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The Quality of Governance and Its Impact on FDI Inflows. A Comparative Study of EU Member States

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Abstract

The principal goal of the article is to assess the quality of governance (QG) in the EU–28 over the period 2004–2020. It also examines the relationship between QG and FDI inward stock as a % of GDP. The study has been divided into five stages. The first one, based on the Worldwide Governance Indicators (WGI), attempts to identify countries that represent similar levels of institutional quality. Based on this criterion and using clustering methods, we divided the EU Member States into four groups. In the second step, we used the values of the synthetic index of QG to compare the level of institutional quality among the Member States between 2004 and 2020. The third step assesses FDI as a % of GDP in the Member States. Due to substantial differences, we divided them into four groups, arranged in ascending order of FDI as a % of GDP. In the fourth stage of the analysis, we examined the relationship between FDI as a share of GDP and groups of countries with similar QG. Finally, we examined the relevance of six individual dimensions of governance for FDI inflows in the EU–28 countries.

The study demonstrates that the EU Member States differ significantly regarding the overall QG measured with the WGI. The results of the statistical analysis allow us to positively verify the hypothesis about a positive relationship between QG and the inflow of FDI. The most important partial variable is regulatory quality. The added value of this article comes from grouping the EU–28 based on the similarity of their quality of governance (measured by six dimensions

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of governance) and demonstrating that it impacts FDI inflows. We created a synthetic index of governance quality values to compare the level of institutional quality among the Member States between 2004 and 2020.

Keywords: quality of governance, FDI, EU Member States, hierarchical cluster analysis

JEL: F21, F23

Introduction

Globalisation involves flows of capital seeking attractive investment locations. Capital flows, in particular, those that take the form of foreign direct investment (FDI), are of strategic importance to the economy as they impact GDP and exports, which, in turn, indirectly generate new jobs and promote regional and local economic recovery (Chipalkatti, Le, and Rishi 2021, pp. 1–18).

FDI may speed up economic growth by increasing labour force productivity by introducing advanced modern technologies. To ensure the inflow of FDI, a country should focus on improving the investment climate. Traditional location advantages, such as cheap labour, availability of raw materials, or cheap production factors, are still relevant and strongly impact the attractiveness of a location. Nevertheless, foreign investors' desire to invest largely depends on the host country's credibility, which is a derivative of the level of economic development, economic and political stability, economic (e.g., tax) policy, legal framework, and the institutional development of bodies that support entrepreneurship. All of those make up what is called *good governance,* a process which ensures transparent operations and accountability of institutions, boosts institutional effectiveness, helps to foster economic competitiveness of the country, and builds trust in the business community.

The literature on the subject mostly claims that "a certain optimal level of institutional development is a prerequisite for the materialisation of the growth-enhancing effect of FDI" (Yeboua 2020, p. 2) and that the host country's institutional quality "affects profitability, and institutionally strong countries can attract foreign investors by offering high returns" (Sabir, Rafique, and Abbas 2019, p. 4). The quality of institutions and good governance enhance productivity and economic stability, attracting and enhancing foreign investment (Hayat 2019, pp. 561–579). Many studies have demonstrated that strong institutions of host countries attract more FDI (Hayat 2019, pp. 561–579; Sabir, Rafique, and Abbas 2019, pp. 1–20; Belfqi, Qafas, and Jerry 2021, pp. 1–29; Khan, Weili, and Khan 2022, pp. 30594–30621). By contrast, weak and inadvertent governance discourages FDI because of political instability, a weak rule of law, inactive mechanisms for reducing corruption, and a lack of accountability and transparency (Hossain and Rahman 2017, p. 165).

The role of governance indicators in increasing FDI has attracted attention from researchers and policymakers for the last few decades. Governments thus strive to create a good business atmosphere to attract FDI and offer a favourable working environment for multinational companies. They do it irrespective of how economically advanced their country is, although most studies suggest that it is very relevant, in particular, for those who invest their capital in transition and developing economies.

In light of the above considerations, the paper attempts to answer the following questions: Is there really any relationship between the quality of governance and FDI inflow? What is the role of governance in stimulating FDI inflows into the EU–28? Which of the six dimensions of governance quality impacts the most FDI inward stock as a % of GDP in the EU Member States? Hence the principal goal of the article is to assess the quality of governance (QG) in the EU–28 and to examine the relationship between governance and FDI inward stock as a % of GDP. The main hypothesis states that there is a positive relationship between the quality of governance and the value of FDI inward stock as a % of GDP.

To achieve our goal, we used various statistical methods, i.e., hierarchical cluster analysis, contingency analysis, synthetic index values, and descriptive statistics. We used Worldwide Governance Indicators (WGI) to assess the QG in the EU MS for the period 2004–2020. The WGIs capture the quality of governance in six dimensions: (1) voice and accountability, (2) political stability and absence of violence, (3) government effectiveness, (4) regulatory quality, (5) the rule of law, and (6) control of corruption. They have been used as a measure in similar analyses by many researchers (e.g., Subasat and Bellos 2013, pp. 107–131; Shah and Afridi 2015, pp. 31–55; Khan, Weili, and Khan 2022, pp. 30594–30621).

Literature review

Although the literature offers several definitions of *governance*, most emphasise the importance of a capable state, which is accountable to its citizens and operates under the rule of law (Kaufmann and Kraay 2007, pp. 1–43; Rothstein and Teorell 2008, p. 170). One of the most frequently quoted definitions was put forward by the World Bank in 1992. It defined *governance* broadly by describing it through the following qualities: open and development-seeking policymaking, professional administration, working in the public interest, the rule of law, transparent processes, and a strong civil society. In this context, good governance is "central to creating and sustaining an enabling environment for development" (World Bank 1992, p. 47), and it is an essential complement to sound economic policies. That mainly refers to public administration and its capacity to deliver on public services, which was highlighted on many occasions in later World Bank publications (e.g., World Bank 1994; 1997; 2002; Lateef 2016). Nowadays,

we can also hear about "the demand for good governance" (Bhargava, Cutler, and Ritchie 2011). It stresses the relevance of actions that can be undertaken by the government to create effective and responsible programmes and public services. They include reforming financial management, the judiciary, and public procurement, and adopting anti-corruption laws and right-to-information laws.

Governance is a way of governing exercised in a responsible, accountable, and transparent manner based on the principles of efficiency, legitimacy, and consensus (Munshi 2004, p. 51). It promotes the development of an effective framework for business operations through stable regulations, the rule of law, efficient state administration adapted to the roles of democratically elected government, and a strong civil society that is independent of the state (Hirst 2000, p. 14).

As stated by many authors, *governance is thus equated with institutional quality*. For instance, according to Huther and Shah (1999, p. 2), governance encompasses "all aspects of the exercise of authority through formal and informal institutions in the management of the resource endowment of a state". Similar conclusions were reached by Kaufmann, Kraay, and Mastruzzi (2003, pp. 1–115), Zhuang, de Dios, and Lagman-Martin (2010, pp. 1–55), or Kaufmann, Kraay, and Zoido-Lobatón (1999, pp. 1–60). Kaufmann, Kraay, and Zoido-Lobatón defined governance as "the traditions and institutions by which the authority in a country is exercised" (1999, p. 1). Kaufmann and Kraay (2007, pp. 1–43) use the terms "governance", "institutions", and "institutional quality" interchangeably throughout their paper.

The assertion that QG seriously impacts economic performance has been confirmed by several studies (e.g., Knack and Keefer 1997, pp. 590–602; Khan 2006; Helpman 2008; North 2019). The impact of governance on economic growth has been examined by Mira and Hammadache (2017, pp. 107–120), while the relationship between governance and economic development was investigated by Sharma (2012, pp. 729–744) and Khouya and Benabdelhadi (2020, pp. 47–67). In light of current global challenges, some focus on the impact of governance on inclusive growth (OECD 2015; Doumbia 2018, pp. 1–35; Ivanyna and Salerno 2021, pp. 1–44) or sustainable development (Magoni, Adami, and Radaelli 2021, pp. 547–561).

The relevance of good governance is also considered an element of a country's investment attractiveness, and we examine the relationships between the development of domestic institutions and FDI inflows and outflows. Numerous empirical studies have demonstrated that countries with strong institutions attract more FDI (Globerman and Shapiro 2002, pp. 1899–1919; Buchanan, Le, and Rishi 2012, pp. 81–89; Jadhav 2012, pp. 5–14; Peres, Ameer, and Xu 2018, pp. 626–644; Hayat 2019, pp. 561–579; Sabir, Rafique, and Abbas 2019, pp. 1–20; Belfqi, Qafas, and Jerry 2021, pp. 1–29; Dobrowolska, Dorożyński, and Kuna-Marszałek 2021, pp. 23–44; Khan, Weili, and Khan 2022, pp. 30594–30621). Dunning (2002) stated that institutional factors, such as good governance and econom-

ic freedom, are increasingly more important and popular determinants of FDI because the motivations of multinational companies have shifted from market-seeking and resource-seeking to efficiency-seeking. Higher institutional quality means the country's consumer market is more active and efficient, and consumer demand ensures the profitability of the investment projects conducted there (Aibai et al. 2019).

On the other hand, some studies have found a *negative and insignificant relationship* between institutional factors and FDI inflows (Subasat and Bellos 2013, pp. 107–131; Nondo, Kahsai, and Hailu 2016, pp. 12–30). Bellos and Subasat (2012a, pp. 565–574; 2012b, pp. 303–328) provide evidence that weak governments in selected countries of Latin America that undergo economic transformation attract FDI. They confirmed these results in a follow-up study, this time covering as many as 18 Latin American countries (Subasat and Bellos 2013, pp. 107–131). Usually, however, poor institutional quality is seen as an obstacle to FDI inflows, as it represents a threat to investments and increases the cost of doing business (Aziz 2018, p. 111). Foreign investors will see avoiding problems with regulatory, bureaucratic, and judicial frameworks, property rights, enforceable contracts, or performance and content requirements as positive. Poor institutions are like a tax. They increase investment costs and thus impede foreign investment (Buchanan, Le, and Rishi 2012, pp. 81–89). This is why governments should carefully "adjust policies and institutions". Otherwise, they may adversely affect the size of FDI inflow and " be detrimental to economic growth" (van Bon 2019, pp. 601–623).

The literature also examines the reverse causality – the effect of FDI on institutional quality, though the number of studies is limited (Wako 2021, p. 1). The findings of those studies are diverse, ranging from negative or insignificant effects (Lee 2014; Demir 2016, pp. 341–359; Fon et al. 2021, pp. 1–18) to positive effects (Long, Yang, and Zhang 2015, pp. 31–48). Other studies reveal that FDI positively affects the economic growth of host countries only if strong institutions exist in the host economy (e.g., Miao et al. 2020, pp. 1–20).

Researchers who examine the effect of institutional quality upon the inflow of FDI usually focus on developing, emerging and transition economies (Busse and Hefeker 2009, pp. 397–415; Wernick, Haar, and Singh 2009, pp. 317–322; Dorożyński and Kuna-Marszałek 2016, pp. 119–140; Hossain and Rahman 2017, pp. 164–177; Kurul and Yalta 2017, pp. 1–10), while developed countries are rarely examined. The studies mostly deal with comparisons between developing and developed countries (Buchanan, Le, and Rishi 2012, pp. 81–89; Qureshi et al. 2020, pp. 80–91). Some conclude that institutional quality positively and significantly impacts FDI inflow in Asia (Mengistu and Adhikary 2011, pp. 281–299; Raza et al. 2021, pp. 2596–2613), Latin American countries (Subasat and Bellos 2013, pp. 107–131), South Asian Association for Regional Cooperation countries, Central Asian countries and the Association of South-East Asian Nations (Shah and Afridi 2015, pp. 31–55; Ullah and Khan 2017, pp. 833–860), and African coun-

tries (Ajide and Raheem 2016, pp. 319–341; Nondo, Kahsai, and Hailu 2016, pp. 12–30). On the other hand, the region of Central and Eastern Europe, which has attracted many foreign investors over the last two decades, is relatively rarely investigated. Studies confirming the positive impact of institutional quality on investment attractiveness can be found in Doytch and Eren (2012, pp. 14–32), Dorożyński and Kuna-Marszałek (2016, pp. 119–140), Dobrowolska, Dorożyński, and Kuna-Marszałek (2020, pp. 91–110), and Owczarczuk (2020, pp. 87–96).

FDI inflow to the EU Member States

The COVID–19 pandemic caused a substantial decline in global FDI in 2020, bringing FDI flows back to the level seen in 2005 (in 2020, they fell by one-third to 1 trillion USD). The crisis has negatively impacted the most productive types of investment, i.e., greenfield investments in industrial and infrastructure projects. This means that international production, one of the key drivers of economic growth, has been severely affected (World Investment Report 2021, pp. 3–4).

Europe was also strongly affected by COVID–19. Foreign investors announced ca. 5000 new projects in Europe in 2020, which means a 30% drop compared to 2019. Capital investment also declined by 18%, to USD 177.3 bn in the same period. The UK was the top destination country for FDI in Europe in 2020, with 868 projects, followed by Germany (733 projects, i.e. 14% of the market share). They were followed by Spain, France, Poland, the Netherlands, and Ireland. Poland was the only Member State from Central and Eastern Europe. Of the top 10 host European countries, only Ireland recorded a higher number of FDI projects in 2020 compared to 2019, with a 2% increase (*The FDI Report…* 2021, pp. 16–17).

