages (SDG3). SDG_03_10: *S*; SDG_03_20: *S*; SDG_03_40: *D*; SDG_03_50: *D*; SDG_03_60: *D*;
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (SDG4). SDG_04_10: *D*; SDG_04_10A: *D*; SDG_04_20: *S*; SDG_04_30: *S*; SDG_04_40: *D*, (source: OECD); SDG_04_50: *S*; SDG_04_60: *S*;
- Goal 5: Achieve gender equality and empower all women and girls (SDG5). SDG_05_20: *D*; SDG_05_30: *D*; SDG_05_40: *D*; SDG_05_50A: *S*; SDG_05_50B: *S*; SDG_05_60A: *S*, (source: EIGE); SDG_05_60B: *S*, (source: EIGE);
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all (SDG7). SDG_07_10: *D*; SDG_07_11: *D*; SDG_07_20: *D*; SDG_07_30: *S*; SDG_07_40: *S*; SDG_07_50: *D*; SDG_07_60: *D*;
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (SDG8). SDG_08_10: *S*; SDG_08_11: *S*; SDG_08_20: *D*; SDG_08_20A: *D*; SDG_08_30: *S*; SDG_08_30A: *S*; SDG_08_40: *D*; SDG_08_60: *D*;
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation (SDG9). SDG_09_10: *S*; SDG_09_20: *S*; SDG_09_30: *S*; SDG_09_40: *S*; SDG_09_60: *S*;
- Goal 10: Reduce inequality within and among countries (SDG10) SDG_10_10: *S*; SDG_10_20: *S*; SDG_10_30: *D*; SDG_10_50: *D*;
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable (SDG11) SDG_11_10: *D*; SDG_11_20: *D*; SDG_11_31: *S*; SDG_11_40: *D*; SDG_11_60: *S* (source: EC services);
- Goal 12: Ensure sustainable consumption and production patterns (SDG12) SDG_12_20: *S*; SDG_12_30: *D*; SDG_12_41: *S*; SDG_12_50: *D*;
- Goal 13: Take urgent action to combat climate change and its impacts (SDG13). SDG_13_10, *D*; SDG_13_20: *D*; SDG_13_50: *S*;

[1] All indicatoros were retrieved from https://ec.europa.eu/eurostat/data/database, the codes of indicators according to https://ec.europa.eu/eurostat/data/database.

[2] *S* and *D* describe the character of indicator: *S* is dedicated for stimulants, and *D* indicates for destimulants.

- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (SDG15). SDG_15_10: *S*; SDG_15_20: *S* (source: DG ENV, EEA); SDG_15_41: *D* (source: EEA); SDG_15_50: *D* (source: JRC);
- Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels (SDG16). SDG_16_10 *D*; SDG_16_20: *D*; SDG_16_30: *S*; SDG_16_40: *S* (source: DG COMM); SDG_16_50: *S*; SDG_16_61: *S*; SDG_16_62: *S*; SDG_16_63: *S* (source: EC services), European Central Bank (ECB);
- Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development (SDG17). SDG_17_10: *S* (source: OECD), *S*; SDG_17_30: *S*; SDG_17_40: *D*; SDG_17_50A: *S*; SDG_17_50B: *S*.

Referring to sustainable finance (SF) models, we based our approach on that of Schoenmaker (2017). Schoenmaker distinguished finance-as-usual (F); SF 1.0: profit maximisation, while avoiding "sin" stocks (F > S and E); SF 2.0: internalisation of externalities to avoid risk (T = F + S + E); and SF 3.0: contributing to sustainable development while observing financial viability (S and E > F)[3].

In the area containing indicators describing the sustainable finance (F) models in the analysed EU countries, the following indicators were considered: F1 (government support to agricultural research and development, Euro per inhabitant, *S*), F2 (Gini coefficient of equivalised disposable income, coefficient of 0 (maximal equality) to 100 (maximal inequality, *D*), F3 (government expenditure on "education" as a ratio to GDP, % of GDP, *S*), F4 (government expenditure on health as a ratio to GDP, *% S*), F5 (government expenditure on social protection, as a ratio to GDP, % *S*), F6 (government expenditure on law courts, Euros per inhabitant, *S*), F7 (government gross debt, as a ratio to GDP, %, *S*), F8 (shares of labour taxes in total tax revenues, percent of total taxes, *S*), F9 (share of environmental tax revenue in total government revenue from taxes, %, *S*), F10 (percent of total revenues from environmental taxes and social contributions, *S*), F11 (consolidated banking leverage, domestic and foreign entities (asset-to-equity multiple), *D*), F12 (bank credit to the private sector as percent of GDP, *S*), F13 (official development assistance as share of gross national income, percent of gross national income (GNI), *S*), F14 (European Union (EU) imports from developing countries, in million euros per 100,000 inhabitants, *S*), and F15 (income from natural resources, percent of GDP, *S*).

The indicators explaining the sustainable finance scope were selected to reflect the three-dimensional nature of sustainable finance, where variables: F1, F8, F9, F10, and F15 are related to the environmental sustainability and sustainable finance; variables: F2, F3, F4, F5, and F6 are related to the social pillar; and variables: F7, F11, F12, F13, and F14 are related to then economic pillar. When selecting the indicators within the sustainable finance scope, we based our approach on that presented by: Apergis et al. (2013) (environmental pillar), Burchardt and Vizard (2007) (social pillar) and economic (Čihák et al., 2012). The reference indicator framework to monitor the SDGs in an EU context was established by European

[3] F – financial value; S – social impact; E – environmental impact; T – total value.

Commission in 2017. The variables set consist of at most 6 indicators per SDGs in order to guarantee the same importance to all goals (EU SDG indicator set 2020). The indicators related to: economic, social and environmental sustainability are crucial to evaluate the Agenda 2030 objectives.

Indicators that refer to environmental pillar of sustainable development (included in SDG2, SDG7, SDG9, SDG11, SDG12, SDG13, SDG15, SDG17) and sustainable finance (F1, F8, F9, F10, and F15 mitigate negative impact of externalities) are related to negative externalities – environmental degradation (SDG2, SDG11, SDG12, SDG13, SDG15 represent negative externalities describe as *D*; SDG13 one exception "commitment on climate-related expenditure" positive impact describe as S; variables in SDG7, SDG9, SDG17 mitigate negative externalities described as *D*). One of the crucial air pollution sources is the emission of CO2. CO2 is responsible for climate change (global warming). CO2 emissions from the agricultural production represent 21–25 percent of total CO2 emissions (FAO, 2020). The Authors like Oates (1995), Parry and Small (2005), Lin and Li (2011) argue that environmental taxes are responsible for reducing the impact of pollution on environmental devastation. The correlation between public spending on R&D and GHG is also observed (Apergis et al., 2013; Lee & Min, 2015).

