EVALUATION OF REGIONAL SUSTAINABLE DEVELOPMENT OF SELECTED CHINESE PROVINCES

Jing Cai
Doctoral School of Entrepreneurship and Management, Budapest Business School, Budapest, Hungary

György Iván Neszmélyi
Faculty of Commerce, Hospitality and Tourism, Budapest Business School, Budapest, Hungary

Vasa László
Faculty of Economics, Széchenyi István University, Győr, Hungary

ABSTRACT
This study aims to investigate and evaluate the status of sustainable development in the Fujian, Guangdong, and Zhejiang provinces over a decade (2011-2020) using the quantitative analysis approach of the entropy weight TOPSIS method. Based on the 12th and 13th Five-Year Plans, this research analyzes the three provinces' social, economic, and environmental development using data collected from relevant economic and social sectors in China. The findings demonstrate that the sustainable development levels in the respective regions of these three provinces have improved, despite the impact of the COVID-19 pandemic during the study period. Drawing upon the 14th Five-Year Plan promulgated in 2021, the report provides recommendations for future social, economic, and environmental development in the examined region. The study's results have implications for similar regions seeking to achieve sustainable development goals.

Keywords: sustainable development; regional sustainable development; economic zone; Chinese economic strategy; entropy weight TOPSIS method

DOI: http://dx.doi.org/10.15549/jeecar.v10i3.1200

INTRODUCTION

The UNGA (United Nations General Assembly) first used the term "sustainable development" in March 1980. In 1987, the WCED (World Commission on Environment and Development) defined sustainable development as meeting existing demands without compromising future generations' abilities (WCED., 1978). The paper recommends a sustainable development strategy, indicating the new development vision. Among the Sustainable Development Goals (SDGs), "building inclusive, safe, disaster-resilient, and sustainable cities and human settlements" is listed as the eleventh goal. This is because urbanization is increasing throughout the world. More than fifty percent of the world's population has moved to cities since 2007.

Furthermore, this number is expected to grow by ten percent by 2030, to 60%. The development of metropolises and cities, which accounts for approximately sixty percent of the global GDP, are the drivers of economic growth, and it can also bring benefits to citizens, such as education, healthcare, employment, and living quality (Cohen, 2006; Gonzalez-Garcia et al., 2018). At the same time, however, these areas account for around 70% of the world's total carbon emissions and more than sixty percent of used resources, which means that human demand for the extraction and consumption of natural resources will be extremely increased (Ahmed et al., 2020; Jia et al., 2021; Sharma et al., 2021). Speedy urbanization is causing increasing problems, such as more people are living in slums, infrastructure and services are not good enough or are overcrowded, as well as issues with garbage collection, water infrastructure, sanitation facilities, transportation, increased air, and water pollution(Fan & Fang, 2020; Zhao et al., 2020), and urban sprawl (Koop, 2017; Programme, 2016; Yu et al., 2019; Zhang, 2016). Hence, the topic of sustainable development is still crucial for modern human society.

China is undoubtedly one of the nations' attempting to attain sustainable development. According to the data of The World Bank, China, with a population of 1.41 billion people in 2020 and representing approximately 18% of the global population, remains the world's most populous country. Due to its huge population and limited total resources, sustainable development is an inevitable choice for China (Bao & Fang, 2012; Ghose, 2014; Yang, 2018). At the 1992 Rio Conference on Environment and Development, the Chinese government first pledged to implement a sustainable development strategy. Then in March 1994, the State Council of China discussed and adopted the "China Agenda 21 - China's White Paper on Population, Environment, and Development in the 21st Century". The Chinese government established "sustainable development" as a major strategy to guide national economic and social development and incorporated the idea of sustainable development into national and local economic and social development plans in 1996.

Additionally, according to the document entitled China's Sustainable Development Report 2012 - China's Sustainable Development in the Shifting Global Context, China has set sustainable development as a national strategy and has made efforts to promote sustainable development in relevant areas, including population control, energy conservation, emission reduction, and ecological improvement since 1996. Recently, the fourteenth Five-Year Plan from the year 2021 to 2025 was published in March 2021. Since 1953, China has created and carried out long-term plans for national economic and social development (using a five-year time frame as the unit of measurement) to align the economy with key policy objectives and to disseminate these guidelines across all parts of the government (Casey & Koleski, 2011). This plan details the strategies of the Chinese national economic and social development. Additionally, sustainable development is still a core issue in the 14th Five-Year Plan for China. The Chinese economy has prioritized quality above speed in its development (Gu et al., 2021).

Nevertheless, the coronavirus pandemic is undoing years of worldwide progress in eliminating hunger and poverty (Joshi et al., 2021; Naidoo & Fisher, 2020). The year 2020 was extremely complex and challenging, both domestically and internationally, especially in light of the severe impact of the 2019 novel coronavirus pandemic. The 2020 HLPF and ECOSOC theme was the realization of the decade of action and achievement for sustainability. The conference focused on how to share responsibility for better recovery and reconstruction in the aftermath of the coronavirus crisis. UN Secretary-General Guterres noted that the 2019 coronavirus pandemic destroyed decades of worldwide achievements in reducing poverty and hunger and has hindered sustainable development goals. If sustainability is the goal, then people must know if they're moving toward it. Therefore, it is of practical significance to comprehensively evaluate the sustainable development of a certain region in the past.

In this document, the original expression "urban agglomeration on the west coast of the Strait" used in the previous plans disappeared and was replaced by the expression "coastal urban agglomeration of Guangdong, Fujian, and Zhejiang provinces." This implies that China intends to raise the level of development of cities along the southeast coast to the same level as the other regions by using coordinated regional development methods. In other words, the main purpose of the planning of Guangdong, Fujian, and Zhejiang coastal urban agglomeration is to improve the overall economic development level of these three provincial capitals in the southeast coastal area and to become a transitional zone connecting the Pearl River Delta and the Yangtze River Delta, which in order to avoid the danger of being siphon by the two places. This also means that the Chinese government will invest more support for the region's development in the next five years so that the three provinces can achieve deeper cooperation and closer ties to seek a better development situation. For this reason, the author of this paper chooses Fujian, Guangdong, and Zhejiang as the three provincial capitals to be analyzed. In addition, the evaluation and analysis of the sustainable development level of these three provinces in the past ten years are of practical significance, not only for evaluating the work in the past ten years and then for providing suggestions for future development but also for other developing countries.

