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# Empirical Analysis of the Logistics Sustainable Development in Poland: The Role of Macroeconomic Stability, Financial Security, and Social Development

## Abstract

The paper discusses the sustainable development of Polish logistics companies from 2008 to 2022. The study is motivated by the growing relevance of reconciling macroeconomic, financial, and social aspects of green transformation processes. The main objective is to evaluate the impact of macroeconomic stability, financial security, and social development on economic, social, and environmental performance. The method uses Ordinary Least Squares (OLS) and Seemingly Unrelated Regression (SUR). It utilises synthetic indicators of sustainable development and its most significant drivers: the Macroeconomic Stabilisation Index (MSP), Financial Security Index (FS), and Human Development Index (HDI). The findings confirm the positive dynamics of sustainability and indicate that HDI has the strongest and most significant impact on sustainable development, with a one-year lag specifically. Economic security supports financial growth, while environmental progress is catalysed by monetary expansion. The study contributes a new analytical model with macroeconomic and social determinants, with implications for researchers and policymakers.

## Keywords

sustainable development | logistics sector | macroeconomic stabilisation | economic security

## JEL Codes

O1, O18

## 1. Introduction

The sustainable development of enterprises (SD) means development in three economic, social, and environmental pillars. In the logistics sector, sustainable development is mainly focused on the natural environment and reducing its negative impact. The solutions that logistics companies seek are primarily ecological transport, optimisation of logistics processes, or sustainable packaging materials. The growing understanding of the importance of qualified personnel and support for the development of local communities also plays an important role.

The purpose of the research is to show how macroeconomic stability, financial security, and social development influence the sustainable development of logistics companies in Poland. Research focuses on 2008-2022 and attempts to determine which of

these drivers has the strongest and most significant influence.

Socioeconomic development that respects the protection of the natural environment is significant due to the supporting importance of logistics for other sectors of the economy and its high intensity of emissions. Due to the strategic role of logistics in supply chains, transformation is crucial to achieving the EU's climate goals.

The sustainable development of logistics enterprises depends on several factors, including exogenous ones, such as macroeconomic conditions, economic situation, level of social development, status and prospects for the implementation of environmental programmes and solutions, level of society's education, availability of external sources of financing; and endogenous inherent in the enterprise itself, including the financial situation of enterprises,

management style, management's approach to environmental protection and social issues, and the possibility of self-financing ecologically and socially responsible projects.

The novelty of this paper is the analysis of the impact of macroeconomic stability, financial security, and social development of countries on the sustainable development of companies in the logistics sector in Poland. Unlike previous studies, this article integrates economic and social dimensions into a single analytical framework, providing a more comprehensive assessment of sustainable development in the sector.

The main innovative elements of the study are the application of the SUR model and the inclusion of three key variables, including an indicator developed based on the macroeconomic stabilisation pentagon, the HDI index, and the author's financial security index. This methodological approach captures the complex interdependencies between macroeconomic stability, financial conditions, and social progress.

The article supplements the literature by showing the strength and direction of the influence of essential economic and social factors. The purpose of the paper is to verify the extent to which macroeconomic stability, financial security, and social development determine the sustainable development of logistics companies in Poland. The following central hypothesis is "Social development has a stronger, statistically significant impact, compared to financial security and macroeconomic stabilisation, on the sustainable development of logistics enterprises from 2008 to 2022". In addition, the following research questions were asked: Does the sustainable development of logistics companies have a positive trend from 2008 to 2022? Are the dynamics of economic development greater than the dynamics of social and environmental development? Do macroeconomic stabilisation, social development, and financial security of the sector positively impact the pillars of sustainable development?

The research paper uses linear regression methods, including ordinary least squares (OLS) and seemingly unrelated regression (SUR), which allow a more precise estimation of interrelated equations reflecting different dimensions of sustainable development. We create synthetic indicators of macroeconomic stabilisation (MSP), financial security (FS), and sociodevelopment (HDI).

The results are significant for policymakers, logistics companies and financial institutions

interested in improving the sustainability of the sector. Models help to recognise the primary aspects that influence the green transition in logistics.

## 2. Literature Review

Sustainable development of enterprises refers to improving the economic, social, and environmental situation (Matinaro et al. 2019; Marrucci et al. 2022). It is defined in the literature on the subject in many ways (Table 1).

In a narrow sense, scholars have delineated a distinction between sustainable development and ecodevelopment, emphasising the critical role of commercial enterprises in supporting environmental conservation (Svtlichna et al. 2024; Domaska et al. 2023). Although sustainable development seeks to balance economic growth with social and environmental considerations, ecodevelopment places a more pronounced emphasis on ecological preservation (Pons et al. 2024). This differentiation is particularly significant in the context of corporate practices, as it underscores the need for organisations to transcend mere sustainability measures and actively contribute to the protection and restoration of natural ecosystems. Proponents of ecodevelopment posit that businesses should not only minimise their environmental impact but also actively participate in initiatives that improve biodiversity, restore habitats, and promote ecological regeneration. This approach requires a fundamental transformation in business models, elevating environmental stewardship to a core organisational objective rather than a secondary consideration (Fatimah et al. 2023). By aligning their operations with eco-development principles, commercial entities can play a crucial role in safeguarding the natural environment while simultaneously pursuing economic objectives, thus fostering a more harmonious relationship between human activities and ecosystems (Sachs et al. 2019; Aguilera et al., 2021).

In a more comprehensive meaning, it encompasses a holistic approach to business practices that extends beyond mere profit making. In a broader context, SD involves implementing strategies to enhance an organisation's economic and financial performance, while simultaneously addressing social and environmental concerns (Husain et al. 2023). This multifaceted approach includes initiatives to support

**Table 1.** Selected Definitions of Sustainable Enterprise Development

| Author                                                 | Definition                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dyllick and Hockerts (2002)                            | Meeting the needs of a firm's direct and indirect stakeholders (...) without compromising its ability to meet the needs of future stakeholders as well                                                                                                                                                                     |
| Colbert and Kurucz (2007)                              | Keep the business going, future-proofing                                                                                                                                                                                                                                                                                   |
| Porter and Kramer (2007)                               | Take decisions considering the common value                                                                                                                                                                                                                                                                                |
| Grudzewski, Hejduk, Sankowska, Wańtuchowicz (2010)     | A sustainable enterprise is the concept of the company of 'tomorrow', flexible to the constant turbulent changes in the environment and capable of functioning in chaos and crisis                                                                                                                                         |
| Novikova, O.F., Amosha, A.I. and Antoniuk, V.P. (2012) | Economic – provides for the formation of an economic system harmonised with the environmental factor in the development; social –affirms the human right to a high standard of living under the conditions of ecological safety; ecological –determines the conditions and limits of restoration of the ecological systems |
| Zu (2013)                                              | The sustainable enterprise incorporates the principles of sustainability into each of its business decisions                                                                                                                                                                                                               |
| Trojanowski (2015)                                     | Balancing the economic goals of the company with the environmental and social goals is not an easy task. Taking action on the sustainable concept requires a different approach from management staff and mid-level and executive staff.                                                                                   |
| Oželienė (2017)                                        | A holistic approach to business thinking that seeks to integrate consideration of the three aspects of sustainability—social, environmental, and economic                                                                                                                                                                  |
| Pabian (2017)                                          | A sustainable enterprise operates on the basis of sustainable resources. These resources include people, infrastructure, durable and nondurable assets, as well as any outgoing goods                                                                                                                                      |
| Brach, Gul, Kawecki (2020)                             | A sustainable company ensures the environmental friendliness of its operating processes while striving to meet the expectations of all stakeholders to prolong the chances of long-term market survival                                                                                                                    |
| Zhou, Liu, Luo (2022)                                  | Enterprises strive to improve the level of environmental management and pay attention to ESG performance management                                                                                                                                                                                                        |