The group of financial variables like: F2, F3, F4, F5, and F6 refer to social pillar of sustainable finance. The variables related to SDG1, SDG2, SDG3, SDG4, SDG5, SDG10, SDG11, SDG16 described *D* indicate negative externality (social exclusion) and described S represent positive impact, mitigate it. We used Burchardt and Vizard (2007) research results to explain the selection of variables in the scope of: life (variables: SDG1, SDG2, SDG3, SDG4 SDG10), individual family and social life (variables: SDG5, SDG10), health (variables SDG3, SDG16), standard of living (variables SDG1, SDG11, SDG16); taking into account their coherence with negative externalities related to social pillar of sustainable development and sustainable finance and the way one can mitigate it. Taking into account the framework of social exclusion in European Union, social exclusion is determined by labour market position (SDG1, SDG5, SDG9, SDG10); life history (SDG1); social class; capital/welfare resources (SDG1, SDG4, SDG5); health wellbeing (SDG3, SDG16) (European Communities, 2002, p. 21).

The variables related to economic pillar of sustainability and to sustainable finance include indicators: F7, F11, F12, F13, and F14. The variables F11, F12 refer to financial soundness (Čihák et al., 2012). The indicators F7, F13, F14 correspond with economic development and welfare. According to Rubin (2011) the development and adoption of new technology is a comprehensive response to global climate change. Rubin (2011) points out that R&D is a critical element of the policy portfolio needed to foster innovations that reduce GHG emissions. Reducing GHG emissions is possible through innovations in technology and institutions will require increased numbers of skilled workers. This explains the economic variables included in SDG8, SDG9, SDG10, SDG17. The role of inclusive innovations in inclusive growth and social inclusion is crucial one and coherent with SDG9 (Heeks et al., 2013). It is worth mentioning, the selection of indicators was determined by Eurostat data set availability and comparability for period of time and countries.

3. Research method

To examine the relationships between the indicated areas, a two-stage research procedure was used. In the first stage, to calculate rankings in each of the distinguished areas, we separately considered a taxonomic measure of development based on standardized sums. The application of a taxonomic measure allowed us to compare the development of objects (in this case, EU countries belonging to the OECD). The higher the value taken by the taxonomic measure, the higher the level of the phenomenon marked by the object is. The construction of taxonomic measure uses different methods to normalize diagnostic indicators. In the study, we standardized the indicators. In this method, every diagnostic indicator is considered equally important. Based on the standardized sum method, the synthetic measure was calculated as follows (Bąk et al., 2019):

$$g_i = \frac{1}{m}\left[\sum_{j\in S}\frac{y_{ij}-\overline{y}_j}{s_j}+\sum_{j\in D}\frac{\overline{y}_j-y_{ij}}{s_j}\right], \tag{1}$$

where: S – set of indicators that are stimulants; D – set of destimulants; $\overline{y}_j$ – mean value; s_j – standard deviation.

In the next step to the calculation of taxonomic measure of development the following formula can be applied: $g_i^{'} = g_i - \min_i g_i$, $g_i^{''} = \frac{g_i^{'}}{\max_i g_i^{'}}$, $i = 1, \ldots,$. The application of the formula for g_i' shifts the scale of the *gi* measure to the zero point, and the transformation of $g_i^{''}$ leads to the upper limit of the taxonomic measure equal 1. Finally, taxonomic measures are in the range <0, 1>. Based on the value of the taxonomic measure, four typological groups of EU countries can be distinguished: group A: $g_i^{''} \geq \overline{g_i^{''}} + s_{g_i^{''}}$, group B: $\overline{g_i^{''}} + s_{g_i^{''}} > g_i^{''} > \overline{g_i^{''}}$, group C: $\overline{g_i^{''}} > g_i^{''} \geq \overline{g_i^{''}} - s_{g_i^{''}}$, group D: $g_i^{''} < \overline{g_i^{''}} - s_{g_i^{''}}$.

In the second stage, to deeply analyse the relationships between considered areas, we used correspondence analysis. This method was selected to detect relationships between the categories of synthetic measures calculated on the basis of the value of diagnostic indicators belonging to the selected five SDGs and sustainable finance. A detailed description of this method can be found in many reports (Greenacre, 1984, 1993; Goodman, 1986; Clausen, 1998; Bąk et al., 2019). Here, we applied the modified version of this method based on the values of taxonomic measure of development, transformed on a nominal scale. The results of division of EU countries into four typological groups were the basis of analyses presented in the paper. This means that in the modified version of correspondence analysis, the six synthetic measures obtained as a result of the division of EU countries in each analysed area that were divided into typological groups were the basis of calculation. For each of these variables, four categories were obtained, of which the first was associated with the highest values of the synthetic measure, and the fourth with the lowest. Finally, the categories of individual measure were presented as follows: taxonomic measure for Goal 1, SDG1:1 (best situation); SDG1:2, SDG1:3, and SDG1:4 (worst situation). The same method was applied to the rest of the considered variables representing the results achieved by EU countries for Goals 3, 9, 10, and 13, as well as in the area of sustainable finance, where F1 indicates countries with the best situation in this area and F4 indicates the worst.

In the first step of correspondence analysis, a complex contingency table (Burt matrix, contingent, cross-tabulation) included the number of all categories of measure, was applied to describe *n* objects (Greenacre, 1984, p. 140; 1994, p. 141; Andersen, 1991, p. 387; Lebart et al., 1984, p. 84). This is a matrix of *Z* variables that includes blocks (submatrices) referring to consecutive measures: $\mathbf{Z} = [\mathbf{Z_1}, ..., \mathbf{Z_Q}]$, where $\boldsymbol{Q}$ is the number of characteristics. The Burt matrix is calculated on the basis of an equation: $\mathbf{B} = \mathbf{Z^T Z}$, which produces the symmetrical block matrix with diagonal matrices. In these matrices the number of categories of characteristics is contained. While the contingency tables for each pair of analysed variables outside the diagonal matrix are calculated. The dimension of actual space of the coexistence of category of variables is calculated as:

$$K = \sum_{q=1}^{Q} (J_q - 1). \tag{2}$$

The procedure requires to choose the best size of projection (dimensional space) of the categories of variables. For these purpose the Greenacre's criterion (Greenacre, 1984, p. 145; 1993, p. 145; 1994, p. 156) according to which the eigenvalues should be calculated taking into account the following condition:

$$\lambda_{B,k} > \frac{1}{Q}. \tag{3}$$

In the next step, the improvement of the results of the correspondence analysis presented in form of Burt matrix should be provided. The following formula is applied for this purpose:

$$\tilde{\lambda}_k = \left(\frac{Q}{q-1} \right)^2 \cdot \left(\sqrt{\lambda_{B,k}} - \frac{1}{Q} \right)^2, \tag{4}$$

where: Q – number of variables; $\lambda_{B,k}$ – *k*-th eigenvalue.