In general, investors still see the EU as an attractive and relatively safe location, even though the member countries greatly differ in their ability to attract FDI. The Northern Member States are the most effective in competing for foreign investors. At the end of 2020, the total value of the FDI inward stock in four leading countries (the Netherlands, the UK, Ireland, and Germany) exceeded the value of FDI stock in all the other countries combined (ca. USD 7,506 bn compared to USD 6,263 bn). However, the examined values look different when we consider the FDI inward stock as a % of GDP. Then we find that the undisputed leaders are Cyprus, Malta, and Luxembourg (respectively 2034%, 1693%, and 856% of their GDP). At the bottom of the ranking are Germany, Greece, and Italy, with a share of FDI stock in GDP of less than 30% (Table 1).

Table 1. FDI inward stock (in millions of USD) and FDI inward stock as a % of GDP (as at the end of 2020)

No.	EU MS	FDI inward stock as % of GDP (2020)	No.	EU MS	FDI inward stock in millions of USD
1	Cyprus	2034.43	1	Netherlands	2,890,579
2	Malta	1692.78	2	UK	2,206,202
3	Luxembourg	856.30	3	Ireland	1,350,055
4	Ireland	321.88	4	Germany	1,059,326
5	Netherlands	317.35	5	France	968,138
6	Belgium	123.65	6	Spain	853,291
7	Estonia	110.98	7	Belgium	635,929
8	Bulgaria	88.37	8	Luxembourg	627,358
9	UK	81.53	9	Italy	485,842
10	Portugal	79.49	10	Cyprus	480,867
11	Czechia	78.22	11	Sweden	408,824
12	Sweden	76.10	12	Poland	248,732
13	Spain	66.61	13	Malta	240,905
14	Hungary	65.44	14	Austria	194,058
15	Slovakia	61.18	15	Czechia	188,772
16	Latvia	60.97	16	Portugal	183,556
17	Croatia	57.29	17	Denmark	135,125
18	Austria	45.29	18	Romania	107,526
19	Romania	43.41	19	Hungary	100,993
20	Lithuania	42.58	20	Finland	96,903
21	Poland	41.84	21	Slovakia	63,992
22	Slovenia	38.60	22	Bulgaria	59,724
23	Denmark	38.13	23	Greece	51,801
24	France	37.16	24	Estonia	34,450
25	Finland	35.69	25	Croatia	32,066
26	Germany	27.95	26	Lithuania	23,709
27	Greece	27.34	27	Latvia	20,457
28	Italy	25.77	28	Slovenia	20,420

Source: own elaboration based on UNCTADSTAT.

The quality of governance based on the Worldwide Governance Indicators[1]

Governance quality and its components in individual countries or regions of the world have been assessed for many years by different institutions and international organisations. It provides the basis for annual reports with rankings of countries based on selected indicators and assessment criteria. These data are used by, among others, foreign investors when making location decisions.

The most popular measures of QG based on aggregate data and international comparative studies include rankings published by the World Bank, the European Central Bank, the International Institute for Management Development, and the World Economic Forum. Unfortunately, institutional quality indicators are usually highly correlated (Globerman and Shapiro 2002; Buchanan, Le, and Rishi 2012; Ullah and Khan 2017). To avoid the problem, we used aggregate and individual governance measures, such as the Worldwide Governance Indicators[2].

The WGIs report aggregate and individual governance indicators for over 200 countries and territories over the period 1996–2020, for six dimensions of governance (Documentation n.d.):

1) **Voice and Accountability**, which captures the perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media;

2) **Political Stability and Absence of Violence/Terrorism**, which measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism;

3) **Government Effectiveness**, which captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies;

4) **Regulatory Quality**, which measures the perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development;

1 Based on Worldwide Governance Indicators.

2 WGI were initiated by Kaufmann and Kraay in 1999 and developed by Zoido and Mastruzzzi.

5) **Rule of Law**, which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence;

6) **Control of Corruption**, which measures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the "capture" of the state by elites and private interests.

These aggregate indicators combine the opinions of numerous enterprises, citizens, and expert survey respondents in developed and developing countries. They are based on over 30 individual data sources composed of various survey institutes, experts, non-governmental organisations, international organisations, and companies[3].

The relationship between the quality of governance and FDI inflow into the EU Member States

Based on the results of studies that assess the quality of governance in the EU Member States published in the Worldwide Governance Indicators Reports, in the first step of our analysis, we used hierarchical cluster analysis methodology[4] to identify countries that represent similar QG. Using Ward's method[5], we obtained a dendrogram which shows a hierarchical structure arranged in order of descending similarity of components in the set (see Figure 1).

The analysis allowed us to divide all of the EU–28 Member States into four groups that represent similar levels of QG:

- Group 1_{gov}: Finland, Sweden, Luxembourg, Denmark, Netherlands, Austria, Ireland;
- Group 2_{gov}: Belgium, France, Germany, United Kingdom, Cyprus, Estonia, Spain;
- Group 3_{gov}: Malta, Latvia, Portugal, Slovak Republic, Czech Republic, Hungary, Slovenia, Poland, Lithuania;
- Group 4_{gov}: Bulgaria, Romania, Greece, Italy, Croatia.

3 These data sources are rescaled and combined to create the six aggregate indicators mentioned above, using a statistical methodology known as an *unobserved components model*. A key feature of the methodology is that it generates margins of error for each governance estimate. These margins of error need to be taken into account when making comparisons across countries and over time (Kaufmann, Kraay, and Mastruzzi 2010).

4 Hierarchical cluster analysis is used to identify homogenous groups of elements based on selected characteristics in a given set of data (Lasek 2002; James et al. 2014).

5 Ward's method is one of the agglomeration methods used in hierarchical cluster analysis.

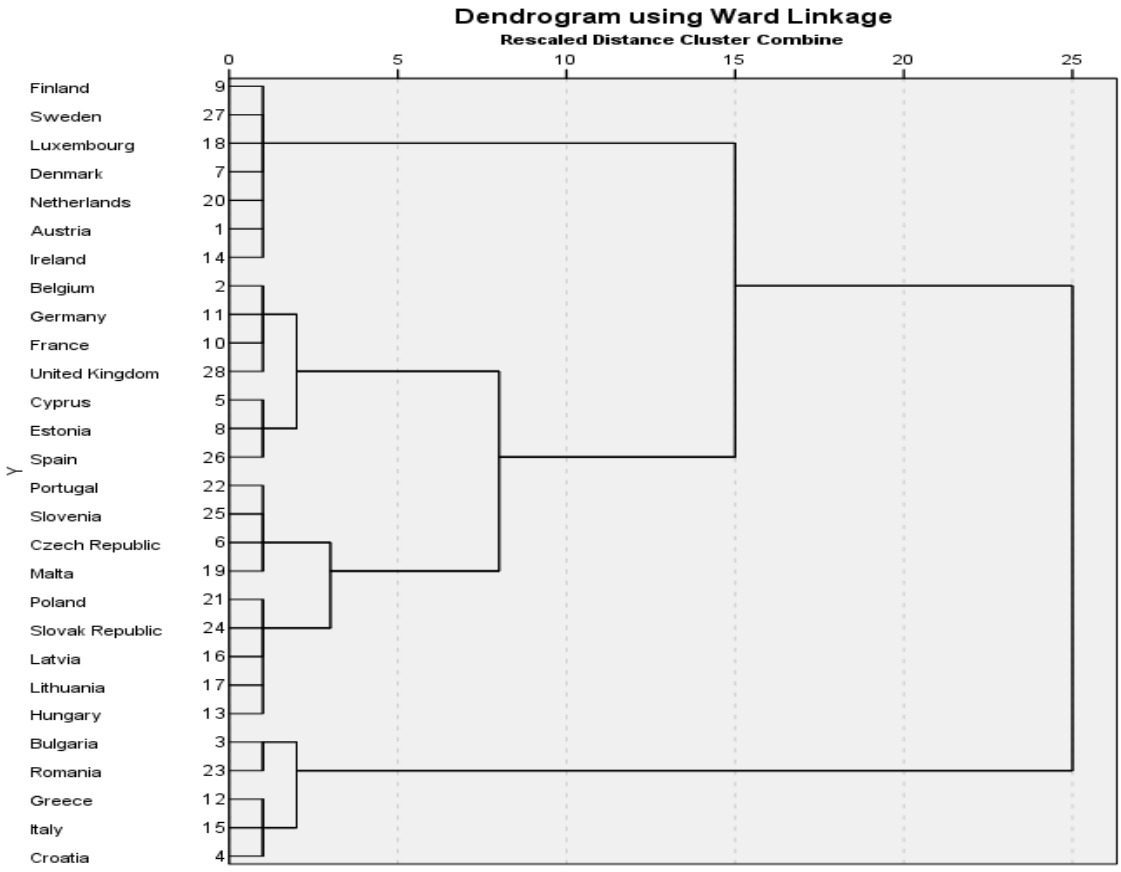


Figure 1. Dendrogram for the EU–28 obtained using Ward's linkage method

Source: own compilation using PS IMAGO.

Although hierarchical cluster analysis helped to distinguish four groups of countries with similar QG, it failed to identify which group performs better than others. Hence, in the second step of the analysis, we compared the quality of governance among the four groups of countries. We constructed a synthetic index of governance quality values for each Member State based on the data from 2004–2020. This measure is a sum of percentile ranks[6] for the countries published by the WGI for six dimensions of governance over the investigated period. The ranking of the EU countries based on the synthetic index is presented in Figure 2.

6 Percentile ranks from 0 (the lowest) to 100 (the highest).

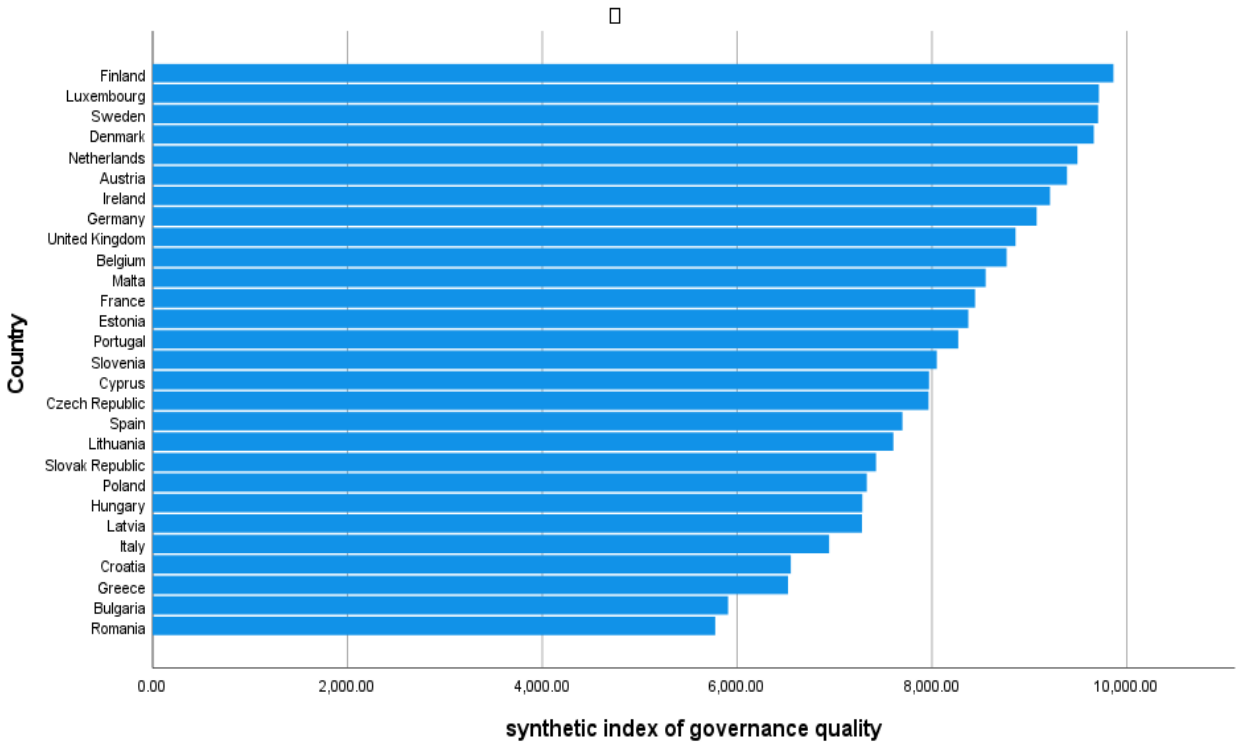


Figure 2. Ranking by the synthetic index of governance quality in EU Member States, 2004–2020

Source: own compilation using PS IMAGO.

Using the synthetic index of governance quality, we calculated the mean value of the index for the four groups of countries (see Table 2).

Table 2. The mean value of the synthetic index of governance quality for the EU Member States, 2004–2020

Group	Country	Mean of synthetic index of governance quality
group 1_{gov}	Finland, Sweden, Luxembourg, Denmark, Netherlands, Austria, Ireland	9577.43
group 2_{gov}	Belgium, France, Germany, United Kingdom, Cyprus, Estonia, Spain	8455.80
group 3_{gov}	Malta, Latvia, Portugal, Slovak Republic, Czech Republic, Hungary, Slovenia, Poland, Lithuania,	7752.36
group 4_{gov}	Bulgaria, Romania, Greece, Italy, Croatia	6340.85

Source: own compilation using PS IMAGO.

The ranking revealed that the highest QG was reported by countries from Group 1_{gov}: Finland, Sweden, Luxembourg, Denmark, Netherlands, Austria, and Ireland. At the other

extreme is Group 4_{gov}: Bulgaria, Romania, Greece, Italy, and Croatia, where investors can expect the lowest quality of governance.

Tables 1 and 3 show the inflow of FDI and descriptive statistics of the FDI inward stock as a % of GDP for the EU–28 at the end of 2020. It is clear from the tables that the data are very differentiated, highly skewed, and with high kurtosis. The 5% trimmed mean and M-estimators differ significantly from the mean, which is evidence of the absence of homogeneity in the examined population.