Source: literature on the subject

employee well-being and promote the development of local communities (Koon 2024). Furthermore, SD emphasises the adoption of ecoinnovations and environmentally friendly solutions to mitigate the adverse effects of business operations on the natural environment (Larbi-Siaw et al. 2022). By integrating these diverse elements, companies can create long-term value for stakeholders while contributing to the overall health of society and the world. This comprehensive understanding of SD underscores the interconnectedness between economic prosperity, social responsibility, and environmental stewardship in achieving sustainable business practices (Zuzek, Mickiewicz 2014; Sagan 2021; Cosmulese et al. 2021; Sun et al. 2023).

Sustainable enterprise development within stakeholder theory emphasises the importance of balancing current stakeholder needs with a company's long-term viability and future stakeholder expectations

(Ribeiro et al. 2021). This approach recognises that a company's success is not solely measured by short-term financial gains but also by its ability to create lasting value for all stakeholders. By integrating sustainable practices into their operations, companies can maintain their ability to fulfil tasks and meet evolving stakeholder demands (Waheed et al. 2024). This involves considering environmental, social, and economic factors in decision-making processes, fostering innovation, and adapting to changing market conditions (Gorski et al. 2023). Ultimately, sustainable enterprise development in stakeholder theory aims to create a resilient and adaptable organisation that can thrive in the present while safeguarding its ability to meet the needs of future generations of stakeholders. (Dyllick, Hockerts 2002; Bose 2020; Krasodomska et al. 2022).

SD reorienting the company's goals towards increasing value for contractors requires determining

the impact of the enterprise on its environment, building an environmentally friendly image, achieving the best possible financial results, multidimensional management and testing various business models and scenarios, implementation of continuous learning processes organisation, eliminating threats in the area of implementation of SD (Grudzewski et al. 2010; Amin et al. 2021; Mach et al. 2023).

Logistics enterprises (Section H of PKD 2007: Transport and warehousing) play a pivotal role in creating countries' stable economic development because of the large share of working people in total employment and contribution to GDP. Additionally, the logistics sector supports other companies by stimulating goods transport and providing services (West, Börjesson 2020; Xie 2022).

Despite its positive contribution to the development of high emission intensity, the sector is also important (Bernardo et al. 2021). The SD of the logistics sector demands the implementation of ecological innovations, electrification of transport, and the development of technologies and transport solutions that reduce greenhouse gas emissions into the atmosphere (Pereira et al. 2017; Banik, Lin 2019; Taghvaei et al. 2022; Remyha et al. 2022).

The EU environmental protection policy implemented over the past decade has resulted mainly in logistics companies being forced to take actions to reduce emissions. Undoubtedly, the assumptions of the Green Deal impose new obligations in the field of ecology to reduce greenhouse gas emissions by transport to 90% by 2050.

The SD of logistics enterprises depends on the internal situation of the sector (financial conditions, financial security, business model, implemented strategy and management style) and external conditions (macroeconomic, environmental taxes, legal regulations in the field of environmental protection, geopolitical conditions, and the level of development of society itself). The macroeconomic conditions play a crucial role in the stable development of the logistics sector (Comporek et al. 2022).

Transport activity is used as an appropriate leading indicator of macroeconomic change, particularly under conditions of uncertainty in the economy. Logistics indices can identify some signals of recession or recovery of the economy, which helps determine sustainability dynamics within the sector (Wierzbińska & Stańczyk 2023). Furthermore, financial management tools, such as control systems

and variance analysis, are more used in small and medium enterprises to enable resilience and economic efficiency (Nowak 2022). These approaches could assist in calculating financial security in logistically orientated firms that experience external shocks or transformations.

Also, an important element is having an appropriate rank of financial security (a financial and property situation that allows development). High profitability and operational efficiency allow firms to get reasonable credits and loans (high financial liquidity, low debt level) and good investor ratings (Misztal 2021).

In recent years, the theme of integrated sustainability has been one of the topics on the research agenda in Europe. Focusses on the integration between economic, social, and environmental development and emphasises the necessity of assessing these side by side rather than isolation. This approach is particularly relevant to EU countries, where policy integration and multidimensional development are central to achieving long-term goals such as the Green Deal and Agenda 2030 (Dyllick & Hockerts 2002; Sachs et al. 2019). Theoretically, macroeconomic stability, social progress, and financial resilience are interconnected and should be analysed through a single lens (Aguilera et al. 2021; Cosmulese et al. 2021). This study adopts an integrated approach through the intersection of macroeconomic, financial, and social indicators in assessing the sustainability of the logistics sector. The model reflects that concerted action in these three areas is required for sustainable development, especially in structurally changing economies.

We use statistical methods to examine the influence of macroeconomic stability, financial security, and social advancement on the sustainable development of Polish logistics companies. The study covers the period 2008-2022. Ordinary least squares (OLS) and seemingly unrelated regression (SUR) are the primary methods used. OLS is used to confirm the effect of the development values in a particular year on the results in the following year. SUR is used to analyse the interrelations of economic, social, and environmental development.

Three leading indicators were developed to build the models: a macroeconomic stabilisation index (MSP), a financial security index (FS), and the Human Development Index (HDI). The Sustainable Development Indicator (SD) has three components:



economic (E), social (S), and environmental (Env). All indicators are built upon normalised Eurostat data.

### 3. Research Methods

We use statistical methods to examine the influence of macroeconomic stability, financial security, and social advancement on the sustainable development of Polish logistics companies. The study covers the period 2008-2022. OLS is used to confirm the effect of the development values in a particular year on the results in the following year. SUR is used to analyse the interrelationships of the economic, social, and environmental development interrelations together.