The existing research literature states that some scholars interpret the content of sustainable development as a synthesis of economic, social, and ecologic objectives (Daly, 1990; Geissdoerfer et al., 2017; Gladwin et al., 1995; Purvis et al., 2019). The presentation of sustainable development is the intersection among three dimensions – environment, society, and economy of a region. They are formulated as separate and connected entities (Giddings et al., 2002). (Jeurissen, 2000) describes the essence of sustainable development based on a "triple bottom line" that emphasizes economic stability, ecological sustainability, and social equality — an aspect that businesses have a tendency to disregard. Some other scholars have also explained the relationship between the three issues based on the "triple bottom line" model(Fuentes et al., 2019; Holden & Linnerud, 2007; Holden et al., 2014; Holden, 2014). It is necessary to harmonize the relationship between economic efficiency, social effectiveness, and environmental sustainability in order to achieve sustainable development (Fuentes et al., 2019; Geissdoerfer et al., 2017; Huang et al., 2016; Hysa et al., 2020). Based on this, this study uses the quantitative research method to evaluate the three pillars of the regional sustainable development situation.

In summary, this paper applies the Entropy weight TOPSIS method to explore and evaluate the comprehensive situation of sustainability of Fujian, Guangdong and Zhejiang provinces over a decade in the context of the twelfth and thirteenth Five-Year Plans. The main contributions of this paper are twofold. One is that this paper employed a systematical and scientific framework to evaluate the sustainability of some provinces in China. The other one is that the conclusion of this paper can provide policy references and recommendations for other developing countries from social, economic, and environmental development, which has practical significance. The rest of the study is organized as follows. The next section presents the methodology part, which states formula derivation, indicator system, data resource, weighing method, and research process. Section three reports the main empirical results, and section four and five of the Article draws conclusions and provides elements for consideration.

METHODOLOGY

Research Method

The basic principle of the TOPSIS method is to find the optimal and the inferior solution (represented by the optimal vector and the inferior vector, respectively) among the finite solutions based on the original normalized matrix and then calculate the distance between the evaluation object and the optimal solution and the inferior solution, respectively, to obtain the relative proximity of the evaluation object to the optimal solution, which is used as the basis for the evaluation of the superiority or inferiority(Xu et al., 2021). The improvement of the Entropy weight TOPSIS method over the original TOPSIS method is that it adopts proportional normalization instead of vector normalization first. Secondly, it adopts the weight model of entropy weight (Sun et al., 2017). The Entropy weight TOPSIS method is divided into five steps as follows. The calculation steps are as follows.

1) Original matrix normalization.
    i. With n objects (years) to be evaluated and m evaluation indicators for each object, the original data matrix is formed as follows.

$$X=\begin{bmatrix} X_1, & X_2, & \ldots, & X_{1m} \\ X_{11}, & X_{12}, & \ldots, & X_{2m} \\ \ldots, & \ldots, & \ldots, & \ldots \\ X_{n1}, & X_{n2}, & \ldots, & X_{nm} \end{bmatrix} \quad (1)$$

ii. The matrix R is obtained by standardizing the original data matrix X.

$$R=\left(r_{ij}\right)_{n\times m} \quad (2)$$

iii. r_{ij} is the standard value of the i evaluation object on the j evaluation index $r_{ij}\in[0,1]$, where positive indicators (the larger, the better).

$$r_{ij}=\frac{X_{ij}-min\{X_j\}}{max\{X_j\}-min\{X_j\}} \quad (3)$$

For the inverse indicator, the smaller the value, the better.

$$r_{ij}=\frac{max\{X_j\}-X_{ij}}{max\{X_j\}-min\{X_j\}} \quad (4)$$

2) Based on the "entropy weighting method" to construct a standardized weighting matrix Z. The entropy method determines the weights of indicators based on the amount of information provided by each indicator. The greater the difference of an evaluation indicator, the lower the entropy value, the more information the indicator contains and transmits, and the greater the corresponding weight.

i. To define f_{ij} as the weight of the indicator value under the j evaluation indicator of the i evaluated object of the matrix R, so:

$$f_{ij}=\frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}} \quad (5)$$

ii. Then, calculate e_j the entropy value of the j indicator:

$$e_j=-K\sum_{i=1}^{n} f_{ij}\cdot \ln\left(f_{ij}\right), \left(K=1/\ln(n)\right) \quad (6)$$

iii. The weights of each evaluation index are calculated as follows:

$$W_j=\frac{1-e_j}{\sum_{j=1}^{m}\left(1-e_j\right)},\ 0\le W_j\le 1,\ \sum_{i=1}^{m} W_j=1$$

iv. Next, to construct the normalized weighting matrix Z:

$$Z=W_j\cdot R \quad (7)$$

3) To determine the optimal and inferior solutions. Assuming that J represents the set of positive indicators and J' represents the set of negative indicators, then the optimal vector Z^+ and the worst vector are Z^-, respectively:

$$\left\{\left(\max_i Z_{ij}\,\middle|\, j\in J\right),\left(\min_i Z_{ij}\,\middle|\, j\in J'\right),\ i=1,2,\cdots,n\right\}=\left\{Z_1^+,Z_2^+,\cdots,Z_m^+\right\} \quad (8)$$

$$=\left\{\left(\min_i Z_{ij}\,\middle|\, j\in J\right),\left(\max_i Z_{ij}\,\middle|\, j\in J'\right),\ i=1,2,\cdots,n\right\}=\left\{Z_1^-,Z_2^-,\cdots,Z_m^-\right\} \quad (9)$$

4) The distance of each evaluation object to the optimal solution S_i^+ and the distance to the worst solution S_i^-:

$$S_i^+=\sqrt{\sum_{j=1}^{m}\left(Z_{ij}-Z_j^+\right)^2},\ (i=1,2,\cdots,n) \quad (10)$$

$$S_i^-=\sqrt{\sum_{j=1}^{m}\left(Z_{ij}-Z_j^-\right)^2},\ (i=1,2,\cdots,n) \quad (11)$$

5) Calculate the relative closeness of each evaluation object to the optimal solution C_i^*.

$$C_i^*=S_i^-\Big/\left(S_i^++S_j^-\right),\ 0\le C_i^*\le 1,\ (i=1,2,\cdots,n) \quad (12)$$

Suppose the evaluation object overlaps with the best solution, the corresponding $C_i^*=1$. If the evaluation object coincides with the worst solution, then the corresponding $C_i^*=0$.