Table 3. Statistics describing FDI inward stock as a % of GDP in the EU in 2020

Descriptives	Statistic	Std. Error
Mean	234.870	92.6708
95% Confidence Interval for Mean – Lower Bound	44.725	
95% Confidence Interval for Mean – Upper Bound	425.014	
5% Trimmed Mean	151.909	
Variance	240460.602	
Std. Deviation	490.3678	
Minimum	25.8	
Maximum	2034.4	
Range	2008.7	
Interquartile Range	65.9	
Skewness	3.056	.441
Kurtosis	8.781	.858
Percentiles 25	39.413	
Percentiles 50	63.310	
Percentiles 75	105.331	
M-Estimators		
Huber's M-Estimator[a]	65.001	
Tukey's Biweight[b]	56.586	
Hampel's M-Estimator[c]	57.315	
Andrews' Wave[d]	56.598	

[a] The weighting constant is 1.339

[b] The weighting constant is 4.685.

[c] The weighting constants are 1.700, 3.400, and 8.500,

[d] The weighting constant is 1.340*pi.

Source: own compilation using PS IMAGO.

Given the circumstances, in the third step of our analysis, we divided the countries into four groups arranged in ascending order of FDI inward stock as a % of GDP based on measures of position such as quartiles. We transformed the FDI inward stock as a % of the GDP variable measured on a numerical scale into a variable measured on an ordinal scale. As a result, we produced the following groups of countries:

- Group 1_{fdi}: Belgium, Cyprus, Estonia, Netherlands, Ireland, Luxembourg, Malta;
- Group 2_{fdi}: United Kingdom, Sweden, Spain, Portugal, Hungary, Czech Republic, Bulgaria;
- Group 3_{fdi}: Austria, Croatia, Lithuania, Latvia, Poland, Romania, Slovak Republic;
- Group 4_{fdi}: Greece, Italy, France, Germany, Slovenia, Denmark, Finland.

In the fourth step of the study, we assessed the relationship between the QG in the countries of EU–28 from 2004–2020 and FDI inward stock as a % of GDP in 2020. The correlation analysis started with the drafting of the scatterplot for the variables (Figure 3).

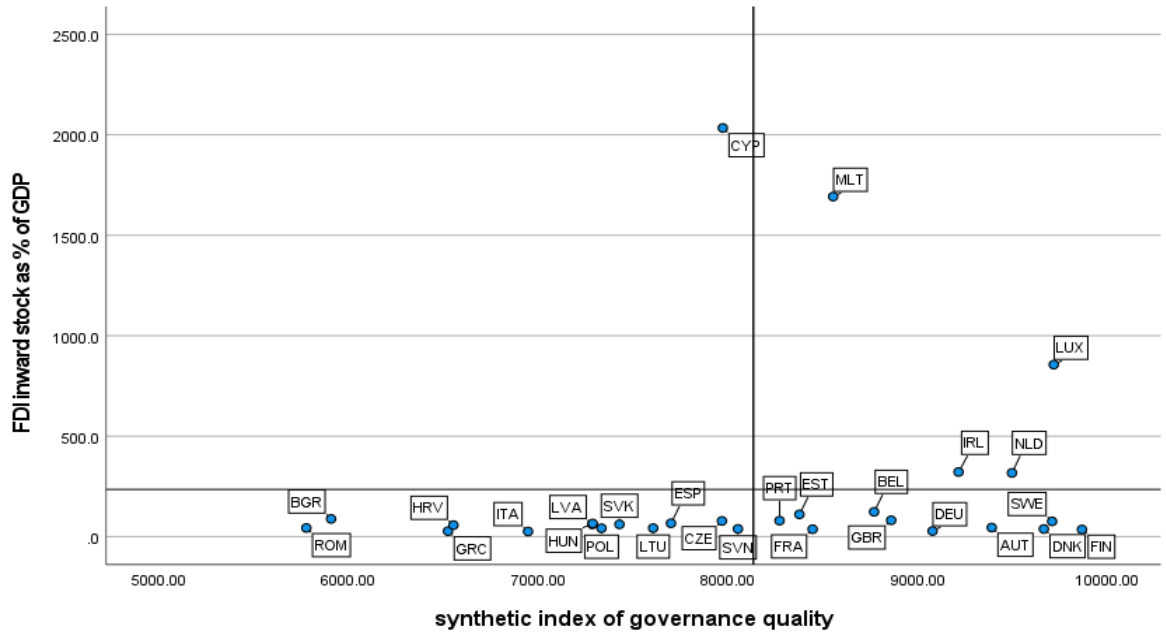
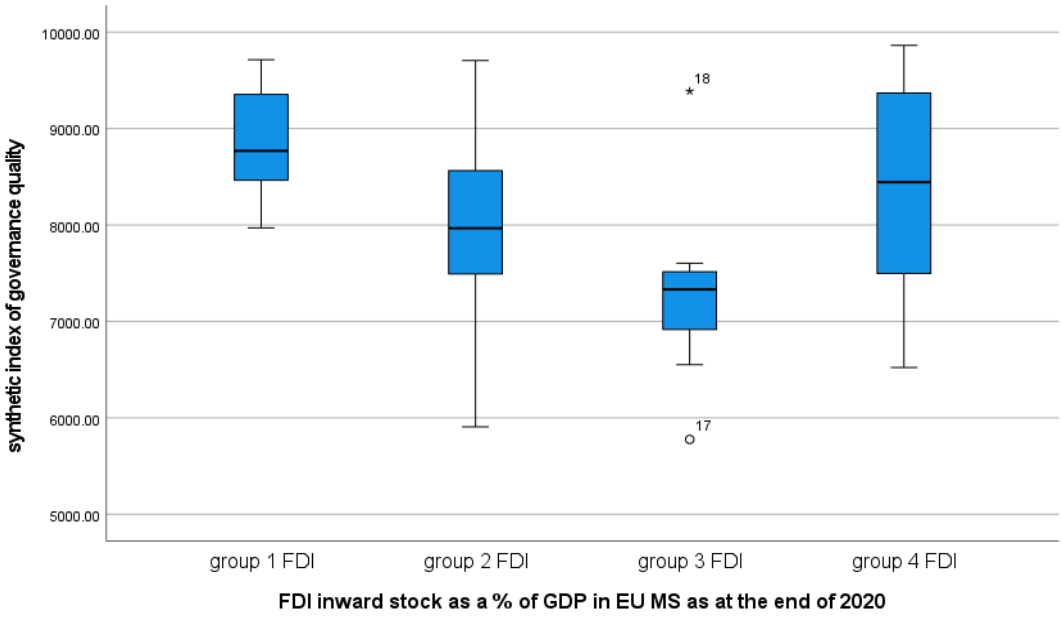


Figure 3. Scatterplot for the synthetic index of governance quality and FDI inward stock as a % of GDP

Source: own compilation using PS IMAGO.

The scatterplot confirms the conclusions drawn in the previous step, suggesting huge differentiation of the FDI inward stock as a % of GDP among the Member States largely due to the values of this variable for Cyprus, Malta, and Luxembourg. That is why we decided to assess how much the synthetic index of governance quality differs across

the four distinguished groups of EU Member States arranged in ascending order of FDI as a % of GDP based on the measures of position such as quartiles (see Figure 4).

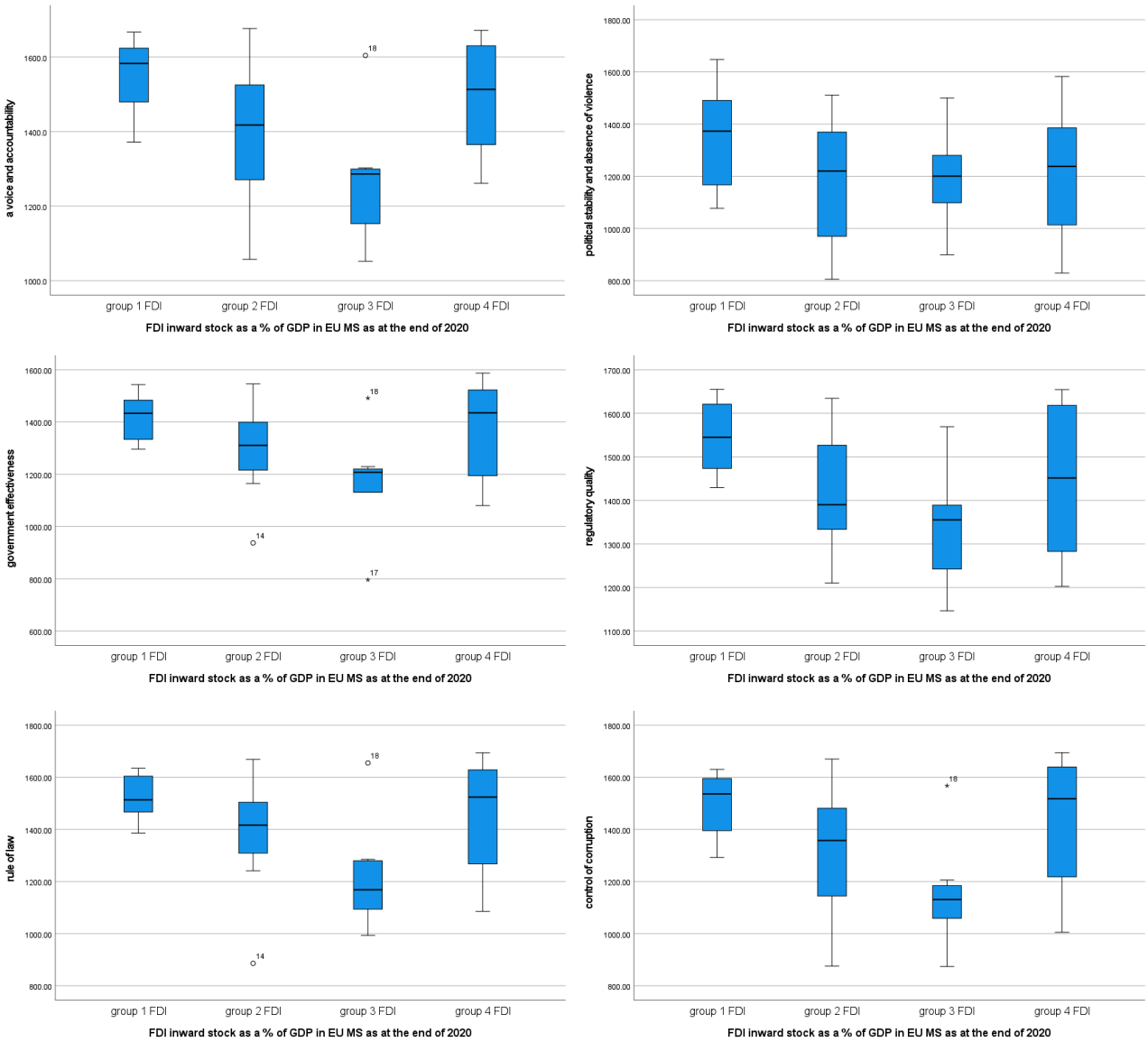


° number 17 – Romania, * number 18 – Austria.

Figure 4. Boxplot for the synthetic index of governance quality in groups of countries based on the FDI inward stock as a % of GDP in the EU Member States as at the end of 2020

Source: own compilation using PS IMAGO.

The highest median of the synthetic index of governance quality among the Member States was reported for Group 1_{fdi}, which means that the largest inflows of FDI inward stock as a % of GDP are characterised by countries offering the highest institutional quality to potential investors. The median values are lower in Group 2_{fdi} and Group 3_{fdi}, which comprise countries with moderate levels of FDI inward stock as a % of GDP. The results for Group 4_{fdi}, which contains countries reporting the lowest levels of FDI inward stock as a % of GDP, are surprising. It comprises Greece, Italy, France, Germany, Slovenia, Denmark, and Finland, i.e., leaders of governance quality (e.g., Finland, Denmark, Group 1_{gov}) who simultaneously report relatively low FDI inward stock as a % of GDP (35.69% and 38.13%, respectively, i.e., Group 4_{fdi}). A similar relationship can be observed for France and Germany (Group 2_{gov} in governance quality ranking and Group 4_{fdi} in FDI inward stock as a % of GDP).



° number 17 – Romania, number 18 – Austria, number 14 – Bulgaria

Figure 5. Boxplot for the synthetic index of governance quality for six dimensions of governance in groups of countries based on FDI inward stock as a % of GDP

Source: own compilation using PS IMAGO.

In the last stage, we examined the relevance of individual dimensions of QG for FDI inflows. The results are presented in Figure 5. The distribution of median values in all areas covered by the study is analogous to the distribution in the synthetic index. The biggest differences between the groups can be found in the following dimensions: *voice and accountability*, *regulatory quality* and *rule of law*. On the other hand, for *political stability and absence of violence,* the values of the median of the synthetic index of governance quality in Groups 2–4 are almost identical and slightly below results scored by Group 1_{fdi}, which is a sign of the relatively small differences across the groups of Member States.

Grouping countries in ascending order of FDI as a % of GDP based on quartiles and dividing them into groups with a similar quality of governance allowed us to construct a contingency table (Table 4). By examining the data from Table 4, one may assume that countries with higher governance quality usually report higher FDI inward stock as a % of GDP (e.g., Netherlands, Luxembourg, Ireland). However, there are exceptions to this rule (e.g., Malta).