The selection of SUR and OLS models is based on the existing literature using similar approaches in analysing sustainability and growth across sectors (see, e.g., Comporek et al. 2022; Misztal 2021). Such approaches help better measure interconnections among interdependent facets of sustainability, particularly in sectors governed by internal cost drivers and external macroeconomic conditions. The SUR procedure, for instance, has also been proven quite effective in better understanding contemporaneous effects on economic, social, and environmental outcomes.

To build the models, three main indicators were developed: the Macroeconomic Stabilization Index (MSP), The Financial Security Index (FS), and the Human Development Index (HDI). The Sustainable Development Indicator (SD) has three components: economic (E), social (S), and environmental (Env). All indicators are built on the basis of normalised Eurostat data. The central research hypothesis is that social development has a stronger and statistically significant impact, compared to financial security and macroeconomic stabilisation, on the sustainable development of logistics companies from 2008 to 2022. This approach results from the often international nature of running a logistic business, connections with the situation in other sectors of the economy, and the sector's high dependence on issues such as economic growth and consumer expectations. In addition, the following research questions were asked:

- Does the sustainable development of logistics companies have a positive trend from 2008 to 2022?

- Are the dynamics of economic development greater than the dynamics of social and environmental development?
- Do macroeconomic stabilisation, social development, and financial security of the sector positively impact the pillars of sustainable development?

We conducted our research in stages. First, I form the indicator of SD. We use the following formula:

$$SD_i = E_i + S_i + Env_i = \frac{1}{n} \sum_{j=1}^n E_{ij} + \frac{1}{n} \sum_{j=1}^n S_{ij} + \frac{1}{n} \sum_{j=1}^n Env_{ij}; \quad (i = 1, 2, \dots, n) \quad (1)$$

where  $SD_i$  is the synthetic indicator in the  $i$ -year;  $n$  is the number of metrics  $E_u$  – economic development in the  $i$ -year;  $S_i$  – social development in the  $i$ -year;  $Env_i$  – environmental development in year  $i$ .

Then, we transform the explanatory variables to unify their measuring scales using the following formulas:

- stimulants:

$$z_{ij} = \frac{y_{ij}}{\max_i \{y_{ij}\}}, \quad z_{ij} \in [0; 1]; \quad (2)$$

- destimulants:

$$z_{ij} = \frac{\min_i \{y_{ij}\}}{y_{ij}}, \quad z_{ij} \in [0; 1]. \quad (3)$$

where  $z_{ij}$  is the normalised value of the  $j$ -th variable in the  $i$ -th year;  $y_{ij}$  is the value of the  $j$ -th variable in the  $i$ -th year;  $\min_i \{y_{ij}\}$  is the lowest value of the  $j$ -th variable in the  $i$ -th year;  $\max_i \{y_{ij}\}$  is the highest value of the  $j$ -th variable in the  $i$ -th year.

We normalised the indicators of SD and its pillars (E, S, Env) based on diagnostic variables divided into stimulants and destimulants (Table 2). We assumed no collinearity between the variables and the equivalent weights of the impact on SD.

To assess the financial security indicator (FS), We use formulas (2) and (3). The stimulants included classic current liquidity, classic quick liquidity, return on net sales (ROS), return on total assets (ROA), return on equity (ROE), and turnover of liabilities in days. Destimulants included inventory turnover in

**Table 2.** Diagnostic variables used in SD and its pillars (E, S, Env)

| Synthetic index                 | Diagnostic variable | Description of the variable                                  | Stimulant | Destimulant |
|---------------------------------|---------------------|--------------------------------------------------------------|-----------|-------------|
| Economic development (E)        | $y_1$               | Total number of companies in a country                       | +         |             |
|                                 | $y_2$               | Turnover or gross premiums [million euro]                    | +         |             |
|                                 | $y_3$               | Production value [million euro]                              | +         |             |
|                                 | $y_4$               | Value added at factor cost [million euro]                    | +         |             |
|                                 | $y_5$               | Gross operating surplus [million euro]                       | +         |             |
|                                 | $y_6$               | Total purchases of goods and services [million euro]         | +         |             |
|                                 | $y_7$               | Gross investment in tangible goods [million euro]            | +         |             |
|                                 | $y_8$               | Investment rate (investment/value added at factors cost) [%] | +         |             |
|                                 | $y_9$               | Share of personnel costs in production [%]                   |           | +           |
|                                 | $y_{10}$            | Average personnel costs [thousand euro]                      |           | +           |
| Social Development (S)          | $y_{11}$            | Wages and Salaries [million euro]                            | +         |             |
|                                 | $y_{12}$            | Social security costs [million euro]                         | +         |             |
|                                 | $y_{13}$            | Total number of employees in a country                       | +         |             |
|                                 | $y_{14}$            | Turnover per person employed [thousand euro]                 | +         |             |
|                                 | $y_{15}$            | Apparent labour productivity [thousand euro]                 | +         |             |
|                                 | $y_{16}$            | Gross value added per employee [thousand euro]               | +         |             |
|                                 | $y_{17}$            | Growth rate of employment [%]                                | +         |             |
|                                 | $y_{18}$            | Number of persons employed per enterprise                    | +         |             |
|                                 | $y_{19}$            | Investment per person employed [thousand euro]               | +         |             |
|                                 | $y_{20}$            | Personnel costs [million euro]                               |           | +           |
| Environmental Development (Env) | $y_{21}$            | Carbon dioxide emission [tons]                               |           | +           |
|                                 | $y_{22}$            | Methane emission [tons]                                      |           | +           |
|                                 | $y_{23}$            | Nitrous oxide emission [tons]                                |           | +           |
|                                 | $y_{24}$            | Sulphur oxides emission [tons]                               |           | +           |
|                                 | $y_{25}$            | Ammonia emission [tons]                                      |           | +           |
|                                 | $y_{26}$            | Carbon monoxide emission [tons]                              |           | +           |
|                                 | $y_{27}$            | Nitrogen oxides emission [tons]                              |           | +           |
|                                 | $y_{28}$            | Generation of total waste [tons]                             |           | +           |

Source: own study based on Eurostat [<https://ec.europa.eu/Eurostat>], access: 28.12.2024

days, receivable turnover in days, and general debt. To calculate the MSP, we use the following formula (Kołodko, 1993):