Data Resource

The Fujian Provincial Statistical Yearbook (2011-2020), the Guangdong Provincial Statistical Yearbook (2011-2020), and the Zhejiang Provincial Statistical Yearbook (2011-2020) provide the majority of the data for our study. The China Environmental Statistics Yearbook and various bulletins of the corresponding years provide supplemental data.

Table 1: Sustainable Development Evaluation Indicator System for Fujian, Guangdong, and Zhejiang

Social Subsystem Indicators	Economic subsystem indicators	Environmental Subsystem Indicators
M1 Unemployment rate	M7 Gross regional product (GDP) per capita (billion yuan)	M13 Daily treatment capacity of urban sewage (million cubic metres)
M2 number of health technicians per 10,000 population (persons)	M8 Share of secondary sector in GDP	M14 Harmless treatment rate of domestic waste (%)
M3 Average number of students enrolled in tertiary education per 100,000 population (persons)	M9 Share of tertiary sector in GDP	M15 Park green space per capita (m2/person)
M4 Per capita disposable income of rural residents	M10 Total tourism revenue (billion yuan)	M16 Coal consumption (million tonnes)
M5 Disposable income per capita in urban areas (yuan)	M11 Employment in urban units in scientific research and technical services (10,000 persons)	M17 Electricity consumption (billion-kilowatt hours)
M6 Population density (persons/km2)	M12 Public transport vehicles per 10,000 people (standard units)	M18 Water resources per capita (cubic metres/person)

Source: Initial data were obtained from the Fujian Provincial Statistical Yearbook (2011-2020), the Zhejiang Provincial Statistical Yearbook (2011-2020), and the Guangdong Provincial Statistical Yearbook (2011-2020) (http://dqbg.cei.cn/).

Based on the synthesis of data availability and feasibility and comprehensively considering the subsystem development status, an indicator system of the sustainable development of Fujian, Guangdong, and Zhejiang was then constructed. The indicator system for this study is divided into three areas, which are economic, social, and environmental, with a total of 18 indicators. For example, in the social area, it covers employment, health care, education, social security, etc. The environmental area has indicators of urban greening, wastewater treatment, integrated waste treatment, and so forth (details are shown in Table 1).

The establishment of the indicator system should fully reflect the fair, reasonable, scientific, and potential for sustainable development. After referring to relevant documents and studies, taking into account the actual situation based on the constructed evaluation index system, and considering the feasibility of data collection and the reliability of data sources, the authors of this paper selected 18 comprehensive indicators that can reflect the sustainable development level of Fujian, Guangdong, and Zhejiang. These 18 indicators are classified into economic, social, and environmental subsystems.

Research Results

The calculation results of the entropy value (e_j), weights (W_j%), optimal vector (Z^+), and worst vector (Z^-) of the sustainable development indicator system of Fujian Province (FJ), Guangdong Province (GD) and Zhejiang Province (ZJ), respectively is shown below in Table 2 below.

From the perspective of the weight column in the social subsystem, Fujian and Guangdong both have the highest Share of the M1 Unemployment rate. In Zhejiang, the indicator with the highest weight is M6 Population density (persons/km2). In Fujian, the comparatively higher-weight indicators are the M4 Per capita disposable income of rural residents and M5 Disposable income per capita in urban areas (yuan).

Table 2: The results of the calculation of various indicators in Fujian, Guangdong and Zhejiang provinces

	Social Subsystem Indicators						Economic Subsystem Indicators						Environmental Subsystem Indicators					
FJ	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
e_j	0.87	0.90	0.89	0.88	0.89	0.92	0.87	0.91	0.85	0.84	0.93	0.89	0.93	0.94	0.88	0.85	0.87	0.85
W_j %	6.36	4.91	5.28	5.70	5.49	3.91	6.47	4.25	7.38	8.01	3.25	5.57	3.59	2.75	5.83	7.46	6.28	7.51
Z^+	0.06	0.05	0.05	0.06	0.06	0.04	0.07	0.04	0.07	0.08	0.03	0.06	0.04	0.03	0.06	0.08	0.06	0.08
Z^-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GD	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
e_j	0.58	0.92	0.88	0.87	0.89	0.90	0.88	0.95	0.82	0.89	0.90	0.87	0.35	0.92	0.93	0.94	0.88	0.90
W_j %	15.35	2.95	4.29	4.73	4.02	3.69	4.50	1.88	6.73	3.99	3.63	4.64	23.74	2.80	2.55	2.26	4.54	3.71
Z^+	0.15	0.03	0.04	0.05	0.04	0.04	0.05	0.02	0.07	0.04	0.04	0.05	0.24	0.03	0.03	0.02	0.05	0.04
Z^-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZJ	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
e_j	0.87	0.90	0.89	0.88	0.88	0.83	0.88	0.85	0.91	0.89	0.86	0.90	0.35	0.92	0.93	0.94	0.88	0.90
W_j %	5.12	3.82	4.28	4.78	4.73	6.56	4.77	6.01	3.51	4.44	5.60	3.78	25.54	3.01	2.74	2.43	4.88	3.99
Z^+	0.05	0.04	0.04	0.05	0.05	0.07	0.05	0.06	0.04	0.04	0.06	0.04	0.26	0.03	0.03	0.02	0.05	0.04
Z^-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Initial data were obtained from the Fujian Provincial Statistical Yearbook (2011-2020), the Zhejiang Provincial Statistical Yearbook (2011-2020) and the Guangdong Provincial Statistical Yearbook (2011-2020) (http://dqbg.cei.cn/).

The comparative higher weight indicators for Guangdong are M3 Average number of students enrolled in tertiary education per 100,000 population and M4. In Zhejiang, the indicators that account for a higher proportion are M1, M2 number of health technicians per 10,000 population (persons) and M4. These indicators are key factors for improving the level of social progress in the region.