New (modified) coordinate values in selected dimensional space for particular categories of variables were calculated as follows (Stanimir, 2005):

$$\tilde{\mathbf{F}} = \mathbf{F}^* \cdot \boldsymbol{\Gamma}^{-1} \cdot \tilde{\boldsymbol{\Lambda}}, \tag{5}$$

where: $\tilde{\mathbf{F}}$ – matrix (*n*×*m* dimensions) of new coordinate values for the variable categories; $\mathbf{F}^*$ – matrix (with dimensions of *n*×*m*) of the original coordinate values for the variable categories; $\tilde{\mathbf{A}}^{-1}$ – diagonal inverse matrix of singular values; $\tilde{\boldsymbol{\Lambda}}$ – diagonal matrix of modified eigenvalues (dimension).

The final result of correspondence analysis is the presentation of the simultaneous occurrence of the categories of variables in a graphic form (Greenacre & Hastie, 1987, pp. 437–447; Goodman, 1986, pp. 243–309). In this case, it is necessary to decide the number of dimensions that allow the best mapping of the results obtained. It is worth paying attention that if a space larger than three is, usually to present the coexistence of characteristics the methods of classification can be applied (Bąk, 2013, p. 135). The values of projection coordinates of each category are defined as variables, and the categories of all analysed characteristics are objects. The methods of classification are usually applied when the number of all characteristics and its options is high. In this case the dispersion of points in the graph is an obstacle to distinguishing the classes unambiguously.

4. Results and discussion

The detailed results of the first stage of procedure described in the previous paragraph are presented in Table 1. First of all, consideration needs to be given to the seven states that were in the first three places in the rankings and in the first typological group, at least in the case of three goals. These include: Sweden (goals: 1, 4, 5, 9, 13, 15 and 17), the Netherlands (goals: 3, 8, 11, 12, 17), Germany (goals: 8, 9, 10, 13), Luxembourg (goals: 3, 7, 10, 16), Denmark (goals: 5, 9, 16), Finland (goals: 1, 15, 16) and France (goals: 3, 12, 13). Among them are three countries (Denmark, the Netherlands and Sweden), which are also ahead in the field of sustainable financing. Particularly noteworthy is Sweden, which found itself in the first typological group due to sustainable finance and in the case of eight goals (1, 4, 5, 8, 9, 13 15, 16, 17). For four purposes (2, 3, 7 and 10) its position was also above the average in the studied group of countries, which allowed it to be included in the second typological group. Only in the case of objectives 11 and 12 this country was included in the third group.

Table 1. The results of rankings in each considered areas of sustainable development and finance

Country	F			SDG1			SDG2			SDG3			SDG4			SDG5		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Austria	0.520	7	B	0.642	6	B	0.807	4	A	0.799	5	B	0.653	9	B	0.221	3	C
Belgium	0.492	8	B	0.326	16	B	0.126	22	D	0.634	11	B	0.515	14	C	0.583	2	B
Czechia	0.230	16	C	0.918	2	C	0.540	11	B	0.466	16	C	0.495	15	C	0.024	4	D
Denmark	1.000	1	A	0.545	11	A	0.466	12	C	0.677	10	B	0.748	5	B	0.775	1	A
Estonia	0.610	6	B	0.575	9	B	0.764	6	B	0.397	20	C	0.647	10	B	0.340	3	C
Finland	0.705	4	A	1.000	1	A	0.291	17	C	0.633	12	B	0.631	11	B	0.663	2	B
France	0.368	12	C	0.657	5	C	0.723	8	B	0.439	18	C	0.552	13	B	0.709	1	A
Germany	0.459	9	B	0.399	14	B	0.756	7	B	0.604	14	B	0.443	16	C	0.471	2	B
Greece	0.175	19	C	0.000	23	C	0.296	16	C	0.629	13	B	0.163	21	D	0.169	4	D
Hungary	0.105	22	D	0.349	15	D	0.446	14	C	0.466	17	C	0.223	20	D	0.000	4	D
Ireland	0.284	14	C	0.415	13	C	0.227	19	D	0.728	9	B	1.000	1	A	0.175	4	D
Italy	0.269	15	C	0.157	22	C	1.000	1	A	0.761	7	B	0.000	23	D	0.530	2	B
Latvia	0.327	13	C	0.321	18	C	0.863	3	A	0.059	22	D	0.423	17	C	0.388	3	C
Lithuania	0.000	23	D	0.223	20	D	0.593	10	B	0.000	23	D	0.684	8	B	0.630	2	B
Luxembourg	0.401	11	B	0.599	8	B	0.227	20	D	0.835	3	B	0.754	4	B	0.416	3	C
Netherlands	0.784	2	A	0.572	10	A	0.194	21	D	0.915	2	A	0.710	7	B	0.546	2	B
Poland	0.186	18	C	0.530	12	C	0.252	18	D	0.320	21	D	0.720	6	B	0.309	3	C
Portugal	0.163	20	C	0.299	19	C	0.431	15	C	0.593	15	C	0.265	19	C	0.343	3	C
Slovakia	0.199	17	C	0.752	4	C	0.889	2	A	0.417	19	C	0.035	22	D	0.149	4	D
Slovenia	0.639	5	B	0.600	7	B	0.000	23	D	0.788	6	B	0.827	3	A	0.604	2	B
Spain	0.140	21	D	0.172	21	D	0.685	9	B	1.000	1	A	0.300	18	C	0.388	3	C
Sweden	0.729	3	A	0.862	3	A	0.775	5	B	0.814	4	B	0.859	2	A	1.000	1	A
United Kingdom	0.425	10	B	0.325	17	B	0.466	13	C	0.747	8	B	0.608	12	B	0.351	3	C