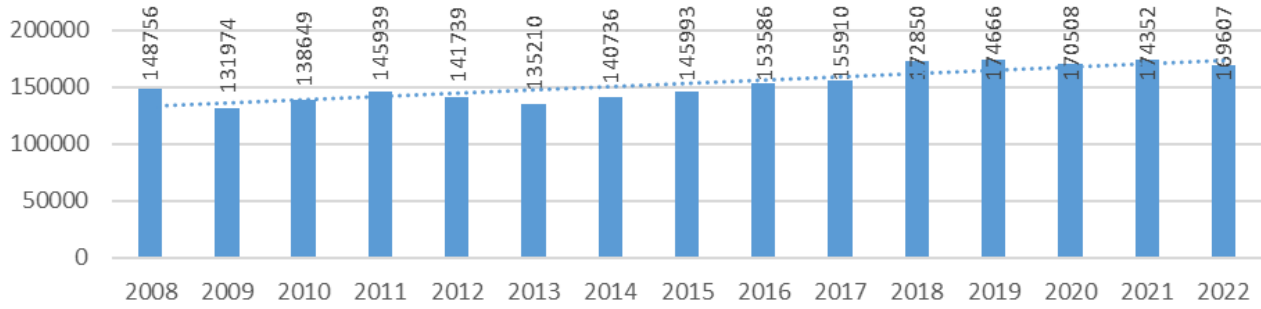
$$MSP = MSP_1 + MSP_2 = a + b + c + d + e = [(AGDP * U) + (U * HICP) + (HICP * G) + (G * CA) + (CA * AGDP)] * k \quad (4)$$

where GDP-gross domestic product; U-unemployment; HICP-harmonised price index, G-governance expenditure; CA-current account;  $k = \frac{1}{2} \sin 72^\circ = 0,475$ ; other designations as above.

Human development indicator (HDI) is based on the formula:

$$HDI = \sqrt[3]{LEI \cdot EI \cdot II} = \sqrt[3]{\frac{LE-20}{85-20} \cdot \frac{MYSi+EYSi}{2} \cdot \frac{\ln(GNIpc)-\ln(100)}{\ln(75,000)-\ln(100)}} \quad (5)$$

where: LEI- Life Expectancy Index; EI- Education Index; MYSi- Mean Years of Schooling Index; EYSi- Expected Years of Schooling Index; LE- Life expectancy at birth; GNIpc- Gross national income at purchasing power parity per capita.



**Figure 1.** Research sample- number of logistics enterprises  
Source: own calculations based on Eurostat

In the next step, a regression estimation is performed to evaluate the links between SD and MSP, HDI, and FS. The linear regression is selected according to formula (6):

$$SD_i = \beta_0 + \beta_1 MSP_i + \beta_2 MSP_{(i-1)} + \beta_3 HDI_i + \beta_4 HDI_{(i-1)} + \beta_5 FS_i + \beta_6 FS_{(i-1)} + \varepsilon_i \quad (6)$$

To assess the impact of determinants of economic (E), social (S), and environmental (Env) development, we build structural equation models based on the following procedures.

$$\begin{aligned} Ei &= \beta_0 + \beta_1 MSP_i + \beta_2 MSP_{(i-1)} + \beta_3 HDI_i + \beta_4 HDI_{(i-1)} + \beta_5 FS_i + \beta_6 FS_{(i-1)} + \beta_7 Si + \beta_8 Envi + \varepsilon_i \\ Si &= \beta_0 + \beta_1 MSP_i + \beta_2 MSP_{(i-1)} + \beta_3 HDI_i + \beta_4 HDI_{(i-1)} + \beta_5 FS_i + \beta_6 FS_{(i-1)} + \beta_7 Ei + \beta_8 Envi + \varepsilon_i \\ Envi &= \beta_0 + \beta_1 MSP_i + \beta_2 MSP_{(i-1)} + \beta_3 HDI_i + \beta_4 HDI_{(i-1)} + \beta_5 FS_i + \beta_6 FS_{(i-1)} + \beta_7 Ei + \beta_8 Si + \varepsilon_i \end{aligned} \quad (7)$$

The SUR estimator is as follows:

$$\sqrt{R}(\hat{\beta} - \beta) \xrightarrow{d} N(0, (\frac{1}{R} X^T (\Sigma^{-1} \otimes I_R) X)^{-1}) \quad (8)$$

## Results

Figure 1 shows the number of companies in the logistics sector (Section H of PKD 2007) in Poland from 2008 to 2022. The trend line is positive; the fewest registered companies were in 2009 (131,974) and the most in 2019 (174,666). The mean number of enterprises was 153,365.

Table 3 presents indicators of sustainable development and economic, social, and environmental development, financial security of the logistics sector, macroeconomic stabilisation, and social development. The indicators show a positive trend, indicating that

the sector is developing steadily, implementing eco-innovations, and the social and economic situation is improving. The financial and property situation of the companies is improving. The level of macroeconomic stabilisation is also increasing, and the social situation in Poland is improving.

Figure 2 shows the values of the indicators of sustainable development and their pillars from 2008 to 2022. The trend lines are positive; the highest growth dynamics were recorded in the case of the social development index of the logistics sector.

Table 4 presents the OLS estimation results and the basic statistical tests that enable this method. The model indicates that the sustainable development of the logistics sector is determined by the social development in Poland from the previous period and the level of the sustainable development index also from the period (t-1). Furthermore, social development in the country improves the general financial and property situation; the economic situation is improving, and the expectations of the economic and environmental protection of the society are increasing, leading to an improvement in the situation in the logistics sector.

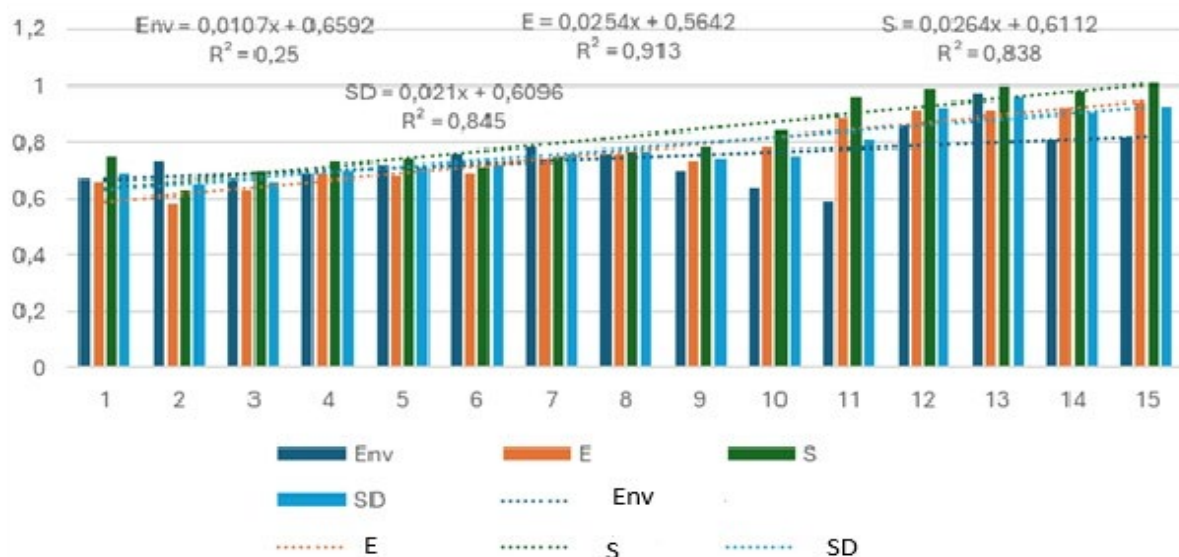
The results of the SUR estimation are presented in Table 5. Economic development is statistically significantly influenced by the financial security and social development of the logistics sector. Financial security hurts social development (its increase improves the sector's economic situation and negatively affects social issues), and economic development has a positive impact. In turn, environmental development depends on economic development, which means that ecological investments and a good economic situation lead to a reduction in the intensity of the emissions in the logistics sector.