From the perspective of the weight column among the economic subsystems, Fujian has the highest Share of M10 Total tourism revenue (billions of yuan). In addition, M9 Share of the tertiary sector in GDP represents the structure of the industry, and M7 Gross regional product (GDP) per capita (billion yuan) represents the growth and size of the economy, which account for the higher Share than other indicators. Guangdong has the highest Share of M9, followed by M12 Public transport vehicles per 10,000 people (standard units), M7 and M10, which characterize economic growth and size. The highest Share in Zhejiang is the M8 Share of the secondary sector in GDP, followed by M11 employment in urban units in scientific research and technical services (10,000 persons) and M7 Gross regional product (GDP) per capita (billions of yuan).

From the perspective of the weight column among environmental subsystem evaluation, Fujian has higher proportions in M18 Water resources per capita (cubic metres/person), M16 Coal consumption (million tonnes), and M17 Electricity consumption (billion-kilowatt hours). Guangdong accounts for a relatively high proportion of M17 and M18, the highest in M13 (23.74%). Zhejiang also has a higher proportion of M17, M18, and M14 Harmless treatment rate of domestic waste (%). Moreover, in the same situation as GD, ZJ also has the extremely highest amount in M13 (25.54%).

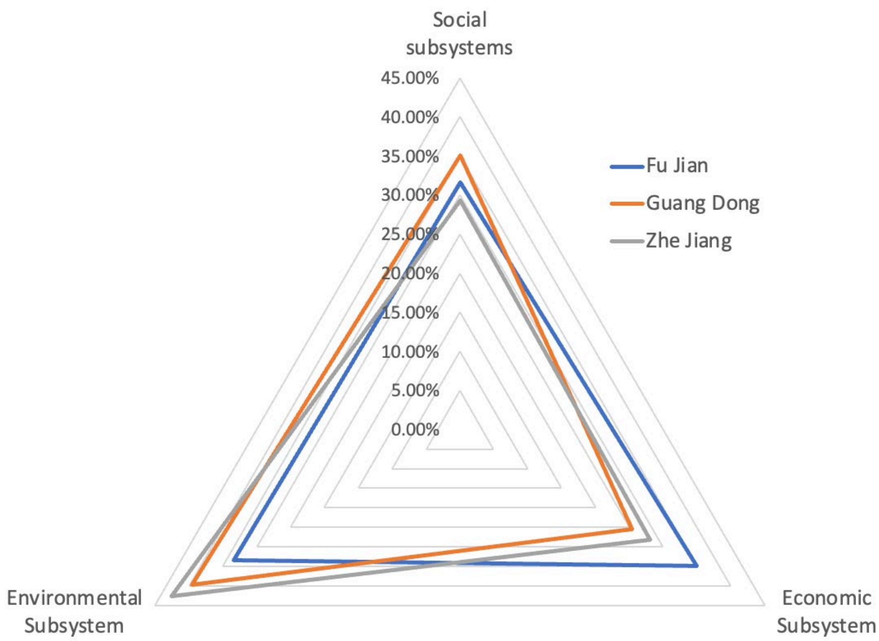

Figure 1: Three-dimensional diagram of the three subsystem weights for Fujian, Guangdong, and Zhejiang (2011-2020)

Source: Initial data were obtained from the Fujian Provincial Statistical Yearbook (2011-2020), the Zhejiang Provincial Statistical Yearbook (2011-2020), and the Guangdong Provincial Statistical Yearbook (2011-2020) (http://dqbg.cei.cn/).

Figure 2 demonstrates that the level of development for each regional subsystem in Fujian was more balanced than in the other two provinces over the decade. However, the primary driver of Fujian's sustainable development was its economic subsystem, as evidenced by its growth. As indicated by the above analysis, the province's development relies on an expansion in the size of the economy or the input of economic factors. Consequently, advancing regional sustainable development in Fujian still requires urgent progress in technological innovation, industrial structure optimization, resource levels and energy consumption, and intensification of production patterns. Furthermore, the environmental subsystem primarily drives the advancement of regional sustainable development levels in Zhejiang and Guangdong. This indicates that these two provinces' ecological governance and protection efforts were outstanding over the decade, and the transformation of their economic structures is beginning to bear fruit.

The Sustainable Development Goals report (Nations, 2015) states that the economy is one of the most important aspects for a country or region, as it can provide employment opportunities and create wealth, which is crucial for the development of a region. At the same time, economic development can also support improvements in society and the environment, such as increasing people's income levels, improving the quality of life, and promoting the development of environmental protection technologies. Therefore, in the process of promoting sustainable development, economic development is usually the primary task.

From 2011 to 2020, the Fujian Provincial Government issued relatively more policy documents to promote economic development, such as the "Twelfth Five-Year Plan for Fujian Province," the "Opinions of the Fujian Provincial People's Government on Promoting the Development of the Fujian Coastal Economic Zone," and the "Measures of the Fujian Provincial People's Government to Support Economic and Cultural Exchange and Cooperation between Fujian and Taiwan." A series of policies issued by the Fujian Provincial Government aimed at promoting investment, expanding consumption, expanding trade, and strengthening industrial upgrading have brought many economic benefits, such as increasing GDP and expanding employment. Some of the important documents include, but are not limited to:

1. "Implementation Plan for Accelerating the Construction of an Innovative Province in Fujian Province (2011-2020)": This plan clearly proposes to implement a series of specific measures, such as industrial transformation and upgrading, leading technological innovation, talent cultivation and introduction, innovation and entrepreneurship cultivation, construction of scientific research institutions, transformation of scientific and technological achievements, protection of intellectual property rights, and high-end equipment manufacturing to promote scientific and technological innovation and industrial upgrading.
2. "Implementation Plan for Accelerating Information Development in Fujian Province (2011-2020)": This plan proposes a series of policy measures, such as supporting the development of the information industry, strengthening the construction of information infrastructure, promoting government informationization, and promoting information consumption to promote the development of information and digital economy.
3. "Twelfth Five-Year Plan for Promoting the Development of the Cultural Industry in Fujian Province (2011-2015)": This plan clearly proposes to implement a series of specific measures, such as cultural system reform, opening up the cultural market, supporting the cultural industry, integrating cultural creativity, building cultural brands, and constructing cultural facilities to promote the development of the cultural industry.
4. "Implementation Plan for Accelerating the Development of Modern Logistics Industry in Fujian Province (2011-2015)": This plan proposes a series of specific measures, such as strengthening the construction of logistics infrastructure, cultivating leading enterprises, promoting logistics informatization, and strengthening the training of logistics talents, to promote the development of modern logistics industry.