Table 4. Correlation matrix for groups of the EU Member States for the quality of governance and FDI inward stock as a % of GDP

Groups of countries with similar levels of FDI inward stock as a % of GDP	Groups of countries with a similar quality of governance				Total
	Group 1_{gov} Finland, Sweden, Luxembourg, Denmark, Netherlands, Austria, Ireland	Group 2_{gov} Belgium, France, Germany, United Kingdom, Cyprus, Estonia, Spain	Group 3_{gov} Malta, Latvia, Portugal, Slovak Republic, Czech Republic, Hungary, Slovenia, Poland, Lithuania	Group 4_{gov} Bulgaria, Romania, Greece, Italy, Croatia	
Group 1_{fdi} Belgium, Cyprus, Estonia, Netherlands, Ireland, Luxembourg, Malta	3	3	1	0	7
Group 2_{fdi} United Kingdom, Sweden, Spain, Portugal, Hungary, Czech Republic, Bulgaria	1	2	3	1	7
Group 3_{fdi} Austria, Croatia, Lithuania, Latvia, Poland, Romania, Slovak Republic	1	0	4	2	7
Group 4_{fdi} Greece, Italy, France, Germany, Slovenia, Denmark, Finland	2	2	1	2	7

Source: own compilation using PS IMAGO.

To assess the strength of the correlation between the dimensions of QG and FDI inward stock as a % of GDP, we used the contingency coefficient (Table 5). Its value for the six dimensions of governance quality for the EU–28 was 0.503,[7] which shows

7 Own calculations carried out using PS IMAGO.

that there is a moderate positive correlation[8] between the QG and FDI inward stock as a % of GDP. By ensuring appropriate governance quality, the Member States increase FDI as a % of GDP. The values of the contingency coefficients between the six dimensions of governance and FDI as a % of GDP suggest that voice and accountability, regulatory quality, and rule of law exert the biggest impact on FDI. As indicated by the results of our analysis, differences across the Member States are the biggest in these areas.

Table 5. Contingency coefficients between the six dimensions of governance and FDI inward stock as a % of GDP in the EU Member States

Dimensions of governance		Contingency coefficient
1	voice and accountability	0.548
2	political stability and absence of violence	0.429
3	government effectiveness	0.492
4	regulatory quality	0.634
5	rule of law	0.548
6	control of corruption	0.484
Six dimensions of governance		0.503

Source: own compilation using PS IMAGO.

Conclusions

The principal goals of the article were to assess the quality of governance in the EU–28 and to examine the relationship between the quality of governance and FDI inward stock as a % of GDP. The analysis led us to the following conclusions:

1. Numerous studies have demonstrated that there is a relationship between governance quality and economic growth. At the same time, governance quality is often equated with institutional quality. Most researchers agree that it is one of the main determinants of FDI inflow.

2. The EU is one of the most attractive investment locations in the world. The statistical data suggest there is a big discrepancy across the EU–28 regarding the absolute value of invested capital, as well as the value of FDI as a share of GDP.

8 The direction of the relationship was assessed based on the distribution of data in the contingency table (Table 4) and the ranking of variables that describe the quality of governance in the EU Member States (Figures 2 and 3).

3. EU Member States differ significantly in the overall quality of governance, measured with the WGI, as well as the main six dimensions. Simultaneously, it turned out that the examined countries can be divided into groups representing a similar quality of governance. Using hierarchical cluster analysis, we selected four groups. Countries that belong to these four groups exhibit some identical features, e.g., political stability, rule of law, and control of corruption.
4. The results of the statistical analysis revealed a moderate yet positive correlation between the quality of governance and the inflow of FDI. The most important of the partial variables is the regulatory quality, which measures the perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development.
5. In addition, relatively important are the rule of law, which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and voice and accountability, which captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

The results of our study are in accordance with the literature addressing empirical FDI incentives, which stresses the importance of governance for FDI inflow (e.g. Hayat 2019, pp. 561–579; Sabir, Rafique, and Abbas 2019, pp. 1–20; Belfqi, Qafas, and Jerry 2021, pp. 1–29; Khan, Weili, and Khan 2022, pp. 30594–30621). The added value of this article is that it grouped the EU–28 member states based on the similarity of their quality of governance (measured by six dimensions of governance) and demonstrated that it impacts the size of FDI inflow. To achieve this, we created a synthetic index of governance quality values to compare the level of institutional quality among the EU Member States between 2004 and 2020. We examined the relationship between FDI and four groups of countries with similar QG. The novelty was that we examined the relevance of six individual dimensions of governance for FDI inflows in the EU–28.

The study has some limitations. Due to data availability, we investigated only FDI inward stock as a % of GDP. No distinction was made between different entry modes of FDI or specific motivations that drive FDI inflow. Such an investigation would be interesting, especially in the context of EU countries which are so different regarding economic and social development. Furthermore, in subsequent studies, the relationship between other dimensions of governance quality, such as the protection of investors' interests or economic freedom, could be examined. The spectrum of factors that are potentially relevant to FDI inflow could also be expanded. Future studies could also be oriented towards investigating differences in the quality of governance and FDI inflows between the EU–15 (i.e., the "old members") and the EU–13 (the "new members"). It would thus be interesting to compare the role of governance quality between these two groups of countries that exhibit different levels of economic growth.

This study has specific implications for research and practice. Given the positive relationship between QG and FDI inflow, policymakers should consider the importance of institutional quality indicators in attracting FDI. A good governance profile of the host country encourages to invest in it. Thus, governments should implement institutional reforms to ensure a favourable climate for the inflow of FDI and boost the investment attractiveness of their respective economies. Our research demonstrates that government policies should also focus on improving specific dimensions of governance quality, such as regulatory quality. The results show that this dimension of governance has been the most relevant for FDI inflow in the EU–28 Member States.

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Jakość rządzenia a napływ zagranicznych inwestycji bezpośrednich Badanie porównawcze wśród państw członkowskich UE

Głównym celem artykułu jest porównawcza ocena jakości rządzenia w krajach członkowskich UE w latach 2004–2020 oraz zbadanie jego związku z napływem zagranicznych inwestycji bezpośrednich (ZIB). Badanie podzielono na pięć etapów. Pierwszy, oparty na *Worldwide Governance Indicators* (WGI), jest próbą identyfikacji krajów o podobnym poziomie jakości rządzenia. Na podstawie tego kryterium, stosując statystyczne metody grupowania, podzieliliśmy państwa członkowskie UE na 4 grupy. W drugim etapie wykorzystaliśmy syntetyczny wskaźnik do porównania poziomu jakości rządzenia wśród państw członkowskich UE. Następnie przeanalizowaliśmy napływ ZIB do krajów członkowskich UE. Ze względu na znaczne różnice w tym zakresie podzieliliśmy je również na cztery grupy uszeregowane rosnąco pod względem skumulowanej wartości ZIB w relacji do PKB. W czwartym etapie zbadaliśmy związek między napływem ZIB a zagregowaną wartością jakości rządzenia. Na koniec zbadaliśmy znaczenie sześciu zmiennych częściowych jakości rządzenia dla napływu ZIB do krajów członkowskich UE.
Badanie wykazało, że państwa członkowskie UE różnią się istotnie pod względem jakości rządzenia, mierzonej wskaźnikiem WGI. Wyniki analizy statystycznej dostarczyły podstaw do pozytywnej weryfikacji hipotezy o pozytywnym związku pomiędzy jakością rządzenia a napływem ZIB. Stosunkowo największe znaczenie można przypisać jakości wprowadzanych regulacji.

Słowa kluczowe: jakość rządzenia, ZIB, państwa członkowskie UE, hierarchiczna analiza skupień

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Intersectoral Flows in the Economies of the Visegrad Group Countries

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Abstract

We present a comparative study of flows between institutional sectors in the economies of Czechia, Hungary, Poland and Slovakia, with particular emphasis on the role of the foreign sector. The purpose of our study is to determine the strength and nature of inter-sectoral ties in the analyzed countries and point out the similarities and differences between them. The research method is based on the sequence of all transactions included in the System of National Accounts (SNA): product transactions, primary income generation and allocation, income distribution, and financial instrument transactions. The study is distinguished by its consistency and balance within the SNA. The method used to transform data into a payer-payee matrix guarantees the preservation of these properties. It creates a new perspective for assessing the sensitivity of economies to external processes.

It is the first such comprehensive comparative study, providing unambiguous and replicable results based on a standardized accounting system that operates in all European countries. The period covered by the study (2000–2020) allows us to draw interesting conclusions about the processes that took place during and after the accession to the European Union. The results indicate, inter alia, an increase in the involvement of the foreign sector, primarily in production processes (import, export) and investment. Particularly noteworthy is the high degree of financialization of the Hungarian economy.

Keywords: Visegrad Group Countries, flow of funds, system of national accounts, institutional sectors

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Introduction

The Visegrad Group (V4), which includes Czechia, Hungary, Poland, and Slovakia, has been the subject of many comparative studies. On the one hand, it is a group that is fairly homogeneous in terms of economic development and geopolitical location, and they experienced similar systemic transformations. The example of this group can therefore be used to highlight the mechanisms of economic transformation in Central and Eastern Europe compared to highly developed and poorly developed countries. On the other hand, by moving to a greater degree of detail, it is possible to point out some differences within the group itself.

After the Second World War, all the V4 countries functioned under the communist regime, and after 1989, they underwent a similar system transformation. All of them became members of the European Union in 2004, and this moment was preceded by a long preparatory period. Therefore the analysis of many aspects of accession does not indicate the breakthrough nature of the changes that occurred in that particular year. The integration overlapped with the globalization taking place in the world economy. Together with the political transformation that took place in the early 1990s, this led to the gradual opening of these economies, signifying an increase in their dependence on the rest of the world.

The purpose of our article is to examine the differences in the links between institutional sectors in the economies of the V4 countries, with particular emphasis on the role of the rest of the world, which is considered an external institutional sector in the System of National Accounts (SNA). This is the first comparative study of this kind. We try to indicate the differences in the degree and nature of interconnections between the household sector, the government sector, the non-financial enterprises sector and the financial enterprises sector in each country. We also aim to ascertain how economic relations with foreign countries, reflected in the SNA, affect the functioning of individual national institutional sectors.

As mentioned, since it was first defined about 30 years ago, the V4 group has been subjected to many analyses aimed primarily at tracing the economic transformation in general (e.g., Ambroziak et al. 2020; Błaszczyk 2022) and in selected aspects such as catching up in terms of GDP (e.g., Lengyel and Kotosz 2018), innovation (e.g., Dworak and Grzelak 2018; Jabłońska 2020), competitiveness and shaping comparative advantages (e.g., Molendowski 2021), and sustainability (e.g., bio-based production, Lazorcakova et al. 2022). The V4 is also subject to research on political issues (e.g., Zapletalová and Komínková 2020; Strnad 2022). Those analyses, apart from the pure macroeconomic studies, were carried out at the regional (Lengyel and Kotosz 2018) or branch level (Jabłońska 2020). The processes taking place between institutional sectors have not been analyzed so far.

The method we propose, thanks to its simplicity, has three undoubted advantages: interpretative clarity, consistency within the current statistical reporting system, and the replicability of the research, which is thanks, in part, to the first two advantages. The available statistical material, which covers the years 2000–2020, is appropriate for tracing the dynamics of changes resulting from the accession.

The starting point for our analysis is the SNA, which presents the data in the form of flow of funds (FoF) tables. They track the flow of funds throughout the economy and cover both real and financial transactions. This layout is presented in section 2. Section 3 presents the method we use to convert the national accounts to payer-payee matrices. For a detailed description of the calculation procedure, see the Appendix. We consider this new application of the social accounting method to be the most important added value of our article. The results obtained in this way constitute interesting statistical material that describes intersectoral transactions. Changes in the structures of these transactions in the analyzed countries are described in section 4. We present and discuss data on aggregate flows and, in the case of the rest of the world sector, flows divided into four categories. We also present selected observations regarding individual transactions, but due to the volume of the material, we cannot present them in full. Detailed tables for 23 types of transactions are available upon request. The last section presents the main conclusions.

Flow of funds accounts

The basic concept of the FoF accounts comes from the Moneyflow Accounts by Copeland (1949). His study answered the following questions: "When total purchases of our national product increase, where does the money come from to finance them? When purchases of our national product decline, what becomes of the money that is not spent?" These two questions fully reflect the need to present data in the form of FoF accounts. The economy is composed of units grouped into institutional sectors. Units make and receive payments to and from other units that can be classified in the same or another institutional sector. Each payment is classified by the sector making it and its purpose – the type of transaction. Each transaction is simultaneously shown as an outflow of funds for one sector (payer) and an inflow for another (payee). The first official statistics based on Copeland's idea were the Flow of Funds in the United States 1939–1953, published in 1955. Now (since 2013), these data have been published as *Financial Accounts of the United States* (e.g., Federal Reserve Statistical Release 2021). This document is organized into sections: tables of transactions made by institutional sectors, levels tables, and balance sheets for assets and liabilities, as well as integrated macroeconomic accounts (the sequence of transactions is largely in accordance with The System of National Accounts).

Various ways of presenting FoF can be considered depending on the analytical purpose of their application and the level of detail in the published data. The simplest FoF accounts represent transactions of major importance made by institutional sectors. Complex FoF accounts consist of three-dimensional matrices, where the first two dimensions describe institutional sectors involved in transactions (payer-payee), and the third presents various forms of transactions. These matrices show who (which sector) pays to whom and by means of which form of transaction. In other words, these matrices indicate where the money comes from, where it goes and what 'kind' of money it is (Klein 2003).

Originally, FoF accounts were conceived as a set of data on financial assets acquired by institutional sectors and the liabilities incurred by them. The tables in the "from-whom-to-whom" form are constructed as balance sheets. They make it possible to answer questions like "Who is financing whom, in what amount, and with which type of financial instrument?" (Shrestha, Mink, and Fassler 2012). Data in this form are published officially, but only for stocks of financial assets and liabilities, not for transactions in financial instruments or any other types of transactions (see Eurostat database, financial accounts: counterpart information).