**Table 3.** Indicators of SD and its pillars, FS, MSP, HDI and their descriptive statistics

|                 | Env  | E    | S    | SD   | FS   | MSP  | HDI  |
|-----------------|------|------|------|------|------|------|------|
| 2008            | 0.67 | 0.66 | 0.75 | 0.69 | 0.62 | 0.37 | 0.82 |
| 2009            | 0.73 | 0.58 | 0.63 | 0.65 | 0.67 | 0.32 | 0.83 |
| 2010            | 0.67 | 0.63 | 0.7  | 0.66 | 0.77 | 0.38 | 0.84 |
| 2011            | 0.69 | 0.69 | 0.73 | 0.7  | 0.79 | 0.38 | 0.84 |
| 2012            | 0.72 | 0.68 | 0.74 | 0.71 | 0.79 | 0.36 | 0.84 |
| 2013            | 0.76 | 0.69 | 0.71 | 0.72 | 0.81 | 0.4  | 0.85 |
| 2014            | 0.78 | 0.74 | 0.75 | 0.76 | 0.81 | 0.48 | 0.84 |
| 2015            | 0.76 | 0.76 | 0.77 | 0.77 | 0.85 | 0.46 | 0.86 |
| 2016            | 0.7  | 0.73 | 0.78 | 0.74 | 0.87 | 0.51 | 0.86 |
| 2017            | 0.64 | 0.78 | 0.84 | 0.75 | 0.83 | 0.53 | 0.87 |
| 2018            | 0.59 | 0.89 | 0.96 | 0.81 | 0.83 | 0.55 | 0.88 |
| 2019            | 0.86 | 0.91 | 0.99 | 0.92 | 0.84 | 0.53 | 0.88 |
| 2020            | 0.97 | 0.91 | 1    | 0.96 | 0.72 | 0.5  | 0.87 |
| 2021            | 0.81 | 0.92 | 0.98 | 0.90 | 0.88 | 0.58 | 0.88 |
| 2022            | 0.82 | 0.95 | 1.01 | 0.93 | 0.95 | 0.52 | 0.88 |
| <b>Max</b>      | 0.97 | 0.95 | 1.01 | 0.96 | 0.95 | 0.58 | 0.88 |
| <b>Min</b>      | 0.59 | 0.58 | 0.63 | 0.65 | 0.62 | 0.32 | 0.82 |
| <b>Std. Dev</b> | 0.09 | 0.12 | 0.12 | 0.10 | 0.08 | 0.08 | 0.02 |
| <b>Mean</b>     | 0.74 | 0.77 | 0.82 | 0.78 | 0.80 | 0.46 | 0.86 |
| <b>Mediana</b>  | 0.73 | 0.74 | 0.77 | 0.75 | 0.81 | 0.48 | 0.86 |

Source: own study based on Eurostat [<https://ec.europa.eu/Eurostat>], [<https://hdr.undp.org/data-center/human-development-index#/indicies/HDI>] access: 28.12.2024



**Figure 2.** Sustainable development indicator and its pillars- trend line  
Source: own calculations based on Eurostat

**Table 4.** Model 1: OLS, using observations 2009-2022 (T = 14). Dependent variable: SD

|                    | <i>Coefficient</i> | <i>Std. Error</i>  | <i>t-ratio</i> | <i>p-value</i> |     |
|--------------------|--------------------|--------------------|----------------|----------------|-----|
| Const              | -1.95928           | 0.501354           | -3.908         | 0.0024         | *** |
| HDI_1              | 2.74846            | 0.682873           | 4.025          | 0.0020         | *** |
| SD_1               | 0.515422           | 0.139392           | 3.698          | 0.0035         | *** |
| Mean dependent var | 0.784250           | S.D. dependent var |                | 0.103175       |     |
| Sum squared resid  | 0.009287           | S.E. of regression |                | 0.029057       |     |
| R-squared          | 0.932887           | Adjusted R-squared |                | 0.920684       |     |
| F(2, 11)           | 76.45091           | P-value(F)         |                | 3.53e-07       |     |
| Log-likelihood     | 31.36187           | Akaike criterion   |                | -56.72374      |     |
| Schwarz criterion  | -54.80657          | Hannan-Quinn       |                | -56.90121      |     |
| Rho                | 0.144694           | Durbin's h         |                | 0.634536       |     |

**White's test for heteroskedasticity**

Null hypothesis: heteroskedasticity not present; Test statistic: LM = 4.59023 with p-value =  $P(\text{Chi-square}(5) > 4.59023) = 0.467903$

**Test for normality of the residual**

Null hypothesis: error is normally distributed; Test statistic: Chi-square(2) = 2.73955 with p-value = 0.25417

**LM test for autocorrelation up to order 1**

Null hypothesis: no autocorrelation; Test statistic: LMF = 0.306503 with p-value =  $P(F(1, 10) > 0.306503) = 0.591997$

Source: own calculations based on Eurostat database, access: 28.12.2024.

**Table 5.** Seemingly Unrelated Regression (SUR) results

|                                                           | <b>Coefficient</b> | <b>std.</b> | <b>error</b> | <b>t-ratio</b> | <b>p-value</b> |                    |          |
|-----------------------------------------------------------|--------------------|-------------|--------------|----------------|----------------|--------------------|----------|
| <b>E</b>                                                  | Const              | -0.108234   | 0.0392986    | -2.754         | 0.0175         | Mean dependent var | 0.767747 |
|                                                           | FS                 | 0.226024    | 0.0511615    | 4.418          | 0.0008         | R-squared          | 0.981872 |
|                                                           | S                  | 0.844548    | 0.0257470    | 32.80          | 4.08e-013      |                    |          |
| <b>S</b>                                                  | Const              | 0.127311    | 0.0460402    | 2.765          | 0.0171         | Mean dependent var | 0.822582 |
|                                                           | FS                 | -0.265644   | 0.0638185    | -4.162         | 0.0013         | R-squared          | 0.978344 |
|                                                           | E                  | 1.18310     | 0.0358780    | 32.98          | 3.83e-013      |                    |          |
| <b>Env</b>                                                | Const              | 0.450622    | 0.137233     | 3.284          | 0.0059         | Mean dependent var | 0.744505 |
|                                                           | E                  | 0.382787    | 0.176701     | 2.166          | 0.0495         | R-squared          | 0.241918 |
| <b>Breusch-Pagan test for diagonal covariance matrix:</b> |                    |             |              |                |                |                    |          |
| Chi-square(3)= 18.3827 [0.0004]                           |                    |             |              |                |                |                    |          |

Source: own calculations based on Eurostat

## 4. Discussion

The logistics sector enables a stable economic development. The efficient flow of goods contributes to the continuity of supply chains and the smooth delivery of goods to customers (Jaboob et al. 2024). The Polish logistics sector ranks first in the European

Union, responsible for almost 20% of total transport (Kowalska et al. 2023). The financial and property situation of the industry and its growth prospects depend on several factors.