In addition, compared to economic development, the development of society and the environment may require longer-term accumulation and sustained efforts. For example, in terms of society, efforts are needed to promote the construction of basic infrastructure such as education and healthcare, strengthen social fairness and justice, and improve the level of people's livelihood security. In terms of the environment, efforts are needed to enhance ecological protection, control pollution, and promote a low-carbon economy. In Fujian Province, due to its unique geographical location and economic structure, economic development has always been the government's key focus, resulting in more policies driven by economic development. However, in Guangdong Province and Zhejiang Province, especially in recent years when environmental issues have become increasingly prominent, the government has paid more attention to environmental protection and social development issues and has formulated more relevant policies. At the same time, the policy orientation and implementation of the three provinces may differ due to various complex factors, leading to different performances in sustainable development.

Examples of environmental protection policies in Guangdong Province include, but are not limited to: In 2013, Guangdong Province began implementing the "Pearl River Delta Clean Air Action Plan" to reduce air pollution and improve air quality. The plan includes multiple measures, such as pollution control in industrial enterprises and reduction of emissions from motor vehicles. In 2016, Guangdong Province introduced the "Guangdong Atmospheric Pollution Prevention and Control Regulation" to strengthen the prevention and control of atmospheric pollution, and to regulate measures such as reducing emissions at the source and strengthening supervision and monitoring. In 2017, Guangdong Province launched the "Clean Energy Replacement" action plan, which aims to replace coal-fired electricity and fossil fuels with clean energy by 2020. This plan will promote the development of clean energy such as natural gas, wind power, and photovoltaics. In 2018, Guangdong Province introduced the "Guangdong Soil Pollution Prevention and Control Regulation" to strengthen soil environmental monitoring and pollution control, and to regulate measures such as the restoration of polluted sites.

Examples of environmental protection policies in Zhejiang Province include, but are not limited to: In 2015, Zhejiang Province introduced the "Zhejiang Atmospheric Pollution Prevention and Control Regulation" to comprehensively strengthen the prevention and control of atmospheric pollution and to regulate measures such as controlling pollution discharge in industrial enterprises and treating key pollution sources. In 2016, Zhejiang Province began implementing the "Four Waters Joint Treatment" action plan to control pollution in four water bodies: rivers, lakes, urban water, and underground water. This plan will implement a three-year action plan for water pollution prevention and control, with an investment of over 50 billion yuan for water environmental management. In 2017, Zhejiang Province introduced the "Zhejiang Ecological Protection Red Line Demarcation Plan", which clarified the standards for defining ecological protection red lines in Zhejiang Province to protect important ecological functional areas and ecological security barriers. In 2018, Zhejiang Province introduced the "Zhejiang Soil Pollution Prevention and Control Regulation" to strengthen the prevention and control of soil pollution and to regulate measures such as soil environmental monitoring, reducing pollution sources, and restoring polluted sites.

From 2011 to 2020, the three provinces show an overall upward trend in the level of sustainability, which is in line with the expectations of both the 12th and 13th Five-Year Plans. In addition, the development levels in GD and ZJ provinces peaked in 2015, then declined and remained flat until 2020.

Table 3: 2011-2020 Comprehensive Evaluation Results of Sustainable Development in Fujian Province

	S_i^+	S_i^-	C_i^*	C_i^* sort
2011	0.227	0.067	0.227	10
2012	0.194	0.091	0.32	9
2013	0.172	0.099	0.365	8
2014	0.156	0.115	0.425	7
2015	0.14	0.115	0.451	6
2016	0.127	0.153	0.546	4
2017	0.126	0.143	0.531	5
2018	0.124	0.159	0.562	3
2019	0.095	0.195	0.673	1
2020	0.137	0.185	0.574	2

Table 4: 2011-2020 Comprehensive Evaluation Results of Sustainable Development in Guangdong Province

	S_i^+	S_i^-	C_i^*	C_i^* sort
2011	0.318	0.046	0.127	10
2012	0.312	0.05	0.137	9
2013	0.273	0.099	0.267	6
2014	0.269	0.099	0.269	5
2015	0.179	0.249	0.582	1
2016	0.289	0.095	0.247	8
2017	0.286	0.101	0.262	7
2018	0.251	0.13	0.341	3
2019	0.238	0.196	0.452	2
2020	0.281	0.132	0.319	4

Table 5: Comprehensive Evaluation Results of Sustainable Development in Zhejiang Province from 2011-2020

	S_i^+	S_i^-	C_i^*	C_i^* sort
2011	0.301	0.081	0.212	10
2012	0.289	0.084	0.225	9
2013	0.283	0.085	0.23	8
2014	0.278	0.089	0.257	7
2015	0.107	0.27	0.716	1
2016	0.269	0.107	0.285	6
2017	0.266	0.117	0.306	5
2018	0.267	0.123	0.315	4
2019	0.265	0.146	0.362	2
2020	0.259	0.138	0.348	3