The financial crisis of 2008 highlighted the need to link the financial and "real" sphere of the economy through the connections between financial savings and tangible investments. In this context, many authors notice the need to fully integrate the financial balance sheet and the accumulation account (see Palumbo and Parker 2009; *The Financial…* 2009; Shrestha, Mink, and Fassler 2012). The importance of this problem increases with the growing degree of global financial integration that speeds up the spread of financial shocks around the world (Tsujimura and Tsujimura 2011).

Economic processes taking place in the real economy are reflected in the SNA – a sequence of non-financial accounts (production accounts, generation and allocation of primary income, secondary distribution of income, the use of disposable income, and capital accounts), while the financial sphere is presented by financial accounts. The difference between the total sum of resources and uses recorded on the capital account (saving, capital transfers, non-financial accumulation) is net lending or net borrowing – the balancing item of a whole sequence of non-financial accounts in the SNA. The net lending/net borrowing is also calculated by subtracting the net incurrence of liabilities from the net acquisition of financial assets. The financial accounts are fully integrated with the capital account since, in theory, the capital account and financial account measures of net lending/net borrowing should be the same. However, in practice, they are almost never equal because of the different sources of data, the timing of recorded flows, and many other sector-specific reasons (see, e.g., Rostadsand 2004; Abad 2005; Cagetti et al. 2012). Statistics for many countries show a persistent lack of consistency in the derived relationship between the resources generated by disposable income and borrowing on the one hand, and the consumption and accumulation

expenditures on the other, which raises the value of the discrepancy between the non-financial and financial accounts. The lack of integration of non-financial and financial accounts is a significant limitation in conducting analysis that combines these two spheres of the economy, especially based on the system of intersectoral flows.

In response to criticism that the classical FoF analysis (asset-liability matrix based on the balance sheet) only accounts for the financial system, and so the effects on the real sphere of the economy (e.g., production) are overestimated, Tsujimura and Tsujimura (2018; 2021) proposed the expanded FoF matrix. While the asset-liability matrix covers only the stock of financial instruments, the expanded FoF matrix (payer-payee matrix) includes transactions recorded on both the financial and non-financial accounts.

Intersectoral flows matrices

Matrices of intersectoral flows are constructed based on the uses (**P**) and resources (**R**) tables for each form of transaction. Tables **P** for payments and **R** for receipts consist of n columns for institutional sectors and m rows for transactions distinguished in the SNA. In this study, $n = 5$ for four domestic institutional sectors (non-financial corporations, financial corporations, general government, households & non-profit institutions serving households) and the rest of the world sector (RoW). The number of rows is $m = 23$ for transactions listed in Table 1.

Table 1. The list of transactions distinguished in the flow of funds table

Group of transactions	Transaction	*i*
Transactions of products	Intermediate consumption	1
	Final consumption and capital formation	2
	Exports of goods and services	3
	Imports of goods and services	4
Transactions of generations and allocation of primary income	Compensation of employees	5
	Other taxes on production less other subsidies on production	6
	Property income	7

Group of transactions	Transaction	*i*
Transactions of secondary distribution of income and capital transfers	Current taxes on income	8
	Net social contributions	9
	Social benefits other than social transfers in cash	10
	Other current transfers	11
	Adjustment for the change in pension entitlements	12
	Capital taxes	13
	Investment grants	14
	Other capital transfers	15
Transactions of financial instruments	Special drawing rights	16
	Currency and deposits	17
	Debt securities	18
	Loans	19
	Equity and investment fund shares	20
	Insurance, pensions and standardized guarantees	21
	Financial derivatives and employee stock options	22
	Other accounts receivable/payable plus discrepancy	23

Source: own elaborations based on the sequence of accounts in SNA.

Table 2. The scheme of the flow of funds matrix for the *i*-th transaction

sector / sector	*j*	Σ	y_{ik}	z_{ik}
k	$\mathbf{Z} = [z_{ikj}]$ Flows from sector *j* to sector *k* in terms of transaction *i*	Sum of resources of sector *k* in terms of transaction *i*	Excess of uses over resources of sector *k* (if exists; 0 otherwise) in terms of transaction *i*	Sum of resources or uses of sector *k* (whichever is greater) in terms of transaction *i*
Σ	Sum of uses of *j* in terms of transaction *i*			
w_{ij}	Excess of resources over uses of sector *j* (if exists; 0 otherwise) in terms of transaction *i*			
z_{ij}	Sum of resources or uses of sector *j* (whichever is greater) in terms of transaction *i*			

Source: own elaboration.

The data presented in this layout are published by Eurostat (https://ec.europa.eu/eurostat/web/main/data/database). Specifically, we used the following datasets: Non-financial transactions – annual data (nasa_10_nf_tr), Financial transactions – annual data (nasa_10_f_tr), Supply table at basic prices incl. transformation into purchasers' prices (naio_10_cp15), and Use table at basic prices (naio_10_cp1610). We have rearranged the original data into payer–payee matrices (see Table 2). The transformation procedure is described in the Appendix. This method of transforming data into payer–payee matrices preserves the consistency and balance within the system of national accounts.

The table of total intersectoral FoF (payer-payee matrix Z) is the sum of matrices Z_i built for all transactions – see Table 3.

Table 3. The scheme of the aggregate flow of funds matrix

FoF	Uses of sector *j*	Total
Resources of sector *k*	$\mathbf{Z} = [z_{ikj}]$ Flows from institutional sector *j* to sector *k*	$\mathbf{z} = [z_k]$
Total	$\mathbf{z}^T = [z_j]$	

Source: own elaborations.

Transaction structures recorded in such tables are the basis for assessing intersectoral relationships. The analysis of tables constructed for the V4 countries is presented in the next section.

Intersectoral flow of funds in the Visegrad Group countries

FoF tables are a useful tool that enables the analysis of the structures of intersectoral connections in the economy. Below we discuss the results of the calculations described in the previous section. For the purposes of comparative analysis, we present the structures of flows instead of their values so as to omit the problem of different scales of economies. We start with the aggregate FoF matrix (see Table 3), then present the main insights regarding individual transactions (see Table 2) that comprise aggregate flows. The last part of this section focuses on identifying the role of the rest of the world sector.

Aggregate flows

The aggregate structures of transactions carried out for 2020 are presented in Tables 4–7. Significant changes in national transaction structures that have taken place since 2000 are marked with arrows. As the tables show, most transactions in Poland,

Czechia, and Slovakia are carried out by non-financial corporations (over 30% of total flows in 2020) and households, together with non-profit institutions (over 20%). About 1/3 of transactions involving non-financial corporations are transfers between entities included in this sector, and they are primarily related to intermediate consumption. Flows between the non-financial corporations sector and the RoW sector include mainly product transactions, i.e., exports of goods and services produced by non-financial corporations (11–16%) and their imports (8–11%). In turn, flows from non-financial corporations to households are mainly compensation of employees (over 10%). The flows between households and the general government sector are also noteworthy (6,6–8,8%) – they are mainly current transfers. The role of RoW in V4 countries is negatively correlated with the size of the economy. For Poland, this share is 15.9%, for Czechia – 19.7% and for Slovakia – 21.2%.

Hungary is the noticeable exception. The role of the RoW sector is particularly high (over 30%). The country also seems to be dominated by the financial sector. It is involved in over 23% of transactions, while in the other countries, it is less than 7%.

Table 4. Structure of FoF matrix for Poland in 2020

Resources of the *k*-th sector	Uses of the *j*-th sector					Total
	Non-financial corporations	Financial corporations	General government	Households & NPISH	Rest of the world	
	S11	S12	S13	S14_S15	S2	
S11	10.7% ↓	0.6%	3.1%	6.9% ↓	11.6% ↑	32.9%
S12	1.6%	1.0%	1.3%	2.4%	0.6%	6.9%
S13	2.8%	2.8%	2.2%	8.8%	0.9%	17.5%
S14_S15	10.2%	0.9%	8.5%	4.3%	2.9%	26.7% ↓
S2	7.7% ↑	1.6%	2.3%	4.3%	0.0%	15.9% ↑
Total	32.9%	6.9%	17.5%	26.7% ↓	15.9% ↑	100.0%

↑ ↓ increase or decrease of the share by at least 2.5 pp. compared to 2000
Source: authors' own calculations based on Eurostat database: nasa_10_nf_tr, nasa_10_f_tr, naio_10_cp15, naio_10_cp1610 (last update: 8.02.2022).

Table 5. Structure of FoF matrix for Czechia in 2020

Resources of the *k*-th sector	Uses of the *j*-th sector					Total
	Non-financial corporations	Financial corporations	General government	Households & NPISH	Rest of the world	
	S11	S12	S13	S14_S15	S2	
S11	12.4% ↓	1.0%	3.1%	5.9%	14.7% ↑	37.1% ↓
S12	1.7%	0.7%	0.6%	1.7%	1.8%	6.5%
S13	2.6%	1.1%	1.6%	7.5%	1.4%	14.2%
S14_S15	10.2%	1.3%	6.6%	2.5%	1.8%	22.4% ↓
S2	10.2% ↑	2.4%	2.4%	4.8%	0.0%	19.7% ↑
Total	37.1% ↓	6.5%	14.2%	22.4% ↓	19.7% ↑	100.0%

Source: authors' own calculations based on Eurostat database: nasa_10_nf_tr, nasa_10_f_tr, naio_10_cp15, naio_10_cp1610 (last update: 8.02.2022).

Table 6. Structure of FoF matrix for Slovakia in 2020

Resources of the *k*-th sector	Uses of the *j*-th sector					Total
	Non-financial corporations	Financial corporations	General government	Households & NPISH	Rest of the world	
	S11	S12	S13	S14_S15	S2	
S11	10.8% ↓	0.7%	2.4% ↓	4.8%	16.2% ↑	34.9% ↓
S12	1.4%	0.2%	1.8%	1.6%	1.6%	6.5%
S13	2.6%	2.1%	2.0%	7.3%	1.5%	15.5%
S14_S15	8.8%	1.1%	6.7%	3.3%	1.9%	21.9%
S2	11.3% ↑	2.4%	2.6%	5.0%	0.0%	21.2% ↑
Total	34.9% ↓	6.5%	15.5%	21.9%	21.2% ↑	100.0%

Source: authors' own calculations based on Eurostat database: nasa_10_nf_tr, nasa_10_f_tr, naio_10_cp15, naio_10_cp1610 (last update: 8.02.2022).

Table 7. Structure of FoF matrix for Hungary in 2020

Resources of the *k*-th sector	Uses of the *j*-th sector					Total
	Non-financial corporations	Financial corporations	General government	Households & NPISH	Rest of the world	
	S11	S12	S13	S14_S15	S2	
S11	5.4% ↓	0.7%	1.9%	2.6%	11.5%	22.1% ↓
S12	1.6%	4.3% ↑	0.8%	1.0%	15.6% ↑	23.4% ↑
S13	1.7%	1.3%	1.5%	5.0%	1.3%	10.8%
S14_S15	5.3% ↓	0.6%	4.0%	1.4%	2.1%	13.4% ↓

Resources of the *k*-th sector	Uses of the *j*-th sector					Total
	Non-financial corporations	Financial corporations	General government	Households & NPISH	Rest of the world	
	S11	S12	S13	S14_S15	S2	
S2	8.1%	16.4% ↑	2.5%	3.4%	0.0%	30.4% ↑
Total	22.1% ↓	23.4% ↑	10.8%	13.4% ↓	30.4% ↑	100.0%

Source: authors' own calculations based on Eurostat database: nasa_10_nf_tr, nasa_10_f_tr, naio_10_cp15, naio_10_cp1610 (last update: 8.02.2022).

In all four countries, the importance of the non-financial corporations sector has decreased significantly in favor of the RoW sector. Comparing the structures in 2020 and 2000 (see arrows in Tables 4–7) shows a progressive relative decline in trade in intermediate products between domestic enterprises, and a simultaneous increase in this type of trade with foreign firms. This means greater involvement of domestic companies in global value chains. This process can't be noticed for micro-enterprises belonging to the households sector. In Hungary, the strengthening relationship between the economy and the RoW occurs in the financial sector.

Selected results for the four groups of transactions

A more in-depth analysis based on 23 tables for each transaction shows that in Poland, Czechia, and Slovakia, product transactions (total supply) account for over 60% of all transactions. In Hungary, this share in 2020 was only 40%. In the RoW sector, the dominance of product transactions is even greater. Imports account for 77–85% of all revenues of the RoW in Poland, Czechia, and Slovakia, and exports account for 70–81% of this sector's uses. In Hungary, this share in 2020 was only 36%.

The non-financial corporations sector is the main producer of goods and services manufactured for domestic use and for export, respectively. The former mainly covers intermediate consumption (mainly corporate expenditure, including micro-companies classified as households), final consumption (household and government expenditure) and accumulation (expenditure of all domestic sectors), while the latter is expenditure from the rest of the world. In the analyzed countries, over 35% of product expenditures in 2020 were the expenditures of non-financial enterprises, more than 25% of foreign expenditures (only slightly less in Poland), more than 20% of household expenditures (almost 30% in Poland only), while government expenditures do not exceed 15%. In the structure of revenues, the dominance of non-financial corporations is much more visible – their revenues constitute approximately half of the total revenues in terms of product transactions.

In terms of product transactions, FoF occurs mainly between non-financial corporations and RoW, households and RoW, and inside the non-financial corporations sector. Therefore, it seems that the role of RoW is particularly important and is still growing.

Allocation transfers are mainly flows between non-financial corporations and households as compensation of employees. They account for nearly half of the total transfers recorded on the allocation of primary income accounts of V4 countries in 2020 (slightly less in Hungary). The other flows are compensation of employees paid by the general government sector, mainly to households, and property income. While compensation of employees is income primarily of households and, to some extent, the rest of the world, property income comprises flows between domestic sectors and the rest of the world. Financial institutions are involved in around 20% of property income transactions (even more in Hungary). They are mainly flows from non-financial corporations, inside the financial sector, and from/to RoW.