At the same time, researchers emphasise that due to its importance for the economy, it depends on exogenous and endogenous factors (Cosmulese et al.

2021; Sun et al. 2023). Research on the Polish market indicates a significant impact on macroeconomic conditions, including economic stability (Comporek et al. 2022).

Furthermore, according to the research conducted so far on the macroeconomic situation of the development of logistics companies, the impact strength is often higher than the internal financial situation of individual entities. Researchers also emphasise that stricter legal regulations regarding the emission of harmful substances into the environment force companies in the sector to take active measures and implement ecoinnovations (Waheed et al. 2024).

The central research hypothesis is true because, according to the OLS estimation, only the HDI indicator impacts financial stability. Furthermore, the result of the estimate confirms that this is a delayed impact, since the HDI index of the previous period has a positive impact on the sustainable development of the logistics sector. The model indicates that neither macroeconomic stabilisation nor financial situation are a key factor. However, the results of the SUR estimation must be analysed, as they show that managers in the sector must consider both macroeconomic stability and the financial security of enterprises.

As we mentioned, sustainable development has a positive trend in the period under review. This is a positive phenomenon, although the dynamics are relatively weak. It should be emphasised here that the sector has strong foundations for development and much will depend on the external situation, including the geopolitical one (Feng et al. 2024).

The SUR estimation results show that financial security is essential for the sector's economic, social, and environmental development. Economic development is influenced by social development and financial security, which guarantees new investments. Social development is positively influenced by economic development, whereas financial security is negatively influenced by financial development. This is an interesting result, which may result directly from the construction of the FS indicator and from the fact that investments in corporate social responsibility are not necessarily related to maintaining a high level of liquidity, profitability, and an appropriate level of debt. Environmental development is determined by economic development, which should be positively assessed because company managers are aware of the need to make vital new decisions related to environmental protection. We can speak here of a long-

term approach in which, in turn, stable development is conditioned by maintaining an appropriate balance between financial profit and social and ecological activity (Zhou et al. 2022; Comporek et al. 2022).

Limitations are related to the availability of data, the choice of analytical indicators, the method of normalisation of the data, and the study time (the study period is relatively short). Moreover, the OLS or SUR estimation methods may affect the parameters.

Despite the limitations, the study's results provide important observations that researchers and enterprise managers can use. From the point of view of theory and legislation, both external and internal factors must be considered when formulating regulations and policies for the logistics sector. It is necessary to consider financial security and the socioeconomic context when developing a legal framework and macroeconomic strategies for the sector's sustainable development.

The added value of the document is the analysis of the impact of determinants on the sustainable development of the logistics sector. It emphasises the interconnections of economic, social, and environmental factors. It is vital to create a framework and regulations for macroeconomic stability and financial security, which are key to sustainable development.

Managers should monitor financial security and macroeconomic conditions. The study also provides a comparative tool for assessing sustainable performance in logistics and can guide future comparative studies.

The results of our study support previous studies stressing the importance of macroeconomic and social determinants in defining sustainable development in the transport and logistics sectors (Miształ 2021; Comporek et al. 2022). The results confirm that the social development measured by HDI has the largest and statistically important influence on sustainability performance. This confirms the fundamental research hypothesis. On the other hand, the effects of macroeconomic stability and financial security, as much as they existed, were weaker or indirect based on our results. The results affirm the literature that emphasises the long-term importance of social infrastructure and human capital in supporting sustainable business models (Sachs et al. 2019; Koon 2024).

In future research, we want to focus on determining the influence of another factor on the sustainable development of the logistics sector in

countries in the European Union. I want to extend the analysis to a broader geographic and economic context.

## 5. Conclusions

This document highlights the positive trend toward sustainable development in the Polish logistics sector between 2008 and 2022, with notable reductions in greenhouse gas emissions during the COVID-19 pandemic. Research confirms that social development significantly helps improve the sustainability of logistics companies. But the desired effect of macroeconomic stabilisation was limited, perhaps due to socioeconomic disruption caused by the financial crisis and the pandemic.

Research shows that although the logistics sector is heading toward sustainability, this process is advancing slowly. More intense efforts are necessary to increase economic and social prosperity and environmental protection. Financial security is a key driver of sustainable development, and the economic and social aspects are interrelated.

More research is needed on the impact of internal and external drivers on sustainable growth in the logistics sector within the European Union. These findings are significant for policymakers, who emphasise the need for well-targeted interventions to achieve sustainability in logistics.

The paper discusses the positive trend for sustainable development within Poland's logistics sector from 2008 to 2022, highlighting significant reductions in greenhouse gas emissions during the COVID-19 pandemic. The logistics sector in Poland has shown a positive trend toward decarbonisation, with notable reductions in greenhouse gas emissions, especially during the COVID-19 pandemic. This reduction is in part due to temporary restrictions and environmental regulations (Misztal 2024). Macroeconomic conditions and financial stability have played an important role in this decarbonisation process. However, the impact of macroeconomic stabilisation on sustainable development was limited due to socioeconomic disruptions from the financial crisis and pandemic (Kowalska et al. 2023). Social development is crucial to improving the sustainability of logistics firms. This indicates that social factors, alongside economic ones, contribute to environmental

improvements (Kowalska et al. 2023). Despite the positive trend, the desired effects of macroeconomic stabilisation on sustainable development were limited. This limitation is attributed to socioeconomic disruptions caused by the financial crisis and the pandemic.

Financial security is identified as a critical driver of sustainable development. Economic and social factors are interconnected, emphasising the need for a holistic approach. There is a need for further research on internal and external drivers that influence sustainable growth in the logistics sector across the European Union. This research is essential for policymakers who want to implement targeted interventions to achieve sustainability. This includes taking advantage of social development and addressing financial constraints.

The findings are significant within the context of the broader European Union, where sustainable development is increasingly integrated into policymaking processes.

In general, while progress has been made, more intense efforts are required to accelerate sustainable development in Poland's logistics sector, highlighting the importance of financial stability and social development alongside economic growth.