Continue of Table 1

Country	SDG7			SDG8			SDG9			SDG10			SDG11			SDG12		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Austria	0.389	10	B	0.688	7	B	0.635	7	B	0.325	4	B	0.484	13	C	0.456	12	C
Belgium	0.000	23	D	0.439	15	C	0.625	8	B	0.281	7	B	0.658	5	B	0.546	8	B
Czechia	0.164	18	C	0.702	6	B	0.351	12	C	0.103	14	C	0.367	17	C	0.440	13	C
Denmark	0.610	4	A	0.757	4	B	0.692	3	A	0.273	8	B	0.506	11	B	0.611	5	B
Estonia	1.000	1	A	0.639	9	B	0.241	15	C	0.055	19	C	0.509	10	B	0.000	23	D
Finland	0.325	11	C	0.629	10	B	0.650	5	B	0.243	11	B	0.400	14	C	0.230	22	D
France	0.119	20	D	0.403	17	C	0.648	6	B	0.251	10	B	0.378	15	C	0.816	2	A
Germany	0.172	17	C	0.805	3	A	1.000	1	A	0.333	3	B	0.699	4	B	0.422	14	C
Greece	0.211	14	C	0.000	23	D	0.000	23	D	0.025	21	C	0.033	22	D	0.546	9	B
Hungary	0.118	21	D	0.449	14	C	0.258	14	C	0.013	22	C	0.338	18	C	0.419	15	C
Ireland	0.539	5	B	0.535	11	B	0.301	13	C	0.309	5	B	0.987	2	A	0.489	10	B
Italy	0.159	19	C	0.110	22	D	0.227	17	C	0.187	12	C	0.569	8	B	0.749	3	A
Latvia	0.653	3	A	0.420	16	C	0.206	18	C	0.000	23	D	0.000	23	D	0.407	17	C
Lithuania	0.460	9	B	0.459	12	C	0.232	16	C	0.079	17	C	0.293	19	C	0.328	19	C
Luxembourg	0.673	2	A	0.733	5	B	0.455	11	B	0.642	2	A	0.554	9	B	0.419	16	C
Netherlands	0.181	16	C	0.923	2	A	0.653	4	B	0.288	6	B	0.855	3	A	1.000	1	A
Poland	0.103	22	D	0.371	18	C	0.040	22	D	0.038	20	C	0.281	20	C	0.234	21	D
Portugal	0.513	7	B	0.358	19	C	0.122	20	D	0.091	16	C	0.198	21	D	0.608	6	B
Slovakia	0.313	12	C	0.318	20	C	0.178	19	C	0.064	18	C	0.374	16	C	0.323	20	C
Slovenia	0.515	6	B	0.456	13	C	0.459	10	B	0.091	15	C	0.616	6	B	0.463	11	C
Spain	0.282	13	C	0.222	21	D	0.094	21	D	0.139	13	C	0.595	7	B	0.603	7	B
Sweden	0.501	8	B	1.000	1	A	0.851	2	A	0.271	9	B	0.484	12	C	0.338	18	C
United Kingdom	0.189	15	C	0.663	8	B	0.489	9	B	1.000	1	A	1.000	1	A	0.706	4	A

Country	SDG13			SDG15			SDG16			SDG17		
	1	2	3	1	2	3	1	2	3	1	2	3
Austria	0.429	14	C	0.507	11	B	0.589	9	B	0.245	11	C
Belgium	0.374	15	C	0.269	17	C	0.628	8	B	0.163	14	C
Czechia	0.369	16	C	0.387	16	C	0.255	21	D	0.185	12	C
Denmark	0.621	5	B	0.737	4	B	0.822	3	A	0.536	4	A
Estonia	0.042	22	D	1.000	1	A	0.460	12	C	0.770	2	A
Finland	0.531	12	B	0.903	3	A	0.927	2	A	0.267	9	C
France	0.816	2	A	0.459	13	C	0.299	18	C	0.155	15	C
Germany	0.786	3	A	0.595	8	B	0.660	7	B	0.374	6	B
Greece	0.522	13	B	0.565	10	B	0.000	23	D	0.116	18	C
Hungary	0.742	4	A	0.091	20	D	0.437	14	C	0.055	20	C
Ireland	0.220	19	C	0.208	18	C	0.689	6	B	0.116	19	C
Italy	0.556	10	B	0.656	6	B	0.231	22	D	0.253	10	C
Latvia	0.613	6	B	0.591	9	B	0.366	16	C	0.368	7	B
Lithuania	0.171	20	D	0.439	14	C	0.512	10	B	0.146	16	C
Luxembourg	0.000	23	D	0.061	21	D	1.000	1	A	0.384	5	B
Netherlands	0.103	21	D	0.000	23	D	0.733	5	B	1.000	1	A
Poland	0.233	18	C	0.055	22	D	0.446	13	C	0.039	21	C
Portugal	0.584	8	B	0.424	15	C	0.406	15	C	0.000	23	D

End of Table 1

Country	SDG13			SDG15			SDG16			SDG17		
	1	2	3	1	2	3	1	2	3	1	2	3
Slovakia	0.553	11	B	0.197	19	D	0.347	17	C	0.171	13	C
Slovenia	0.359	17	C	0.605	7	B	0.265	20	C	0.347	8	B
Spain	0.576	9	B	0.677	5	B	0.267	19	C	0.030	22	D
Sweden	1.000	1	A	0.952	2	A	0.796	4	A	0.605	3	A
United Kingdom	0.592	7	B	0.490	12	B	0.492	11	C	0.129	17	C

Note: 1 – means value of taxonomic measure of development, 2 – rank, 3 – typological group.

In all situations, the following countries were ranked the highest (in the first typological group): (1) implementation of Goal 1: Denmark, the Netherlands, and Sweden; (2) Goal 2 Austria, Italy, Latvia (3) Goal 3: the Netherlands and Spain; (4) Goal 4 Ireland, Sweden (5) Goal 5 Denmark, France, Sweden (6) Goal 7 Estonia, Denmark, Latvia, Luxemburg (7) Goal 8 Germany, the Netherlands, Sweden (8) Goal 9: Denmark, Germany, and Sweden; (9) Goal 10: Luxembourg and the United Kingdom; (10) Goal 11 Ireland, the Netherlands, the United Kingdom (11) Goal 12 France, Italy, the Netherlands, the United Kingdom (12) Goal 13: France, Germany, and Sweden; (13) Goal 15 Estonia, Finland, Sweden (14) Goal 16 Denmark, Finland, Luxemburg, Sweden (15) Goal 17 Denmark, Estonia, the Netherlands, Sweden (16) in the area of sustainable finance: Denmark, Finland, the Netherlands, and Sweden. Attention should be paid to Sweden, which was placed in the first typological group due to sustainable finance and achievement of the 1st, 4^{th}, 5^{th}, 8^{th}, 9^{th}, 13^{th}, 15^{th}, 16^{th} and 17^{th} goals. In the case of the remaining objectives (2, 3, 7 and 10), its position was also above average in the examined group of countries, which allowed it to be classified into the second typological group. The Netherlands and Denmark were also in a very good position, as it always placed high in the achievement of goals: 1, 3, 8, 11, 12, 13, 17 (Netherlands) and goals: 1, 5, 7, 9, 16, 17. For other countries, the situation was not so straightforward.