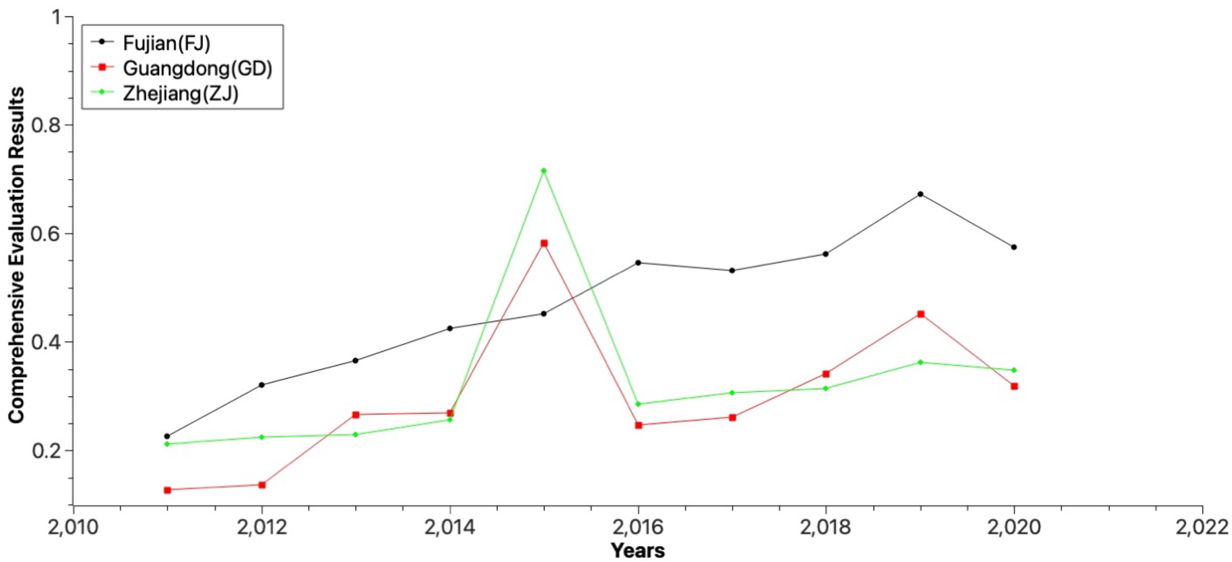

Figure 2 Comparatively Evaluation Results of Sustainable Development in Fujian, Guangdong, and Zhejiang Province

Source: Initial data were obtained from the Fujian Provincial Statistical Yearbook (2011-2020), the Zhejiang Provincial Statistical Yearbook (2011-2020), and the Guangdong Provincial Statistical Yearbook (2011-2020) (http://dqbg.cei.cn/).

The peak measurement in Guangdong Province in 2015 appears, combined with the indicator system in Figure 2, to explain from two perspectives, economic and environmental, mainly because (1) the further development of the economy of Guangdong Province and the improvement of the level of science and technology innovation after the reform and opening up, the government departments in Guangdong began to realize the importance of efficient use of resources. As a result, government departments supported the increase of green innovation R&D investment in policy, financial support to attract high-tech enterprises and talents to Guangdong. The development and utilization of clean energy gradually increased, and the level of resource utilization was also improved. In terms of science and technology innovation, the Report shows that Guangdong, Hong Kong, and Macao have maintained a certain growth rate of research and development personnel in recent years. According to statistics, the total number of research and development personnel in Guangdong was 501,700 in 2015, an increase of 45.6% over 2010. from 2000 to 2015, the total number of research and development personnel in Guangdong increased by 430,600, with an average annual growth rate of 13.9%. (2) To promote the continuous improvement of environmental quality in Guangdong, the Guangdong government has strictly implemented comprehensive green management measures. For example, the "Outline of the Plan for the Reform and Development of the Pearl River Delta Region (2008-2020)" was introduced in 2008 to actively promote the integration of environmental protection in the Pearl River Delta region. This was followed by the Guangdong Provincial Government's document called the Pearl River Delta Environmental Protection Integration Plan (2009-2020), which aims to promote regional environmental protection cooperation among local governments at all levels within Guangdong Province. In August 2011, the Guangdong Provincial Government issued the "Notice on the Issuance of the 12th Five-Year Plan for Environmental Protection and Ecological Construction in Guangdong Province", a document detailing the basic principles and main objectives for local governments at all levels to follow in urban and rural construction and environmental protection in Guangdong Province. This series of measures is the main reason why the sustainable development level of Guangdong Province will peak in 2015.

The peak measurement in Zhejiang Province in 2015 appears, combined with the indicator system in Figure 2, to explain from three perspectives: economic, social, and environmental, mainly because (1) the comprehensive development of education has contributed to the steady improvement of China's population quality, and the average number of students enrolled in higher education per 100,000 population has been growing, especially from 2011 to 2015 steeply improved. (2) The total economic volume has doubled continuously, and the proportion of tertiary industry to GDP has been increasing. In addition, Zhejiang Province has been supporting a number of key enterprises and key projects in the energy conservation and environmental protection industry, with the support of the government, to form an energy conservation and environmental protection industry system with strong industrial competitiveness. (3) In environmental protection, Zhejiang governments at all levels have implemented a number of cleaner production demonstration projects in key areas such as energy, industry, agriculture, transportation, trade and commerce, and services. In 2011, the number of enterprises implementing cleaner production reached more than 200, improving the efficiency of resource utilization and reducing pollutant emissions from the source and the whole process. This series of measures is the main reason why the level of sustainable development in Zhejiang Province can peak in 2015.

In summary, the twelfth Five-Year Plan identifies the establishment of a circular economy as a major strategic objective for China's economic and social growth, as well as a crucial strategy for promoting the construction of ecological civilization and achieving long-term sustainability. Similarly, in the thirteenth Five-Year Plan, the development objectives of maintaining medium-to-high economic growth, promoting innovation-driven development, and accelerating the pace of agricultural modernization were proposed. In addition, the plan also emphasizes the enhancement of the coordination of China's regional development, the consolidation of the construction of an ecological civilization, and makes plans to strengthen the ecological civilization in terms of industry, agriculture, energy use, resource utilization, technological transformation, environmental management, and lifestyle. Furthermore, it has also been pointed out that opening up to international standards should be improved in order to have a deeper integration of the Chinese economy into the world economy, such as the construction of "One Belt, One Road," the free trade zone, the Asian Investment Bank, the BRICS Bank, etc. Last but not least, the Chinese government remained committed to developing people's living standards and constructing a moderately prosperous society in this five-year plan.

As a result, during the decade, Fujian, Guangdong, and Zhejiang placed greater emphasis on regional development coordination in the development of regional economic construction. While maintaining economic growth, they continued to improve the ecological environment, promote the development of a circular economy, and enhance the level of regional sustainable development. This was published in 2015 in the Quality-of-Life

Indicators, and Policy Strategies to Advance Sustainability in the Pearl River Delta was published. The Housing and Urban-Rural Development Department (HURD) of Guangdong and the People's Republic of China commissioned the RAND Corporation to develop a system of quality-of-life indicators and identify related policy options to advance sustainable development in the Pearl River Delta region of Guangdong in south-eastern China. To address sustainable development issues, the Chinese government is committed to increasing the gross domestic product (GDP) and placing a high priority on other development measures that contribute to the growth of economic output at a sustainable level. In 2017, Zhejiang implemented six key environmental protection tasks: the "three battles" of water, gas, and soil control and the "three projects" of environmental risk prevention, ecological protection and restoration, and governance capacity building. A total of more than 1,600 projects have been established, with an investment of more than 300 billion yuan.