## References

- Aguilera, R. V., Aragón-Correa, J. A., Marano, V., & Tashman, P. A. (2021). The Corporate Governance of Environmental Sustainability: A Review and Proposal for More Integrated Research. *Journal of Management*, 47(6), 1468–1497. <http://dx.doi.org/10.1177/0149206321991>
- Amin, A., Liu, X. H., Abbas, Q., Hanif, I., & Vo, X. V. (2021). Globalization, Sustainable Development, and Variation in Cost of Power Plant Technologies: A Perspective of Developing Economies. *Environmental Science and Pollution Research*, 28. <https://doi.org/10.1007/s11356-020-10816-x>
- Banik, D., & Lin, K. (2019). Business and Morals: Corporate Strategies for Sustainable Development in China. *Business and Politics*, 21(4). <https://doi.org/10.1017/bap.2019.26>
- Bernardo, V., Fageda, X., & Flores-Fillol, R. (2021). Pollution and Congestion in Urban Areas: The Effects



of Low Emission Zones. *Economics of Transportation*, 26, 100221. <https://doi.org/10.1016/j.ecotra.2021.100221>

Bose, S. (2020). Evolution of ESG Reporting Frameworks. In D. C. Esty & T. Cort (Eds.), *Values at Work*. Palgrave Macmillan.

Brach, B., Gul, M., & Kawecki, G. (2020). New Definition of a Sustainable Enterprise. *Education of Economists and Managers*, 57(3). <https://doi.org/10.33119/EEIM.2020.57.7>

Cohen, B., & Winn, M. I. (2007). Market Imperfections. Opportunity and Sustainable Entrepreneurship. *Journal of Business Venturing*, 22(1). <https://doi.org/10.1016/j.jbusvent.2004.12.001>

Colbert, B., & Kurucz, E. (2007). Three Conceptions of Triple Bottom Line Business Sustainability and the Role for HRM. *Human Resource Planning*, 30(1).

Comporek, M., Kowalska, M., & Misztal, A. (2022). Macroeconomic Stability and Transport Companies' Sustainable Development in the Eastern European Union. *J. Bus. Econ. Manag.*, 23. <https://doi.org/10.3846/jbem.2021.15913>

Cosmulese, C. G., Socoliuc, M., Ciubotariu, M., Kicsi, R., & Grosu, V. (2021). Optimization Model for Sustainable Food Supply Based on Consumer Behaviour Typology. The Case of the Chisinau Urban Area. *Argumenta Oeconomica*, 46. <https://doi.org/10.15611/aoe.2021.1.11>

Domańska, A., Gryglicka, A., Martyniuk, O., Więcek-Janka, E., & Zajkowski, R. (2023). The State of the Art in Sustainability of Central-Eastern European Family Firms: Systematic Literature Review. *International Entrepreneurship Review*, 9(3). <http://dx.doi.org/10.15678/IER.2023.0903.02>

Dyllick, T., & Hockerts, K. (2002). Beyond the Case for Corporate Sustainability. *Business Strategy and the Environment*, 11. <https://doi.org/10.1002/bse.323>

Fatimah, Y. A., Kannan, D., Govindan, K., & Hasibuan, Z. A. (2023). Circular Economy E-Business Model Portfolio Development for E-Business Applications: Impacts on ESG and Sustainability Performance. *Journal of Cleaner Production*, 415, 137528. <https://doi.org/10.1016/j.jclepro.2023.137528>

Feng, Y., Pan, Y., Lu, S., & Shi, J. (2024). Identifying the Multiple Nexus Between Geopolitical Risk, Energy Resilience, and Carbon Emissions: Evidence from Global Data. *Technological Forecasting and Social Change* 208, 123661. <https://doi.org/10.1016/j.techfore.2024.123661>

Gorski, A. T., & Dumitraşcu, D. D. (2023). Stakeholder Ecosystems and Corporate Sustainability: A Nexus for Value Creation in the Age of Sustainability. *Studies in Business and Economics*, 18(2), 158–177. <http://dx.doi.org/10.2478/sbe-2023-0030>

Grudzewski, W. M., Hejduk, I. K., Sankowska, A., & Wańtuchowicz, M. (2010). *Sustainability w Biznesie czyli Przedsiębiorstwo Przyszłości*. Wydawnictwo Poltex.

Husain, M. N., Harahap, E. F., Bachtar, Y. C., Diawati, P., & Santos, E. R. (2023). The Sustainability Development Dilemma in Green Public Relations: Part of CSR Failure?. *Jurnal Studi Komunikasi*, 7(3), 759–778. <http://dx.doi.org/10.25139/jsk.v7i3.7386>

Jaboob, A. S., Awain, A. M. B., & Ali, K. A. M. (2024). Introduction to Operation and Supply Chain Management for Entrepreneurship. In *Applying Business Intelligence and Innovation to Entrepreneurship* (pp. 52–80). IGI Global. <https://doi.org/10.4018/979-8-3693-1846-1.ch004>

Kołodko, G. (1993). *Kwadratura Pięciokąta. Od Zalamania Gospodarczego do Trwałego Wzrostu*. Poltext.

Koon, V. Y. (2024). Unveiling the Impact of Corporate Humanistic Responsibility on Sustainable Employee Well-Being: Exploring Perceived Support and Shared Experiences. *Business Strategy & Development*, 7(2), e381. <http://dx.doi.org/10.1002/bsd2.381>

Kowalska, M., Misztal, A., & Gniadkowska-Szymańska, A. (2023). The Sustainable Development of the Logistics Sector in the Largest EU Economies—Comparative Analysis. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, (187). <http://dx.doi.org/10.29119/1641-3466.2023.187.15>

Krasodomska, J., Zarzycka, E., & Dobija, D. (2022). Czynniki Determinujące Raportowanie przez Przedsiębiorstwa Informacji o Działaniach na Rzecz Realizacji Celów Zrównoważonego Rozwoju. *Zeszyty Teoretyczne Rachunkowości*, 46. <https://doi.org/10.5604/01.3001.0015.9599>

Larbi-Siaw, O., Xuhua, H., Owusu, E., Owusu-Agyeman, A., Fulgence, B. E., & Frimpong, S. A. (2022). Eco-Innovation, Sustainable Business Performance and Market Turbulence Moderation in Emerging Economies. *Technology in Society*, 68, 101899. <http://dx.doi.org/10.1016/j.techsoc.2022.101899>

Mach, Ł., Dąbrowski, I., Bedrunka-Gudaniec, K., & Frącz, P. (2023). Impact of the Regional Operational Programme on Selected Production Factors of Development. A Case Study for the Opolskie



Voivodeship. *Argumenta Oeconomica*, 2(51). <https://doi.org/10.15611/aoe.2023.2.08>

Marrucci, L., Daddi, T., & Iraldo, F. (2022). Do Dynamic Capabilities Matter? A Study on Environmental Performance and the Circular Economy in European Certified Organisations. *Business Strategy and the Environment*. <https://doi.org/10.1002/bse.2997>