Table 2. Pearson correlation coefficient in the scope of sustainable finance and the selected goals of Agenda 2030 in 2016

Goals:	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	SDG 17	F
SDG1	1.00	–0.02	0.06	0.41	0.20	0.13	0.62	0.47	0.07	0.07	–0.30	0.01	0.12	0.45	0.34	0.49
SDG2	–0.02	1.00	–0.25	–0.45	0.01	0.11	–0.08	0.00	–0.14	–0.24	–0.11	0.44	0.41	–0.24	0.03	–0.17
SDG3	0.06	–0.25	1.00	0.13	0.15	–0.12	0.22	0.33	0.46	0.61	0.45	0.05	0.05	0.25	0.20	0.42
SDG4	0.41	–0.45	0.13	1.00	0.39	0.37	0.66	0.44	0.33	0.42	–0.15	–0.34	0.03	0.61	0.38	0.52
SDG5	0.20	0.01	0.15	0.39	1.00	0.14	0.35	0.58	0.17	0.13	0.15	0.25	0.47	0.42	0.42	0.60
SDG7	0.13	0.11	–0.12	0.37	0.14	1.00	0.25	–0.09	–0.07	–0.09	–0.47	–0.31	0.41	0.26	0.41	0.28
SDG8	0.62	–0.08	0.22	0.66	0.35	0.25	1.00	0.76	0.44	0.44	–0.07	–0.04	0.08	0.75	0.65	0.66
SDG9	0.47	0.00	0.33	0.44	0.58	–0.09	0.76	1.00	0.46	0.45	0.17	0.31	0.22	0.63	0.47	0.71
SDG10	0.07	–0.14	0.46	0.33	0.17	–0.07	0.44	0.46	1.00	0.67	0.32	–0.03	–0.08	0.48	0.08	0.30
SDG11	0.07	–0.24	0.61	0.42	0.13	–0.09	0.44	0.45	0.67	1.00	0.33	–0.20	–0.12	0.40	0.26	0.37
SDG12	–0.30	–0.11	0.45	–0.15	0.15	–0.47	–0.07	0.17	0.32	0.33	1.00	0.18	–0.30	–0.13	0.05	0.09
SDG13	0.01	0.44	0.05	–0.34	0.25	–0.31	–0.04	0.31	–0.03	–0.20	0.18	1.00	0.38	–0.16	–0.23	0.04
SDG15	0.12	0.41	0.05	0.03	0.47	0.41	0.08	0.22	–0.08	–0.12	–0.30	0.38	1.00	–0.03	0.23	0.39
SDG16	0.45	–0.24	0.25	0.61	0.42	0.26	0.75	0.63	0.48	0.40	–0.13	–0.16	–0.03	1.00	0.43	0.58
SDG17	0.34	0.03	0.20	0.38	0.42	0.41	0.65	0.47	0.08	0.26	0.05	–0.23	0.23	0.43	1.00	0.75
F	0.49	–0.17	0.42	0.52	0.60	0.28	0.66	0.71	0.30	0.37	0.09	0.04	0.39	0.58	0.75	1.00

Table 3. Kendall τ correlation coefficient in the scope of sustainable finance and the selected goals of Agenda 2030 in 2016

Goals:	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	SDG 17	F
SDG1	1.00	–0.02	0.06	0.31	0.08	0.08	0.38	0.40	0.12	0.00	–0.23	0.01	–0.03	0.29	0.28	0.36
SDG2	–0.02	1.00	–0.22	–0.30	–0.05	0.05	–0.07	–0.07	–0.11	–0.14	–0.10	0.34	0.31	–0.18	0.11	–0.11
SDG3	0.06	–0.22	1.00	0.19	0.19	0.08	0.23	0.25	0.46	0.45	0.33	–0.04	0.11	0.17	0.19	0.32
SDG4	0.31	–0.30	0.19	1.00	0.28	0.29	0.45	0.33	0.27	0.26	–0.07	–0.25	0.01	0.45	0.23	0.40
SDG5	0.08	–0.05	0.19	0.28	1.00	0.08	0.23	0.42	0.23	0.15	0.13	0.14	0.34	0.26	0.30	0.41
SDG7	0.08	0.05	0.08	0.29	0.08	1.00	0.19	0.01	0.02	0.04	–0.18	–0.17	0.26	0.20	0.29	0.18
SDG8	0.38	–0.07	0.23	0.45	0.23	0.19	1.00	0.62	0.39	0.31	–0.09	–0.05	0.05	0.57	0.49	0.47
SDG9	0.40	–0.07	0.25	0.33	0.42	0.01	0.62	1.00	0.47	0.38	0.15	0.19	0.15	0.46	0.44	0.61
SDG10	0.12	–0.11	0.46	0.27	0.23	0.02	0.39	0.47	1.00	0.59	0.26	0.00	0.00	0.34	0.19	0.37
SGG11	0.00	–0.14	0.45	0.26	0.15	0.04	0.31	0.38	0.59	1.00	0.26	–0.09	0.03	0.25	0.24	0.34
SDG12	–0.23	–0.10	0.33	–0.07	0.13	–0.18	–0.09	0.15	0.26	0.26	1.00	0.19	–0.03	–0.12	–0.11	0.06
SDG13	0.01	0.34	–0.04	–0.25	0.14	–0.17	–0.05	0.19	0.00	–0.09	0.19	1.00	0.28	–0.08	–0.04	0.00
SDG15	–0.03	0.31	0.11	0.01	0.34	0.26	0.05	0.15	0.00	0.03	–0.03	0.28	1.00	–0.06	0.30	0.28
SDG16	0.29	–0.18	0.17	0.45	0.26	0.20	0.57	0.46	0.34	0.25	–0.12	–0.08	–0.06	1.00	0.30	0.36
SDG17	0.28	0.11	0.19	0.23	0.30	0.29	0.49	0.44	0.19	0.24	–0.11	–0.04	0.30	0.30	1.00	0.60
F	0.36	–0.11	0.32	0.40	0.41	0.18	0.47	0.61	0.37	0.34	0.06	0.00	0.28	0.36	0.60	1.00

Table 4. The selected summary statistics calculated for taxonomic measures of development

Summary statistics	SDG1	SDG2	SDG3	SDG4	SDG5	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG15	SDG16	SDG17	F
Mean	0.49	0.51	0.60	0.53	0.43	0.36	0.53	0.41	0.22	0.49	0.48	0.47	0.47	0.51	0.28	0.40
Median	0.53	0.47	0.63	0.61	0.39	0.31	0.46	0.35	0.19	0.48	0.46	0.53	0.49	0.46	0.18	0.37
Standard deviation	0.25	0.27	0.24	0.26	0.24	0.24	0.24	0.27	0.22	0.25	0.21	0.25	0.28	0.24	0.24	0.25
Coefficient of variation [%]	50.86	53.18	40.99	48.74	56.77	66.36	45.99	64.85	99.59	51.44	43.09	53.65	59.30	48.01	86.59	61.82
Asymmetry	0.21	–0.04	–0.84	–0.49	0.27	0.84	–0.12	0.41	2.15	0.22	0.25	–0.09	0.05	0.21	1.49	0.62

The Netherlands, which took first place due to sustainable finance, also occupied quite good positions in achieving the goals of sustainable development, for eleven of them the position of this country exceeded the average value in the entire group of examined objects.