CONCLUSION & POLICY IMPLICATIONS

This research assesses the sustainable development of Fujian, Guangdong, and Zhejiang provinces between 2011 and 2020 using the Entropy weight TOPSIS method. Results show an overall increase in sustainable development for all three provinces, with COVID-19 impacting this period. Fujian, although more balanced than the other two provinces, saw its expansion primarily driven by the economic subsystem, indicating a need for technological progress, innovation, resource levels improvement, energy consumption, and intensification of production patterns. The environmental subsystem drove Zhejiang and Guangdong's sustainable development levels, suggesting exceptional environmental management and protection efforts. The research provides an overview of the three provinces' social, economic, and environmental development based on the 12th and 13th Five-Year Plans, and recommendations for the 14th Five-Year Plan period are made.

According to the Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Vision 2035, the region needs to promote the development of the digital economy and strategic emerging industries. The plan proposes that critical developing industries will account for over 17% of the GDP, and local governments should focus on new-generation information technology, biotechnology, new energy, new materials, high-end equipment, new energy vehicles, and other strategic developing industries. Ecological and environmental conservation efforts should include supporting green technology innovation and establishing a low-carbon green circular economy, modifying production and consumption patterns, upgrading industrial structures, and improving pollution control.

In conclusion, the Entropy weight TOPSIS method is practical for evaluating regional sustainable development, and its outcomes are intuitive. Policymakers can use this method to develop appropriate policies to promote sustainable development in their regions.

LIMITATION & FUTURE RESEARCH

Despite the insights gained from this study on the regional sustainable development of Fujian, Guangdong, and Zhejiang provinces, some limitations remain to be addressed. First, this research only evaluated the sustainable development of these three provinces and did not cover other regions in China. Thus, the generalizability of the findings may be limited. Future research could expand the scope of analysis to include a more comprehensive range of provinces or even nationwide, to provide a more comprehensive picture of China's sustainable development. Secondly, the research period covered from 2011 to 2020, during which the COVID-19 pandemic occurred. Although the data indicates that the pandemic did not significantly impact the sustainable development of the three provinces during this period, there may be some effects that were not captured by the data. Therefore, future research could include more recent data to explore the possible impact of the pandemic on regional sustainable development.

Moreover, the current study focused on the three subsystems of sustainable development, namely, economic, social, and environmental subsystems. Future research could consider other dimensions, such as cultural and political factors, which could also play a crucial role in sustainable development. Lastly, the current research used the Entropy weight TOPSIS method to evaluate sustainable development.

However, other evaluation methods are available, such as the Data Envelopment Analysis (DEA) method, which could provide different insights into sustainable development. Therefore, future research could compare different evaluation methods to gain a more comprehensive understanding of regional sustainable development in China.

REFERENCES

Ahmed, Z., Asghar, M. M., Malik, M. N., & Nawaz, K. (2020). Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological footprint in China [Article]. *Resources Policy*, *67*, 11, Article 101677. https://doi.org/10.1016/j.resourpol.2020.101677

Bao, C., & Fang, C. L. (2012). Water Resources Flows Related to Urbanization in China: Challenges and Perspectives for Water Management and Urban Development [Article]. *Water Resources Management*, *26*(2), 531-552. https://doi.org/10.1007/s11269-011-9930-y

casey, J., & Koleski, K. (2011). *Backgrounder: China's 12th five-year plan.* [Report]. https://www.uscc.gov/sites/default/files/Research/12th-FiveYearPlan_062811.pdf

Cohen, B. (2006). Urbanization in developing countries: Current trends, future projections, and key challenges for Sustainability. *Technology in Society*, *28*(1-2), 63-80. https://doi.org/DOI: 10.1016/j.techsoc.2005.10.005

Daly, H. E. (1990). Toward some operational principles of Sustainable Development. *Ecological Economics*, *2*(1). https://doi.org/https://doi.org/10.1016/0921-8009(90)90010-r.

Fan, Y. P., & Fang, C. L. (2020). A comprehensive insight into water pollution and driving forces in Western China-case study of Qinghai [Article]. *Journal of Cleaner Production*, *274*, 9, Article 123950. https://doi.org/10.1016/j.jclepro.2020.123950

Fuentes, G. R. H., Castrillon, M. A. G., Reatiga, C. M., Barros, A. J. T., & Llanos, J. A. R. (2019). SOCIAL-ENVIRONMENTAL IMPACTS MEASUREMENT AND ORGANIZATIONAL SOCIAL RESPONSIBILITY [Article]. *Dimension Empresarial*, *17*(4), 22. https://doi.org/10.15665/dem.v17i4.2111

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy A new sustainability paradigm? [Review]. *Journal of Cleaner Production*, *143*, 757-768. https://doi.org/10.1016/j.jclepro.2016.12.048

Ghose, B. (2014). Food Security and Food Self-sufficiency in China: From past to 2050. *Food and Energy Security*, *3*(2), 86-95. https://doi.org/ https://doi.org/10.1002/fes3.48

Giddings, B., Hopwood, B., & O'Brien, G. (2002). Environment, economy and society: Fitting them together into sustainable development [Article]. *Sustainable Development*, *10*(4), 187-196. https://doi.org/10.1002/sd.199

Gladwin, T. N., kennelly, J. J., & Krause, T.-s. (1995). Shifting paradigms for sustainable development: Implications for management theory and research. . *The Academy of Management Review*, *20*(4), 874. https://doi.org/https://doi.org/10.2307/258959

Gonzalez-Garcia, S., Manteiga, R., Moreira, M. T., & Feijoo, G. (2018). Assessing the sustainability of Spanish cities considering environmental and socio-economic indicators [Article]. *Journal of Cleaner Production*, *178*, 599-610. https://doi.org/10.1016/j.jclepro.2018.01.056

Gu, W. T., Wang, J. Y., Hua, X. Y., & Liu, Z. D. (2021). Entrepreneurship and high-quality economic development: based on the triple bottom line of sustainable development [Article]. *International Entrepreneurship and Management Journal*, *17*(1), 1-27. https://doi.org/10.1007/s11365-020-00684-9

Holden, E., & Linnerud, K. (2007). The sustainable development area: Satisfying basic needs and safeguarding ecological sustainability [Article]. *Sustainable Development*, *15*(3), 174-187. https://doi.org/10.1002/sd.313