The cross-sectoral structure of flows of current and capital transfers is dominated by flows between government institutions and households in all V4 countries. They are mainly transfers related to pension security, i.e., social security contributions and social security benefits, as well as taxes on income. Over 40% of all income redistribution flows are the general government sector's revenue, while households are the main payers.

The flows of financial instruments take place mainly through the intermediation of financial institutions. In 2020, over 30% of transactions of this type were revenues and expenditures of this sector (50% in Hungary). The role of other sectors is different in the V4 countries. In Poland and Slovakia, the government sector is also an important beneficiary (around 30% of transactions of this type), while in Hungary, the importance of this sector was marginal. In Slovakia, the government sector is also an important financial investor (over 20% of transactions of this type). In Poland and Czechia, household expenditures accounted for approximately 20% of flows. In Czechia and Hungary, transfers between domestic sectors and abroad are particularly significant.

The role of the RoW sector

The expenditure of the rest of the world sector in terms of product transactions is the export of goods and services produced by domestic institutional sectors. In 2020, these expenditures accounted for over 20% of the total supply (see Figure 1). This share increased significantly after joining the EU – by 5 percentage points in Hungary (2020 compared to 2000), by 8 p.p. in Czechia and Slovakia, and by 10 p.p. in Poland. These expenses contributed most to the increase in revenues of the non-financial corporations sector, the main producer of goods and services manufactured for export. In Poland, the share of the household sector is larger

than in the other V4 countries, which means a greater share of micro-enterprises in the economy.

The resources of the rest of the world sector, recorded in the product transaction account, are imports of goods and services that meet intermediate and final demand. In 2020, imports accounted for less than 20% of the supply in Poland, 22% in Czechia, and more than 25% in Slovakia and Hungary (see Figure 1). Compared to 2000, this share increased in each of the countries – by 4–5 p.p. in Poland, Czechia, and Hungary, and by 8% in Slovakia. This growth is lower than in the case of exports, which shows that the trade balances of the V4 countries are improving.

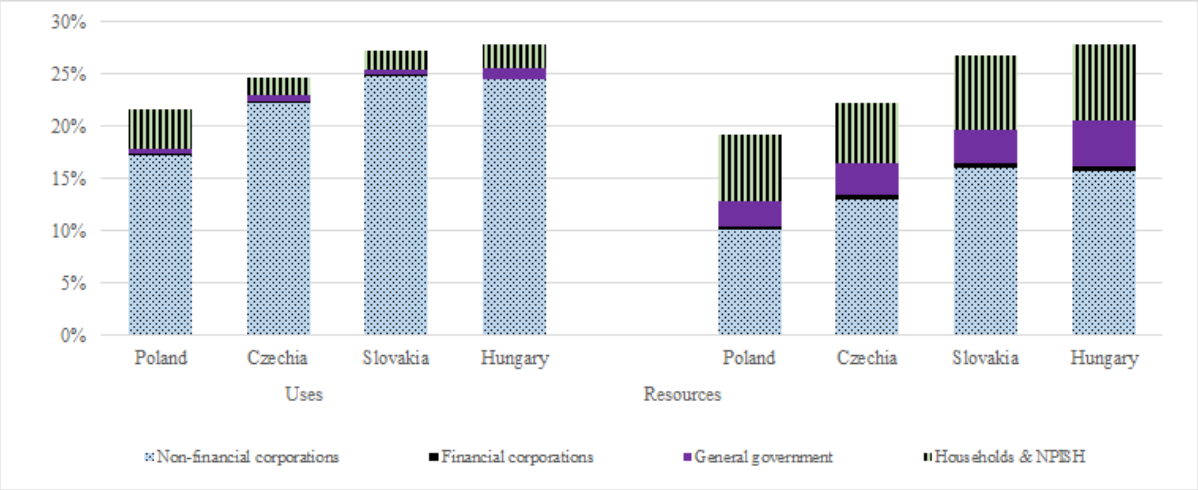

Figure 1. Uses/resources of the rest of the world sector in terms of transactions of products (i = 1, 2, 3, 4) as the resources/uses of domestic institutional sectors (structure in 2020)

Source: own elaborations based on Eurostat database: nasa_10_nf_tr, naio_10_cp15, naio_10_cp1610 (last update: 8.02.2022).

Foreign trade is dominated by the sector of non-financial corporations. This sector's transactions with RoW account for 80–90% of exports and slightly more than 50% of imports. About 30% of imports are expenditures of household sector (mainly final consumption). In Poland, this sector has relatively high share also in exports.

The involvement of RoW in primary income transactions is mainly related to expenditures that constitute household sector income in the form of compensation of employees. This is observed in all V4 countries (see Figure 2). In turn, revenues of RoW are generated mainly by the non-financial corporations sector – mainly property income (distributed income of corporations). The aforementioned strong ties between Hungary's financial sector and the RoW are revealed by, among others, the allocation of primary income account. They mainly concern property income in the form of interest payments and reinvested earnings on direct foreign investment.

Between 2000 and 2020, in each of the analyzed countries, the importance of the rest of the world in the intersectoral flows increased in the area of allocating primary income. Meanwhile, the share of RoW revenues increased more than the share of expenses in the total of transactions of this type.

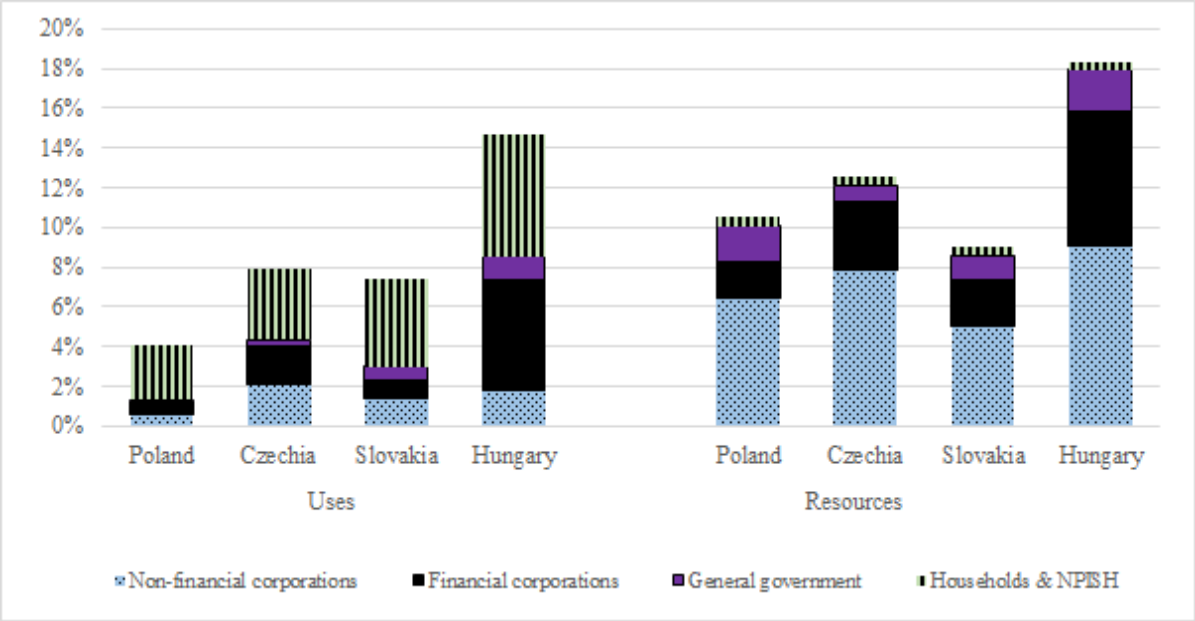

Figure 2. Uses/resources of the rest of the world sector in terms of allocation of primary income (i = 5, 6, 7) as the resources/uses of domestic institutional sectors (structure in 2020)

Source: own elaborations based on Eurostat database: nasa_10_nf_tr (last update: 8.02.2022).

The cross-sectoral structure of flows in terms of current and capital transfers differs significantly in the analyzed countries (see Figure 3). In Hungary, the expenditures of the RoW sector are mainly allocated to households, while in Poland, they are allocated primarily to the government sector (mainly investment grants and miscellaneous current transfers). These transfers play the smallest role in Slovakia, where their balance is negative. The importance of foreign countries in financing investments increased significantly after the V4 countries joined the European Union (EU). In 2020, transfers from RoW accounted for over 75% of investment grants, although in Hungary they were much less – only 42%.

In Poland, transfers from the government sector (mainly VAT and GNI – based EU own resources) dominate. The importance of this sector is also relatively high in Hungary. Czechia, Slovakia, and Hungary are dominated by other current transfers paid by all institutional sectors with different intensities. So, it is difficult to find regularities in the cross-sector structure of RoW revenues.

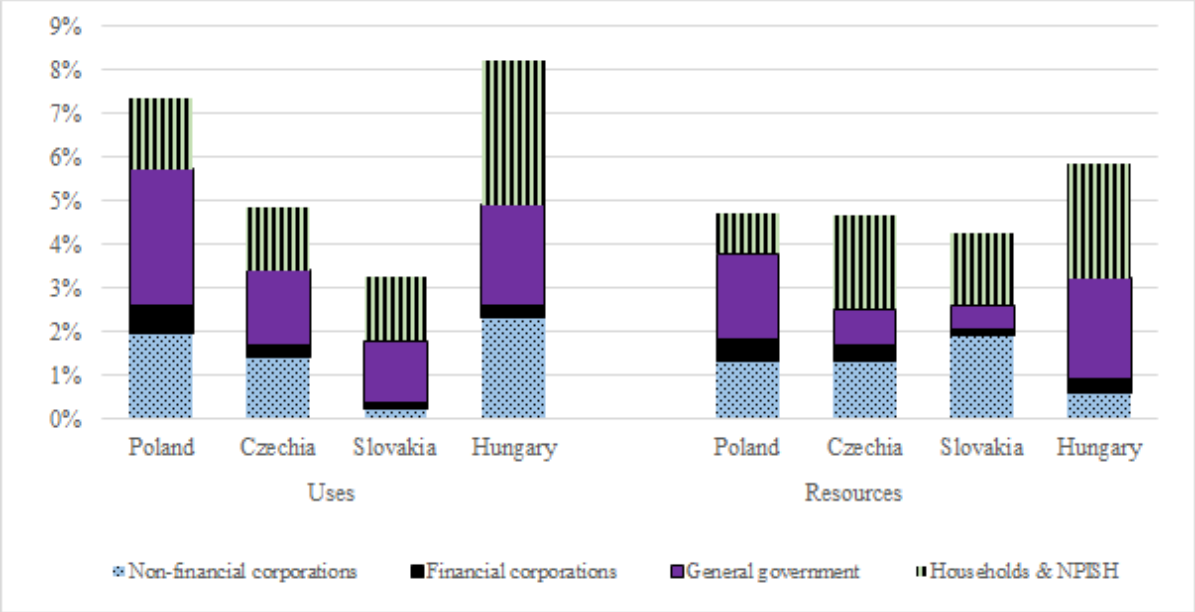

Figure 3. Uses/resources of the rest of the world sector in terms of secondary distribution of income and capital transfers (*i* = 8, ..., 15) as the resources/uses of domestic institutional sectors (structure in 2020)

Source: own elaborations based on Eurostat database: nasa_10_nf_tr (last update: 8.02.2022).

International flows in financial instruments focus on links with the financial corporations sector, and their scope is very volatile over time and space. This is mainly due to the dominance of transactions in terms of equity and their dependence on the situation in the capital markets. As shown in Figure 4, in 2020, financial transactions with foreign countries played a particularly important role in Hungary, accounting for over 40% of all these transactions. It is related to property income flows (see Figure 2). Such a high share results from the particularly high activity of the financial sector (see Table 7), which is a consequence of the high interest of foreign investors. Poland is at the other extreme. RoW expenditure (acquiring financial assets and repaying liabilities) constituted only 8.4% of all financial instrument transfers, of which more than half were purchases of instruments issued by non-financial corporations.

The activity of the financial sector as an issuer was surprisingly low in Poland, resulting in net lending of domestic institutional sectors to the rest of the world. However, 2020 was exceptional. In 2019, the share of foreign expenditure on financial instruments was 14.1%. However, a decreasing tendency is apparent – in 2000, this share was 25.7%, while in 2010, it was 22.0%. In Czechia and Slovakia, RoW expenditure accounted for over 20% of all transfers in financial instruments. In these countries, a relatively large share of the general government can be indicated, resulting from acquiring debt securities issued by this sector. In the case of RoW revenues, only in Czechia do the non-financial sectors play a noticeable role.