The positions of individual states in the ranking of countries due to sustainable finances and the implementation of individual goals were often divergent. An example could be Spain, which takes first place, for example, due to goals 3 and 21 due to sustainable finance.

The differences in the classification results obtained between individual goals and area of sustainable finances are also confirmed by the received assessments of Pearson correlation coefficients (Table 2) and Kendall τ (Table 3). The highest ratings of correlation coefficients (Person and Kendall τ) were obtained in the case of relationships between sustainable finances and Goals 17 and 9. However, the existence of at least average relationship (0.5 and more) can be confirmed by balanced finances and the goals: 1, 3, 4, 5, 8 and 16. Only in the case of goals: 2, 12 and 13 no relationship was found.

These differences confirm the values of the basic descriptive characteristics of estimated taxonomic measures of development. Coefficients of variation are very high and range from 40% to almost 100% (Table 4). The asymmetry of synthetic measures was also high for sus-

tainable finances and SDG3, SDG7, SDG10 and SDG17 and moderate for goals: SDG4 and SDG9. In the case of this first synthetic measure (for F), the asymmetry is right-sided, which means that for most countries the obtained values of the synthetic measure are lower than the average value. Positive asymmetry also occurs in the case of the taxonomic measure for Goals: 1, 5, 7, 9, 10, 11, 12, 15, 17. The situation is different when analysing the synthetic measure related to the implementation of Goals 3 and 4. In this case, for most countries, the obtained values of the synthetic measure were higher than the average value.

In the next table (Table 5) the results of correspondence analysis were presented. In order to check to what extent eigenvalues of lower dimension spaces describe total inertia, the Greenacre criterion was used (Greenacre, 1994, pp. 141–161; Stanimir, 2005). According to this criterion, eigenvalues that are greater than 1/Q are considered as significant for the study. Since the number of variables in the study is 16, eigenvalues higher than 0.0625 are treated as significant. Table 5 shows that eigenvalues fulfilling this condition are assigned to $k \leq 17$, while in 17-dimensional space the degree of explanation of total inertia is 94.03%.

The modification proposed by Greenacre significantly improved the quality of mapping. To confirm which space should be applied to the graphic presentation of the co-existence of the categories of variables, the "elbow" criterion was used. This criterion allows finding the place in which the values of modified eigenvalues started to form so-called talus, which means that the differences between the values are getting smaller. The talus started forming from the fourth eigenvalues. It means that this dimension will be appropriate (Figure 1).

Table 5. The results of original and modified versions of correspondence analysis

k	Eigenvalues γ_k	Singular values λ_k	Percentage of Inertia λ_k / λ	Cumulative Percentage τ_k	Eigenvalues $\tilde{\lambda}_k$	Percentage of Inertia $\tilde{\lambda}_k / \tilde{\lambda}$	Cumulative Percentage $\tilde{\tau}_k$
1	0.647	0.419	13.955	13.955	0.389	16.658	16.658
2	0.524	0.275	9.165	23.120	0.243	10.399	27.057
3	0.519	0.269	8.979	32.099	0.237	10.160	37.217
4	0.480	0.230	7.674	39.773	0.198	8.490	45.707
5	0.468	0.219	7.285	47.059	0.187	7.997	53.704
6	0.448	0.201	6.695	53.754	0.169	7.251	60.955
7	0.424	0.180	6.003	59.756	0.149	6.384	67.339
8	0.387	0.150	5.000	64.756	0.120	5.143	72.482
9	0.367	0.134	4.478	69.234	0.105	4.506	76.988
10	0.351	0.124	4.118	73.352	0.095	4.071	81.059
11	0.335	0.112	3.740	77.092	0.084	3.619	84.678
12	0.324	0.105	3.489	80.581	0.078	3.321	87.999
13	0.318	0.101	3.366	83.947	0.074	3.177	91.177
14	0.303	0.092	3.062	87.009	0.066	2.821	93.998
15	0.273	0.074	2.483	89.492	0.050	2.159	96.156
16	0.265	0.070	2.341	91.833	0.047	1.999	98.156
17	0.257	0.066	2.202	94.034	0.043	1.844	100.000
					$\tilde{\lambda}_k = 2.334$		

To present unequivocal interpretation, the Ward method was applied to group the categories of examined variables on the basis of modified values of eight coordinates determining their location in eight-dimensional space. The results of relationships between the categories of the examined variables using the Ward method are presented in Figure 2. The critical value of the distance at which the combination of classes (4.15) was determined according the measure proposed by Grabiński (2003). A critical value is marked in Figure 2 with a horizontal line; the typological groups are also indicated.

The results of the study confirm the relationship between the sustainable finance model and the implementation of SDGs. The first typological group (the highest-ranked positions

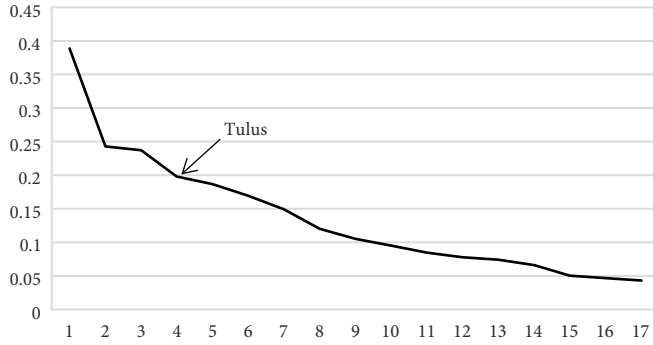

Figure 1. Eigenvalue chart (source: own elaboration based on Table 5)