Holden, E., Linnerud, K., & Banister, D. (2014). Sustainable development: Our Common Future revisited [Article]. *Global Environmental Change-Human and Policy Dimensions*, *26*, 130-139. https://doi.org/10.1016/j.gloenvcha.2014.04.006

Holden, E., Linnerud, K. & Banister, D. . (2014). Sustainable development: Our common future revisited. *Global Environmental Change*, *26*, 130–139. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2014.04.006

Huang, L., Yan, L. J., & Wu, J. G. (2016). Assessing urban sustainability of Chinese megacities: 35 years after the economic reform and open-door policy [Article]. *Landscape and Urban Planning*, *145*, 57-70. https://doi.org/10.1016/j.landurbplan.2015.09.005

Hysa, E., Kruja, A., Rehman, N. U., & Laurenti, R. (2020). Circular Economy Innovation and Environmental Sustainability Impact on Economic Growth: An Integrated Model for Sustainable Development [Article]. *Sustainability*, *12*(12), 16, Article 4831. https://doi.org/10.3390/su12124831

Jeurissen, R. (2000). Cannibals with forks: The triple bottom line of 21st century business [Book Review]. *Journal of Business Ethics*, *23*(2), 229-231. https://doi.org/10.1023/a:1006129603978

Jia, H. X., Li, T. J., Wang, A. J., Liu, G. W., & Guo, X. Q. (2021). Decoupling analysis of economic growth and mineral resources consumption in China from 1992 to 2017: A comparison between tonnage and exergy perspective [Article]. *Resources Policy*, *74*, 15, Article 102448. https://doi.org/10.1016/j.resourpol.2021.102448

Joshi, T., Mainali, R. P., Marasini, S., Acharya, K. P., & Adhikari, S. (2021). Nepal at the edge of sword with two edges: The COVID-19 pandemics and sustainable development goals [Review]. *Journal of Agriculture and Food Research*, *4*, 10, Article 100138. https://doi.org/10.1016/j.jafr.2021.100138

Koop, S. H. A., van Leeuwen, C.J. (2017). he challenges of water, waste and climate change in cities. *Environ Dev Sustain*, *19*, 385–418. https://doi.org/https://doi.org/10.1007/s10668-016-9760-4

Naidoo, R., & Fisher, B. (2020). Sustainable Development Goals: pandemic reset [Editorial Material]. *Nature*, *583*(7815), 198-201. https://doi.org/10.1038/d41586-020-01999-x

Nations, U. (2015). Transforming our world: the 2030 *Agenda for Sustainable Development*. department of economic and social affairs. https://sdgs.un.org/2030agenda

Programme, U. N. H. S. (2016). *The World Cities Report 2016: Urbanization and Development - Emerging Futures*. K. Nairobi.

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins [Article]. *Sustainability Science*, *14*(3), 681-695. https://doi.org/10.1007/s11625-018-0627-5

Sharma, R., Sinha, A., & Kautish, P. (2021). Does renewable energy consumption reduce ecological footprint? Evidence from eight developing countries of Asia [Article]. *Journal of Cleaner Production*, *285*, 13, Article 124867. https://doi.org/10.1016/j.jclepro.2020.124867

Sun, L. Y., Miao, C. L., & Yang, L. (2017). Ecological-economic efficiency evaluation of green technology innovation in strategic emerging industries based on entropy weighted TOPSIS method [Article]. *Ecological Indicators*, *73*, 554-558. https://doi.org/10.1016/j.ecolind.2016.10.018

WCED. (1978). *Our Common Future. World Commission on Environment and Development.* . O. U. Press. https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/152/WCED_v17_doc149.pdf

Xu, X. Y., Zhang, Z. H., Long, T., Sun, S. M., & Gao, J. (2021). Mega-city region sustainability assessment and obstacles identi fi cation with GIS-entropy-TOPSIS model: A case in Yangtze River Delta urban agglomeration, China [Article]. *Journal of Cleaner Production*, *294*, 12, Article 126147. https://doi.org/10.1016/j.jclepro.2021.126147

Yang, B. J., & Ding, H. . (2018). A quantitative assessment of sustainable development based on relative resource carrying capacity in Jiangsu Province of China. *International Journal of Environmental Research and Public Health*, *15*(12), 2786. https://doi.org/https://doi.org/10.3390/ijerph15122786

Yu, W. J., Zhang, Y. J., Zhou, W. Q., Wang, W. M., & Tang, R. (2019). Urban expansion in Shenzhen since 1970s: A retrospect of change from a village to a megacity from the space [Article]. *Physics and Chemistry of the*

Earth, *110*, 21-30. https://doi.org/10.1016/j.pce.2019.02.006

Zhang, X. Q. (2016). The trends, promises and challenges of urbanisation in the world. *Habitat International*, *54*, 241–252. https://doi.org/https://doi.org/10.1016/j.habitatint.2015.11.018

Zhao, Y., Tan, Y., & Feng, S. L. (2020). Does reducing air pollution improve the progress of sustainable development in China? [Article]. *Journal of Cleaner Production*, *272*, 13, Article 122759. https://doi.org/10.1016/j.jclepro.2020.122759

ABOUT THE AUTHORS

Dr. Vasa László, Email: laszlo.vasa@ifat.hu *(Corresponding Author)*

Ms. Jing Cai is a Ph.D. candidate at the Doctoral School of Entrepreneurship and Management, Budapest Business School in Hungary, with a major research interest in regional sciences economics.

Dr. György Iván Neszmélyi is currently working at the Faculty of International Management and Business as a Professor. He was Faculty Head of International Relations between 2018 and 2021, then since 2021, he has been Head of Research at the Oriental Business and Innovation Center of Budapest Business School. Further to this, he is the Academic Director and Lecturer of Advenio eAcademy in Malta and is also involved in the research and academic activities of MATE. His main research field is the examination of economic and social factors in the economic growth of emerging and developing regions. Author and co-author of about 180 scientific publications.

Dr. Vasa László after his degrees in agricultural economics, German-Hungarian translation, and international MBA studies, completed his Ph.D. and post-doctoral degree at Szent Istvan University, Hungary. He worked as an associate professor and vice dean for international affairs of the Faculty of Economics and Social Sciences of the same university. His main fields of research are the economics of transition, post-Soviet studies, and international issues of agricultural economics. He is a professor and Ph.D. supervisor of Hungarian and foreign doctoral schools, and a member of the editorial board of different referred international and Hungarian scientific journals.