Matinaro, V., Liu, Y., Lee, T. R., & Poesche, J. (2019). Extracting Key Factors for Sustainable Development of Enterprises: Case Study of SMEs in Taiwan. *Journal of Cleaner Production* 209. <https://doi.org/10.1016/j.jclepro.2018.10.280>

Misztal, A. (2021). Assessing the Impact of the Financial Condition on the Components of Sustainable Development of Transport Enterprises in Poland in 2008-2019. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 65(1). <https://doi.org/10.15611/pn.2021.1.07>

Misztal, A. (2024). Decarbonization of the Logistics Sector in Poland in the Context of Macroeconomic and Financial Conditions. *Optimum. Studia Ekonomiczne*, 3. <https://doi.org/10.15290/oes.2024.03.117.01>

Novikova, O. F., Amosha, A. I., & Antoniuk, V. P. (2012). *Sustainable Development of the Industrial Region: Social Aspects*. Ukraine Instytut Ekonomiky Promyslovosti NAN Ukrainy.

Nowak, A. (2022). Analysis of Deviations – The Role of Controlling in Small and Medium Sized Agricultural Enterprises. *Journal of Finance and Accounting*, 13(4), 223–232. <https://doi.org/10.12345/jfa.2022.13.4.223>

Oželienė, D. (2017). A Review of Enterprise Sustainable Development Models: Critical Appraisal, Scientific Proceedings. *International Scientific Conference. High Technologies. Business. Society*.

Pabian, A. (2017). Zrównoważone Przedsiębiorstwo jako Rezultat Zmian Organizacyjnych. *Przegląd Organizacji*, 8(931). <https://doi.org/10.3141/po.2017.08.02>

Pereira, R. H. M., Schwanen, T., & Banister, D. (2017). Distributive Justice and Equity in Transportation. *Transport Reviews*, 37(2). <https://doi.org/10.1080/01441647.2016.1257660>

Pons, S., Khalilzadeh, J., Weber, M. R., & Smith, R. A. (2024). Cultivating Sustainability Savvy: The Role of Soft Skills in Shaping Sustainable Practices.

*International Hospitality Review*. <https://colab.ws/articles/10.1108%2Fih-01-2024-0007#>

Porter, M. E., & Kramer, M. R. (2007). Strategy and Society, The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review*, 84(12).

Remyha, Y., Zaiarniuk, O., Lozova, T., Trushkina, N., Yakushev, O., & Korovin, Y. (2022). Energy-Saving Technologies for Sustainable Development of the Maritime Transport Logistics Market. *IOP Conference Series: Earth and Environmental Science*, 1126.

Ribeiro, R. P., & Gavronski, I. (2021). Sustainable Management of Human Resources and Stakeholder Theory: A Review. *Revista de Gestão Social e Ambiental*, 15, 1–21. <http://dx.doi.org/10.24857/rgsa.v15.2729>

Sachs, J. D., Woo, W. T., Yoshino, N., & Taghizadeh-Hesary, F. (2019). Importance of Green Finance for Achieving Sustainable Development Goals and Energy Security. In J. Sachs, W. Woo, N. Yoshino, & F. Taghizadeh-Hesary (Eds.), *Handbook of Green Finance. Sustainable Development*. Springer. [https://doi.org/10.1007/978-981-13-0227-5\\_13](https://doi.org/10.1007/978-981-13-0227-5_13)

Sagan, M. (2021). Instytucjonalne Uwarunkowania Funkcjonowania Przedsiębiorstw a Zrównoważony Rozwój. *Kwartalnik Nauk o Przedsiębiorstwie*, 59. <https://doi.org/10.33119/KNoP.2021.59.2.3>

Sun, H., Wang, G., Bai, J., Shen, J., Zheng, X., Dan, E., Chen, F., & Zhang, L. (2023). Corporate Sustainable Development, Corporate Environmental Performance and Cost of Debt. *Sustainability*, 15(228). <https://doi.org/10.3390/su15010228>

Svitlichna, V., Tonkoshkur, M., Cirella, G. T., Radionova, L., Yatsiuk, M., & Uhodnikova, O. (2024). Sustainable Ecotourism Development: Integrating Public Marketing, Community Engagement, and Environmental Stewardship in Ukraine. In *Handbook on Post-War Reconstruction and Development Economics of Ukraine: Catalyzing Progress* (pp. 271–291). Springer International Publishing. [http://dx.doi.org/10.1007/978-3-031-48735-4\\_16](http://dx.doi.org/10.1007/978-3-031-48735-4_16)

Taghvaei, V. M., Nodehi, M., Saber, R. M., & Mohebi, M. (2022). Sustainable Development Goals and Transportation Modes: Analyzing Sustainability Pillars of Environment, Health, and Economy. *World Development Sustainability*, 1, 100018. <https://doi.org/10.1016/j.wds.2022.100018>

Trojanowski, T. (2015). *Przedsiębiorstwa Wobec Wyzwań Zrównoważonego Rozwoju*. Zeszyty Naukowe Politechniki Śląskiej.

Waheed, A., Shahid Khan, M., Warraich, M. A., & Ali, M. A. (2024). Environmental Policy vs. Environmental Innovation: An Examination of Policies Disclosure on Sustainable Development from Stakeholder Theory Perspective. *Sustainable Development*, 32(3), 2506–2516. <http://dx.doi.org/10.1002/sd.2782>

West, J., & Börjesson, M. (2020). The Gothenburg Congestion Charges: Cost–Benefit Analysis and Distribution Effects. *Transportation*, 47(1).

Wierzbicka, M., & Stańczyk, S. (2023). How to Anticipate Recession Via Transport Indices? Evidence From European Freight Flows. *Transportation Research Procedia*, 67, 45–53. <https://doi.org/10.1016/j.trpro.2023.03.005>

Xie, J. (2022). Comparing the Sustainability of Multimodal Transportation Between China and Europe. *Frontiers in Business, Economics and Management*, 7(1). <https://doi.org/10.54097/fbem.v7i1.3687>

Zhou, G., Liu, L., & Luo, S. (2022). Sustainable Development. ESG Performance and Company Market Value: Mediating Effect of Financial Performance. *Business Strategy and the Environment*, 31(7). <https://doi.org/10.1002/bse.3089>

Zu, L. (2013). Sustainable Enterprise Development. In S. O. Idowu, N. Capaldi, L. Zu, & A. D. Gupta (Eds.), *Encyclopedia of Corporate Social Responsibility*. Springer.

Zuzek, D. K., & Mickiewicz, B. (2014). Aktywność Przedsiębiorstw w Kontekście Wdrażania Zasad Zrównoważonego Rozwoju w Województwie Małopolskim. *Optimum. Studia Ekonomiczne*, 1(67). <https://doi.org/10.15290/ose.2014.01.67.14>