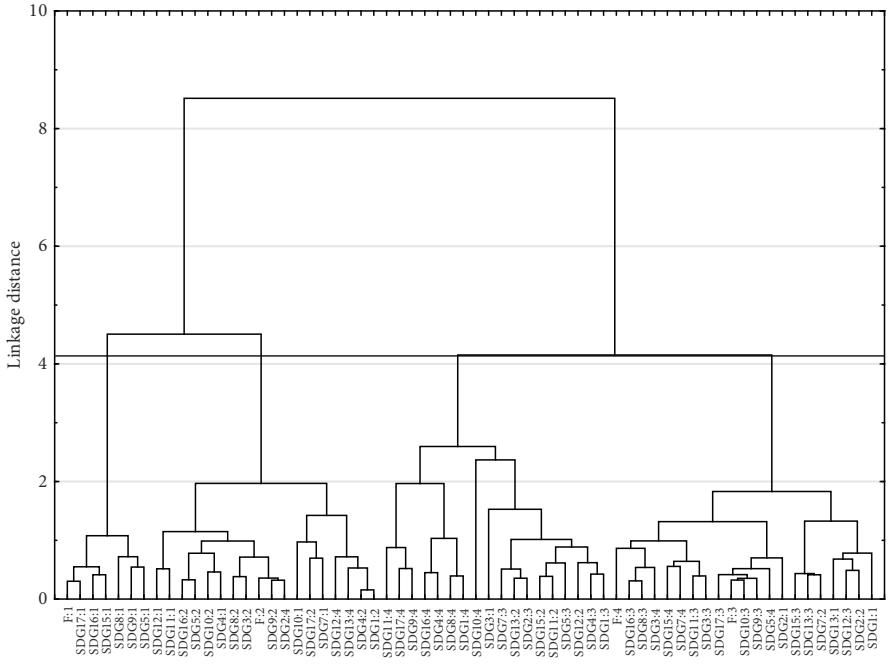

Figure 2. The results of the correspondence analysis (source: own elaboration)

according to SDGs and sustainable finance in the rankings) includes the Scandinavian countries (Denmark, Finland, and Sweden). The Netherlands also ranked highly referring to sustainable finance and SDGs. The lowest ranking positions according to sustainable finance were taken by Hungary, Lithuania, and Spain. Spain's case is interesting because, compared with Hungary and Lithuania, Spain has better achieved SDG, SDG13 and SDG15, but due to financing and low share of revenues from environmental taxes and social contribution, this country is classified in the lowest typological group of sustainable finance. The same indicators explain the position of France in sustainable finance ranking, although France is above average in achievement of SDG9, SDG10, SDG12 and SDG13 compared with the other countries in the same typological group. None of the countries simultaneously ranked first in the implementation of the SDGs (1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17) and the highest place in the sustainable finance. None of the analysed countries simultaneously had the highest level of SDGs implementation for all SDGs. Sweden, Denmark, and Finland were closest to achieving all SDGs in the top ranking positions, but they did not manage to achieve the top ranking position (1) but were over average (2) for SDG3 and SDG10. All Scandinavian countries and the Netherlands were ranked in the top in sustainable finance. The Scandinavian countries and the Netherlands represent the sustainable finance model 3.0, which is the highest level of sustainable finance. Typological groups of countries according to sustainable finance model and SDGs are presented in Table 6.

Countries applying the sustainable finance model 3.0 were the only group fully implementing all of the SDGs analysed, in particular the SDG on climate action. This group of countries is distinguished by a developed system of environmental taxes and the lowest level of income inequality measured by the GINI coefficient. It is also a group of countries with the highest level of sustainability awareness. The sustainable finance model 3.0 is based on public and private financing that are coherent and integrated with each other; the proportions between public and private financing are balanced. The financial market is well developed and many different kinds of sustainable financial instruments are offered by financial institutions.

Countries applying sustainable finance model 2.0 also have a well-developed environmental tax system, but in this group of countries, some countries produce the largest source of GHG emissions in Europe (Germany, Luxemburg, and the U.K.); hence, these countries

Table 6. Relationship between sustainable finance model and SDGs

Conventional finance F*	Sustainable finance model 1.0. F > S, E	Sustainable finance model 2.0. T = F + S + E	Sustainable finance model 3.0. S, E > F
Hungary, Lithuania, Spain	Czech Republic, France, Greece, Ireland, Italy, Latvia, Poland, Portugal, Slovakia	Austria, Belgium, Estonia, Germany, Luxemburg, Slovenia, United Kingdom	Denmark, Finland, the Netherlands, Sweden
SDG1, SDG2	SDG1, SDG10, SDG12	SDG1, SDG3, SDG4, SDG9, SDG10, SDG11, SDG16	SDG1, SDG2, SDG3, SDG4, SDG5, SDG7, SDG8, SDG9, SDG10, SDG13, SDG15, SDG16, SDG17

Note: *F, S, E-dimensions: financial, environmental, social; T – integrated, total value (Schoenmaker, 2017).

have not effectively implemented SDG7, SDG13, SDG17 related to climate change. Public and private financing in model 2.0 are coherent, integrated, and balanced. The role of the financial sector and public financial sector markets in financing of sustainable development are interdependent.

The sustainable finance model 1.0, or conventional finance model, is applied in countries after systemic transformation and states that were most affected by the effects of the 2008 financial crisis. The economies of these countries applying the 1.0 sustainable finance model are based on fossil fuels (coal) and are only starting to adjust activities to replace fossil fuels with renewable energy sources. The environmental taxes system in this group of countries is developing, and these countries focus their efforts on poverty with social programs. The conventional model and model 1.0 are mainly based on public sector financing and the financial market is not adjusted to meet the expectations of sustainable development financing.

The research results show that the implementation of SDGs depends on applying a sustainable finance model. The more sustainable the finance model, the more the SDGs are implemented, with the most crucial impact of sustainable finance model focusing on the environmental pillar of sustainable development (climate action). The less sustainable the finance model, the more visible the focus on socially-related goals.

Comparing the study results with the sustainability rankings, the following conclusions are noteworthy:

- according to the Sustainable Competitiveness Index 2019 (SolAbility, 2019) the top 5 ranking positions are occupied by Scandinavia: Sweden is leading the Sustainable Competitiveness Index – followed by the other the Scandinavian nations;
- in 2017 all Scandinavian countries (Denmark, Sweden Finland, Norway) were on the top 5 ranking position of the Country Sustainability Ranking which analysis countries' ESG performance;
- Sweden is a leader in sustainable financing; its financial institutions have been some of the first active in the green bond market (SEB, Nordea, Kommuninvest, Vasakronan) (Stockhol Sustainable Finance Centre);
- The Nordic Model of governance and public service provision is all about sustainability and social cohesion (The Green Bond market in the Nordics 2018 (Climate Bonds Initiative, 2018));
- Sweden is the sixth largest source of labelled green bond issuance; Norway, Denmark and Finland are in the Top 20 (Climate Bonds Initiative, 2018);
- SDG index for the European Union (2019) revels Denmark, Sweden, Finland are on 3 top ranking positions regarding to achievement of SDGs (Sustainable Development Solutions Network and Institute for European Environmental Policy, 2019).