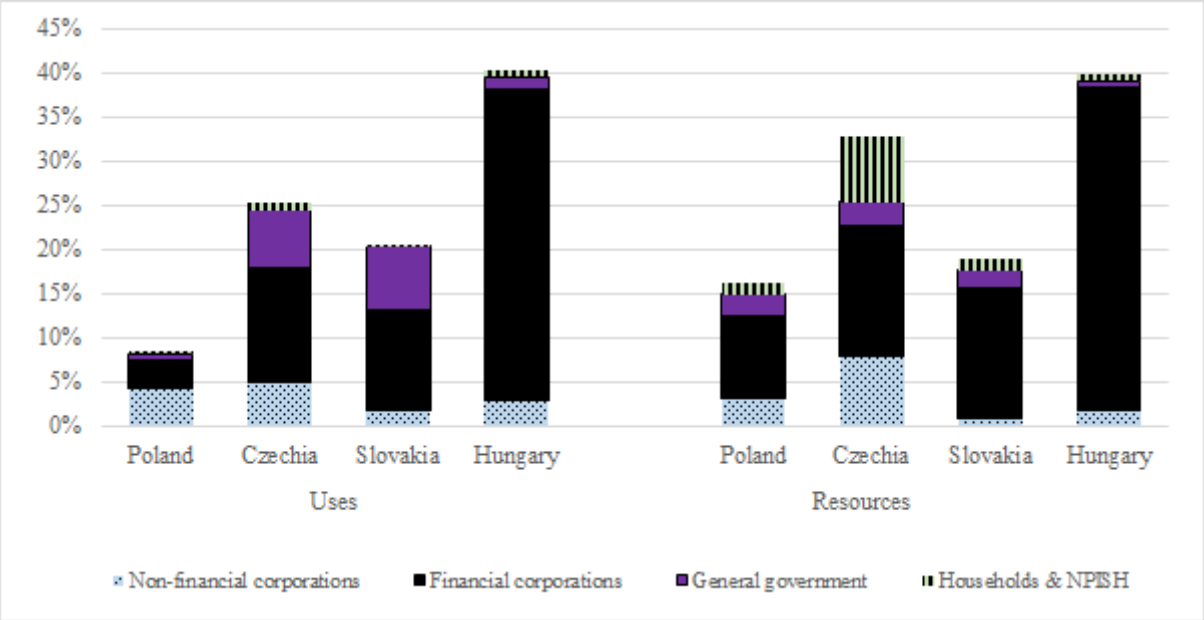

Figure 4. Uses/resources of the rest of the world sector in terms of financial instruments (i = 16, ..., 23) as the resources/uses of domestic institutional sectors (structure in 2020)

Source: own elaborations based on Eurostat database: nasa_10_f_tr (last update: 8.02.2022).

Conclusions

In general, the structures of transactions are very similar in Poland, Czechia and Slovakia. In these countries, the non-financial corporations sector plays a dominant role; the share of the rest of the world sector is also quite significant and negatively correlated with the size of the economy, but currently, it does not exceed 22%. The structure of inter-sectoral links in the Hungarian economy is clearly different. The share of the RoW sector exceeds 30%, and the financial sector (over 23%) dominates the structure of flows between domestic sectors. Transactions between these two sectors account for approx. 16% of all transactions, while in the other V4 countries, it ranges from 0.6% to 2.4%. This difference is also visible when analyzing the generic structure of the transaction. The share of product transactions in Hungary is approx. 20 pp. lower than in other countries. The high degree of financialization of the Hungarian economy is the most striking national characteristic that results from our calculations. The latest analysis of this phenomenon was presented by Piroska (2021) and Karas (2022). However, Hungarian structures are highly volatile, which may result from the low stability of the financial system (capital market in particular). The high involvement of the financial sector in Hungary is a relatively recent phenomenon.

In terms of product transactions, non-financial corporations play the most important role. In Poland, the importance of the household sector in production activity is clearly

greater, which results from the relatively large number of micro-enterprises. Distribution transactions are dominated mainly by general government institutions and households in all V4 countries. Transactions on financial instruments are dominated by the financial corporations sector, but in this case, there is a clear differentiation in the role of other sectors.

The role of RoW in the economies of the V4 countries is growing, and this sector's share in product transactions (exports and imports) between 2000 and 2020 increased by about 5 to 10 p.p., with a slight advantage on the export side, generally improving the foreign trade balance. This upward trend concerns mainly the relationships between RoW and the non-financial corporations sector; it was less noticeable for households. The opening up of economies did not cause a significant increase in the role of consumer imports, but it manifested itself in an increase in involvement in production. This tendency was most pronounced in Poland.

The share of RoW in the allocation of primary incomes also increased, but the share of revenues increased more than the share of expenses. The increase in foreign involvement was mainly due to the increasing mobility of the labor force and transfers related to property income.

The importance of foreign countries in financing accumulation through investment grants and foreign direct investment grew. The latter is visible in transfers of property income and flows of financial instruments.

The cross-sectoral structure of flows in terms of financial instruments, as well as their scope, are very volatile over time and space in the V4. In general, the structures of RoW connections with domestic sectors are very similar in Poland, Czechia and Slovakia. In 2020, in Hungary, the RoW sector's links with financial corporations were much stronger than in other Visegrad countries. The high volatility of these structures may result from the low stability of the financial system (in particular, the capital market) in this country.

The goal of our article has been achieved. The use of a new method of social accounting made it possible to assess the sensitivity of economies to external processes. However, due to the size of the study, we limit ourselves to presenting the results of our calculations and indicating the main observations regarding the structure of inter-sectoral links and their dynamics. An in-depth consideration of the causes of the described processes is beyond the scope of this article due to the word limit.

The developed set of tables may become a starting point for building a model based on the input-output approach, which would make it possible to conduct scenario analyses, in particular, to assess how dependent economies are on the RoW sector. Such research becomes particularly important in the context of analyzing the effects of imposing various types of economic sanctions.

Constructing tables for product transactions disaggregated simultaneously by institutional sector and CPA (Classification of Products by Activity) would significantly increase the cognitive value of simulation analyses. This task requires more extensive activities, preferably involving support from statistical offices.

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Przepływy międzysektorowe w gospodarkach krajów Grupy Wyszehradzkiej

Przedstawiamy studium porównawcze przepływów pomiędzy sektorami instytucjonalnymi w gospodarkach Czech, Węgier, Polski i Słowacji, ze szczególnym uwzględnieniem roli sektora zagranicy. W naszym badaniu staramy się określić siłę i charakter powiązań międzysektorowych w analizowanych krajach oraz wskazać podobieństwa i różnice pomiędzy nimi. Badanie opiera się na sekwencji wszystkich transakcji zawartych w Systemie Rachunków Narodowych (SRN). Są to transakcje produktowe, tworzenie i alokacja dochodów pierwotnych, dystrybucja dochodów oraz transakcje w zakresie instrumentów finansowych. Badanie wyróżnia się spójnością i zbilansowaniem w ramach SRN. Zastosowana metoda transformacji danych do postaci macierzy płatnik-odbiorca gwarantuje zachowanie tych właściwości.

Jest to pierwsze tego typu kompleksowe badanie porównawcze, dostarczające jednoznacznych i powtarzalnych wyników na podstawie ustandaryzowanego systemu rachunkowości, funkcjonującego we wszystkich krajach europejskich.

Okres objęty badaniem (2000–2020) pozwala na wyciągnięcie ciekawych wniosków na temat procesów zachodzących w trakcie i po akcesji do UE. Uzyskane wyniki wskazują m.in. wzrost zaangażowania sektora zagranicy, przede wszystkim w procesy produkcyjne (import, eksport), a także inwestycyjne. Na szczególną uwagę zasługuje wysoki stopień finansjalizacji węgierskiej gospodarki.

Słowa kluczowe: Grupa Wyszehradzka, przepływy finansowe, system rachunków narodowych, sektory instytucjonalne

Appendix – The method of intersectoral flows estimation

The method of transforming the accounts in the transactions-sectors form into intersectoral flows (from-whom-to-whom) is analogous to the method of transforming the supply and use tables into the balance of inter-industry flows of goods and services (Miller and Blair 2009) or assets and liabilities tables (Trębska 2018; Tsujimura and Mizoshita 2003). Constructing the expanded FoF matrix (payer-payee matrix) is a multi-stage estimation procedure.

The first stage is to prepare tables of payments (**P**) and resources (**R**) in the following format, respectively:

$$\mathbf{P}_{m\times n} = \begin{bmatrix} \mathbf{p}_1 \\ \mathbf{p}_2 \\ \cdots \\ \mathbf{p}_m \end{bmatrix}, \quad \mathbf{R}_{m\times n} = \begin{bmatrix} \mathbf{r}_1 \\ \mathbf{r}_2 \\ \cdots \\ \mathbf{r}_m \end{bmatrix}. \tag{1}$$

Each element of matrix $\mathbf{P} = [p_{ij}]$ shows the value of the i-th type of transaction (i = 1, 2, …, m) paid by sector j (j = 1, 2, …, n). In turn, the rows ri of the matrix $\mathbf{R} = [r_{ij}]$ are the vectors showing the resources of sector j in the form an i-th type of transaction.

Two problems arise at this stage. The first problem is that the SNA presents the uses and resources of institutional sectors except for resources from transactions of products. Fortunately, these lacking resources might be determined residually, based on the equality between the sum of all resources ($r_j = \mathbf{i}_m^T \cdot \mathbf{R}$) and uses ($p_j = \mathbf{i}_m^T \cdot \mathbf{P}$) for each institutional sector. In this case, $\sum_{i=1}^{23} r_{ij} = \sum_{i=1}^{23} p_{ij}$ for each j, so the sum of resources from product transactions for each sector j is the difference between the total sum of payments and other resources:

$$\sum_{i=1}^{4} r_{ij} = \sum_{i=1}^{23} p_{ij} - \sum_{i=5}^{23} r_{ij} \quad , \; j = 1,\ldots,5 . \tag{2}$$

Separating the revenues resulting from intermediate consumption and final expenditures requires data recorded on the production account in the institutional sector according to NACE Rev.2, as well as supply and use tables. Cross-classification tables for output $\mathbf{O} = [o_{lj}]$ make it possible to identify which institutional sector (j) carries out a production activity in which industry (l). Unfortunately, these tables are available only for some countries on their national statistical offices' websites. For reasons of availability, this study used data at the section level (l = 1, …, 21). In turn, the elements of matrix Ϙ – co-

efficients $q_{lj} = o_{lj} / \sum_j o_{lj}$ determine the share of output in the *l*-th industry produced by the *j*-th sector.

This information should now be combined with the supply table S, also called the make or output matrix (Miller and Blair 2009, pp. 186–187). It shows the product composition of each industry's output. (S matrix aggregated to 21 industries and products) and makes it possible to determine which products (goods and services) are produced by each institutional sector. The supply table, by product and institutional sector, is the result of the following matrix operation: T = S · Ϙ. Each element t_{hj} (*h* = 1, 2, …, 21 for 21 products) shows the amount of product *h* produced by sector *j*.

Finally, applying use table (U) indicates how much of the output of each product is used to meet intermediate or final demand. Each element t_{hj} is divided into three parts, based on the share of intermediate consumption (1), final consumption and capital formation (2) and exports (3) in the total use of each product.

The transition from the "transaction-by-sector" matrices R and P to the "sector-by-sector" square matrix (payer-payee matrix) requires a sequence of calculations based on R and P:

n-element vectors $\mathbf{d}_i$ showing the shares of resources of sector *j* in terms of the *i*-th transaction ($\mathbf{d}_i \cdot \mathbf{i}_n = 1$):

$$\mathbf{d}_i = \frac{1}{s_i}\mathbf{r}_i,\ i = 1,\ldots,m, \tag{3}$$

where $s_i = \mathbf{p}_i \cdot \mathbf{i}_n = \mathbf{r}_i \cdot \mathbf{i}_n$ is the sum of flows in terms of the *i*-th transaction, $\mathbf{i}_n$ is the summing vector (*n*-element unity column);

n-element vectors $\mathbf{b}_i$:

$$\mathbf{b}_i = \mathbf{p}_i \cdot \hat{\mathbf{z}}^{-1}, \tag{4}$$

where $\hat{\mathbf{z}}$ is a diagonal matrix that consists of elements z_j, which are the sum of resources (equal to the sum of uses) of the *j*-th sector; the given element of vector $\mathbf{b}_i$ shows the share of the *j*-th sector's payments in terms of the *i*-th type of transaction in total uses of sector *j*;

the $n \times n$ matrix $\mathbf{C}_i = [c_{ikj}]$, whose elements show the shares of the *k*-th sector's *i*-th type of resources in z_j:

$$\mathbf{C}_i = \mathbf{d}_i^{\mathrm{T}} \cdot \mathbf{b}_i. \tag{5}$$

Finally, the $n \times n$ matrix $\mathbf{Z}_i = [z_{ii}]$ presents intersectoral financial flows in terms of the *i*-th transaction (see Table 1); each element z_{ikj} reflects the flow of the *i*-th transaction between sectors j and *k*:

$$\mathbf{Z}_i = \mathbf{C}_i \cdot \hat{\mathbf{z}} \,. \tag{6}$$

In the case of non-zero elements y_{ikj} reflecting the flows within the rest of the world sector, which are not recorded in SNA, the RAS method (Miller and Blair, 2009, pp. 276–292) was applied to eliminate them.

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Smart Cities for the Sustainable Development of Local Communities: the Cases of the Volyn Region and the City of Lublin

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Abstract

The concept of a "smart city" is being actively implemented by several European cities to improve citizens' quality of life and sustainability at the local community level. The article evaluates "smart city" programs adopted by Ukraine cities in the Volyn region based on well-being assessment. To do so, a literature review was conducted to identify indicators to assess well-being at the local level, and *Benessere equo e sostenibile dei territori* (BESdT, Equitable, and Sustainable Territorial Well-being) was adopted. BESdT is an institutional measurement framework developed by the Italian National Institute of Statistics (ISTAT) to measure well-being at the local level through a collection of indicators that cover different well-being domains. The BESdT indicators available for Ukraine and Poland were collected and then measured. The main goals of the scientific

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research are to clarify if it is possible to use the BESdT indicators, which are used to assess smart cities in Southern Europe, for the countries of North-Eastern Europe using the example of the Volyn region and the city of Lublin. The work investigates the indicators of smart cities and considers examples of their construction for 2003–2021. The results testify to the upward trend in implementing "smart city" programs in the regional context. In the Volyn region, the priority areas of project implementation are security, transport, and electricity. In this region, development can be identified concerning trends such as a reduced death rate, an improved balance between work and personal life, increased economic prosperity, and the improved environmental component and security of society. On the other hand, a reduction in innovation implementation and a loss of trust in the government were also identified. The analysis shows that the positive changes above are due to the actions of the central rather than the regional government. Based on the analysis, it was established that the countries of North-Eastern Europe have the level of development of Smart City 3.0, except for Ukraine, which has generation 1.0, and in Southern Europe, generation 4.0.