The analysis of sustainable rankings results confirm that the study results are coherent are in line with the rankings. The SDG index is especially important as it is in line with our research results not only for the top on the list but also for other (middle and last) ranking positions. The Report points out what we found in our study that the greatest challenge is to secure achieve of SDGs related to climate change and climate actions among analysed country group.

Based on thy analysis of related work we draw the conclusion that there are no research results we can compare and discuss directly with our study results. There is a research gap

in the scope the study we have discuss. No study has been dealing with the similar to ours research hypothesis: the more sustainable the finance model, the better the link with achievement of SDGs.

Our research results are in consonance with the results of Gambetta et al. (2019). The authors analysed the design of sustainable finance instruments for financing SDGs, including, among others, environmental taxes and public expenditures for social and environmental goals. The Uruguay sustainable finance model (model 1.0.) is in the early stage of development: SDG1 has been achieved totally whereas others SDGs remain a challenge. Financing sustainable development plays a leading role in the public sector. The authors concluded that there is a need for an in-depth study of finance and sustainability.

Our results also align with Discover the SDGs implementation level a year and a half after ratification of 2030 Agenda (Discover the SDGs, 2015; Sustainability for all, 2019). According to the report, Sweden (84.5), Denmark (83.9), Norway (82.3), and Finland (81.0) are in the leading positions, mainly due to their good performance in social and economic issues, although the data showed that they must still work on the transition to a low carbon economy. Spain ranked 30th with 72.2; United Kingdom needed to improve in Zero hunger and Affordable and clean energy (Discover the SDGs, 2015; Sustainability for all, 2019).

The results of the analysis are difficult to compare given the background of related work because such research has not yet been conducted. This is one of the first approaches to examine the relationship between sustainable finance model and SDGs. Much attention has been paid to the role of public expenditure or environmental taxes in achieving SDGs, whereas focus on the relationships with the sustainable finance model is lacking.

Conclusion and recommendations

The implementation of SDGs in the face of climate change, social exclusion, and increasing inequalities is a priority for governments around the world. Simultaneously, implementation of SDGs is not possible without providing funds for their financing. Discussion of the design of sustainable financial systems and sustainable finance model is underway and research on the effectiveness of financing for sustainable development is in an early stage. This paper is one of the first based on an original research approach analysing the relationship between sustainable finance model and SDGs using correspondence analysis. Such analyses have not been conducted before to analyse the link between SDGs and sustainable finance model, which indicates the novelty of our research approach.

The findings verify the main hypothesis of the link between a sustainable finance model and SDGs, indicating that that the more sustainable the finance model, the better the results of a given country in achieving SDGs. The study was conducted for fifteen SDGs (SDGs 1,2, 3,4,5,7,8,9,10,11,12,13,15,16,17). In case of SDG6 and SDG14 the variables are not available. We analysed 23 EU countries belonging to the OECD for 2016. The analysis was based on variables from the OECD database; a total of 98 variables were included in the analysis, of which 83 represented SDGs and 15 represented sustainable finance. As a result of the study, it was shown that SDG1 has been achieved in all sustainable finance models. This is justified by the fact that the sustainable public financial system in its basic form, through the redistributive function of public finances, guarantees the equalization of income and

through social policy provides access for all citizens to basic public goods and services. As part of these basic public goods and services, there is the fight against social exclusion. For the same reason, SDG4, SDG10 have been related to all sustainable finance models. SDG3, SDG4, SDG5, SDG7, SDG8, SDG9, SDG13 and SDG16 due to the fact that they concern and have an impact on well being and quality of life are not possible to achieve only on the basis of a sustainable public financial system. They require also cooperation and involvement of the sustainable market financial system. This is due to, among others from the fact that health and wellbeing is influenced by, among others air quality that can be achieved by implementing technological innovations primarily in the business sector and the state is not able to provide sufficient public funding in this regard, nor in the field of financing innovation. Integrated actions are required here through fiscal policy (public expenditure, taxes) and dedicated sustainable financial products and services and procedures (sustainable benchmarks, sustainable ratings, ESG risk management).

The study results confirm the relationship between the sustainable finance model and implementation of SDGs, which was strongest in countries applying sustainable finance model 3.0. In these countries, both the public and private financial systems are involved in financing sustainable development; these systems interpenetrate and complement each other.

The sustainable finance model 2.0 allows for above average SDGs implementation; however, financing environmental goals requires adaptation to the needs and structure of economies. Countries in this group are characterized by high greenhouse gas emissions. Therefore, processes of adaptation of both public policies and the financial market are required to reduce emissions using environmental taxes and financial products to finance technologies supporting the development of renewable energy sources.

The other two models of conventional finance and sustainable finance model 1.0 included a group of countries whose both public and private financial markets were in the phase of adaptation to the needs of financing sustainable development. The public sector plays a major role in financing sustainable development. Countries from this group achieved SDG1 without any problems, whereas the implementation of the other SDGs was problematic.

This research is pioneering: the relationship between sustainable finance model and SDGs has not been previously studied. Hence, we encountered numerous difficulties during the study development and literature review stages, as well as given the lack of data. The results of the study could contribute to further in-depth research for a broader time perspective and a larger number of variables. We plan to develop analyses based on fuzzy cognitive methods based on data from in-depth interviews, complementary to statistical data that are incomplete and difficult to compare over time for individual countries. Based on the results of the study, the following recommendations were formulated:

- Effective achievement of SDGs requires an effective and integrated financial model based on the public and market financial systems, which are interdependent and related in terms of meeting the criteria of sustainable financing. This is why governments should ensure parallel development and cooperation between public and market financial systems toward sustainability;
- The public financial system upon which the conventional model and the 1.0 model are primarily based is able to provide support for the implementation of the social pillar of sustainable development, but is not able ensure the achievement of environmental

goals; therefore, governments should provide support from financial institutions for the public financial system for financing environmental goals through legal regulations;
- Due to the visible impact of financing on SDG, governments should introduce effective micro- and macro-prudential solutions to control this phenomenon in the financial system;
- Integration of financial policy and sustainable development policy should be a priority for governments; these policies should have common monitoring indicators and common goals to ensure integration of the financial sphere and reality;
- Governments should introduce a system for reporting and monitoring the impact of the public and market financial system on SDG achievement.

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Author contributions

Conceptualization: M.Z.; methodology: I.B., K.Ch.; software: I.B., K.Ch.; validation: I.B., K.Ch.; formal analysis M.Z., I.B., K.Ch.; investigation: M.Z.; resources: MZ. I.B., K.Ch.; data curation: I.B., K.Ch.; writing original draft preparation: M.Z. I.B., K.Ch.; writing review and editing: M.Z., I.B., K.Ch.; visualization: M.Z.; I.B., K.Ch.; supervision: M.Z.; project administration: M.Z.; funding acquisition: M.Z.

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