Keywords: smart city, local community, sustainable development, *Benessere equo e sostenibile dei Territori* (BESdT), city budget

JEL: O18, R11

Introduction

Spatial development is based on the principles of balance and sustainability. Research on the problems of sustainable development of settlements, especially cities, is at the core of Sustainable Development Goal 11 (SDG 11) of the UN's Agenda 2030. The philosophy of sustainable development reflects a comprehensive concept of human development, forming new strategic priorities for socio-economic development. The sustainable development of spatial systems, as a form of organization and ensuring high-quality human life, has given the impulse to change approaches and strategies in the development of states, regions, cities, and local communities. The principles set out in "The transformative power of cities for the common good" (The New Leipzig Charter 2020), "Europe 2020 Smart, Sustainable and Inclusive Growth Strategy" (European Commission 2010), and UN Agenda 2030, illustrate approaches to sustainable development in micro-, meso-, macro and mega levels. The conceptual foundations of the city's sustainable development management are based on the guiding principles and regulatory documents of the European Union (EU), namely the Charter of the Congress of Local and Regional Authorities of Europe (Strasbourg 1957), the European Charter for Regional Spatial Planning (Torremolin Charter 1983), the European Charter for Local Government (Strasbourg 1985), the Gothenburg Strategy for Sustainable Development of Europe (Gothenburg 2001), the Leipzig Charter on Sustainable Urban Development (Leipzig 2007), and the Europe 2020 Strategy "Strategy for Smart, Sustainable and Comprehensive Growth" (Brussels 2010).

A characteristic feature of the sustainable development of the city is complexity and interdisciplinarity. The contribution of experts in the development of the concept of sustainable development at the urban level is to develop research that has evolved into separate sectors of knowledge: ecology, the economics of nature, regional economics, spatial economics, innovation economics, social economics, geography, geoeconomics, urban development, and planning. A synergetic approach to studying sustainable development management of city problems makes it possible to identify inter-environmental integration regularities of the self-organization of urban development as a complex socio-economic and ecological system.

The main goals of the scientific research are: 1) establishing the main BESdT indicators to assess the well-being of smart cities; 2) comparing the indicators of Southern Europe on the example of Italy, and North-Eastern Europe on the example of Poland and Ukraine; 3) establishing patterns of smart city development in North-Eastern Europe on the example of the city of Lublin and the cities of the Volyn region. This article studies the BESdT indicators of smart cities for 2003–2021. Specific cases of the development of smart cities of the Volyn region and the city of Lublin were considered for 2018–2021.

Materials and methods

The term "smart city" is a fuzzy concept (Albino, Berardi, and Dangelico 2015, pp. 3–21). Some scholars use it to refer to the implementation of modern technologies at the urban level, e.g., to improve urban traffic and the mobility of inhabitants. However, many who specialize in sustainability research also highlight other important components (see Albino, Berardi, and Dangelico 2015 for a review of the key dimensions of smart cities). According to Mahizhnan (1999), components of developing a "smart city" include IT education, IT infrastructure, IT economy, and quality of life. Most researchers believe that the development of a smart city is determined by human (e.g., qualified labor), infrastructural (e.g., high-tech communications), social (e.g., intensive and open networking) and entrepreneurial (e.g., creative and risky entrepreneurial activity) capital (Kourtit, Nijkamp, and Arribas 2012, pp. 229–246).

Barrionuevo, Berrone, and Ricart (2012, pp. 50–57) offer five types of capital, including economic (GDP, international operations, foreign investment), social (traditions, habits, religion, family), human (talent, innovation, creativity, education), environmental (energy policy, waste and water management, landscape), and institutional (public activity, administrative government, elections). A smart city should be assessed by the quality of life, the level of sustainable economic development, the management of natural resources through inclusion policies, and the ability to achieve economic, social, and environmental goals (Thuzar 2011, pp. 96–100). It is also influenced by the city's economic

and socio-political issues, the economic-techno-social issues of the environment, foreign economic relationships, the use of appropriate tools, international integration, the availability of development programs, and innovation (Nam and Pardo 2011, pp. 282–291). According to Caragliu, Del Bo, and Nijkamp (2011, pp. 65–82), a smart city cannot operate effectively without the following:

1) the use of network infrastructure to increase economic and political efficiency and ensure social, cultural, and urban development; considering the development of urban business; the social integration of different segments of the population through the use of government services;
2) the crucial role of high-tech and creative industries in the long-term urban development strategy; the important role of social and relational capital in the urban development system;
3) social and environmental sustainability as the main strategic component of smart cities.

Several methods and measurement indicators have been developed to assess the smartness of a city (Albino, Berardi, and Dangelico 2015, pp. 3–21).

According to Caragliu, Del Bo, and Nijkamp (2011, pp. 65–82), it is important to develop a measurement system that should include the following seven levels:

- Level 0: Urban component.
- Level 1: Green component.
- Level 2: Component of the relationship.
- Level 3: Component of tools.
- Level 4: Open integration component.
- Level 5: Software component.
- Level 6: Innovative component.

As smartness is a multidimensional concept that deals with sustainability and quality of life at the local level (Huovila, Bosch, and Airaksinen 2019, pp. 141–153), to measure it, we reviewed methods and frameworks proposed in the literature to measure well-being at the local level. We focus on Equitable and Sustainable Well-being (*Benessere Equo e Sostenibile* – BES), a project to measure the quality of life started in 2010 by the Italian Statistics National Institute (ISTAT) and the National Council of Economy and Labour (CNEL). Based on a participatory and inclusive design process, academics, institutions, associations, and citizens developed a well-being framework and an attendant dashboard of indicators (ISTAT 2013). The framework in-

cludes 130 indicators clustered in 12 domains: Health, Education and training, Work and work-life balance, Economic prosperity, Social relationships, Politics and institutions, Security, Subjective well-being, Landscape and cultural heritage, Environment, Innovation, Research and Creativity, and Quality of services (ISTAT 2019). As discussed in Bellantuono et al. (2021, pp. 50–57), alongside assessment at the national level, ISTAT launched a project to measure equitable and sustainable well-being at the province scale, metropolitan areas, and cities (Calcagnini and Perugini 2019, pp. 149–177). In particular, *Benessere Equo e Sostenibile dei Territori* (BESdT) is configured as the BES framework application at a provincial (NUTS3) scale: the BESdT dashboard consists of 61 indicators clustered in 11 domains (the same as BES, but with Subjective Well-being excluded because of the lack of data at the local level). The BESdT indicators (or a subset of indicators) have been adopted to measure well-being in Italy (e.g., Bellantuono et al. 2021, pp. 1576) and other European countries (e.g., Battis-Schinker et al. 2021; Lazar and Litan 2021, pp. 1009–1028).

Expert assessment methods are used to evaluate smart cities (Lombardi et al. 2012, pp. 137–149; Polinkevych 2016a, pp. 421–429; 2016b, pp. 186–190; 2016c, pp. 126–133; 2016d, pp. 191–197; Antoniuk, Koshova 2021), ratings (Giffender et al. 2007), ensuring the local welfare of cities (Fry et al. 2017, pp. 68–76). It is possible to increase the development of local communities through clustering at the regional level (Polinkevych 2014, pp. 254–257), risk management in periods of crises and pandemics (Polinkevych et al. 2021a, pp. 83–98; 2021b, pp. 99–110), regional sustainable development in the EU and Ukraine (Christopherson, Michie, and Tyler 2010, pp. 3–10; Buzko et al. 2019). The effective development of innovation activity at the enterprise level is impossible without increasing state regulation and applying the experience of developed European countries in implementing innovative models of economic development (Polinkevych and Kamiński 2018, pp. 33–40; Trynchuk et al. 2019, pp. 449–461; Glonti et al. 2020, pp. 169–182; Kuzmak, Kuzmak, and Pohrishchuk 2021).

The article aims to evaluate "smart city" programs adopted by Ukraine cities in the Volyn region based on well-being assessment.

The research methodology is based on a literature review, a survey, and a qualitative case study. Scientific publications from the scientometric database were analyzed for the period 2014–2020, reflecting aspects of sustainable development of territorial communities and smart cities. This allowed us to identify specific features of regional development for the Volyn region.

For advanced analysis, we used a case study (reported in Section 4.1), which revealed the features of the development program of smart cities in the cities of Lutsk, Kovel, Kamin-Kashirsky, and Volodymyr-Volynsky. The BESdT indicators, which were adapted for Ukraine, were used to assess the peculiarities of the development of Ukraine in the Volyn

region. The paper adopts methods of generalization and comparison to determine the level of urbanization of the population in the EU and Ukraine. It compares the BESdT indicators and delineates the general place of the region in socio-economic development.

Results

Data analysis

Today Ukraine is a highly urbanized country, with the level of urbanization increasing to 69.6% in 2021 compared to 66.9% in 1989. Urbanization is higher in the EU than in Ukraine, as evidenced by the data in Figure 1.

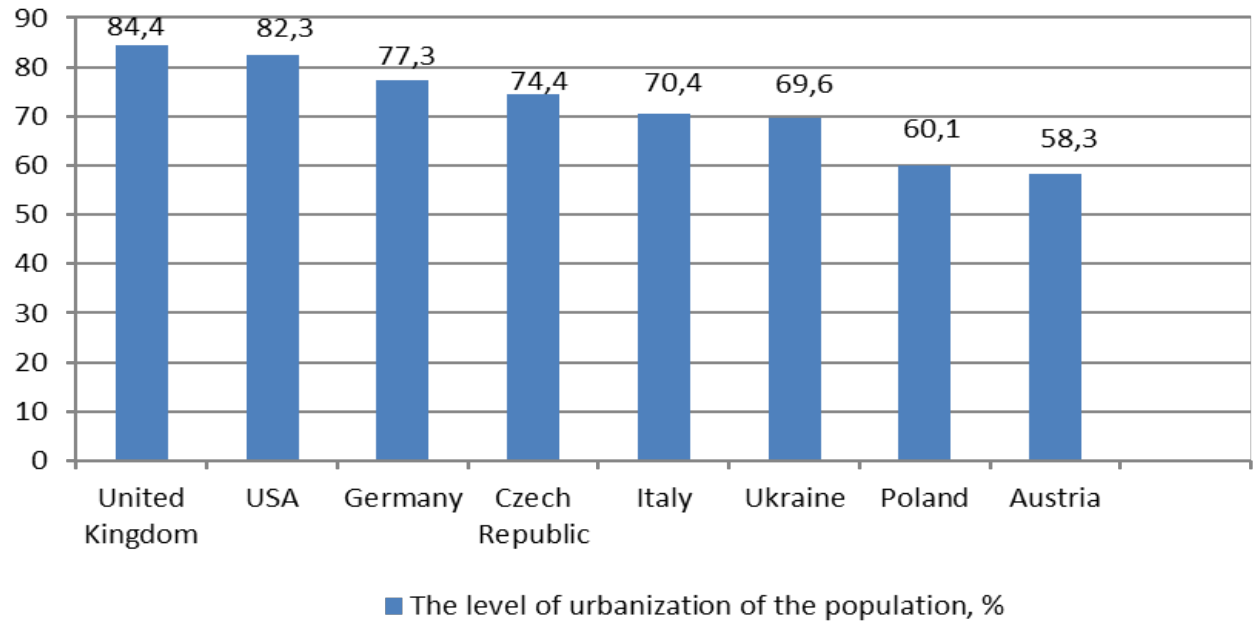

Figure 1. Level of urbanization in the EU and Ukraine in 2021, %

Source: Diia Business. Trade Whit Ukraind n.d.

The Volyn region has a clear European orientation. In comparison, Austria and Poland have less urbanization, at 58.3% and 60.1%, respectively; Italy has 70.4%, the USA – 82.3%, Great Britain – 84.4%, Germany – 77.3%, and the Czech Republic – 74.4%.

Geographically, Ukraine is the largest country in Central-Eastern Europe. However, some researchers do not consider it a country of the Central-Eastern region (Central and Eastern Europe n.d.). The United Nations Group of Experts on Geographical Names (UNGEGN n.d.) listed the following countries as belonging to East-Central and South-Eastern Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Georgia, Greece, Hungary, Montenegro, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia, Europe Turkey and Ukraine (UNGEGN n.d.). Plochii believes that the "New Eastern Europe" should include Ukraine, Belarus,

Moldova, the Baltic countries (according to the CIA World Factbook), and the Caucasus countries (according to the EU Eastern Partnership Program) (Plokhiy 2011). We consider Ukraine to be Eastern Europe, and the level of urbanization in Ukraine does not differ significantly from other countries in Central and Eastern Europe. However, due to the Russian invasion and the aftermath of the COVID–19 pandemic, there are disparities in the development of the regions of Ukraine.

Politicians, at both the national and local levels, need to use BESdT to assess well-being in different areas to better calibrate and monitor the impact of their policies. They should also encourage and facilitate the establishment of subdivisions (working as welfare observatories) in public administration, especially at the regional level, dedicated to identifying specific indicators for the most unstable territories, and measuring and analyzing such indicators over time. Knowledge is required to develop data-focused policies.

Table 1 shows the main BESdT indicators as reported by Bellantuono et al. (2021). However, most BESdT indicators cannot be used in Ukraine due to a lack of data in the State Statistics Service of Ukraine (SSSU) and other institutions. Data can be obtained only for 15 indicators (infant mortality), the employment rate (ages 20–64), paid working days per year (employees), average income per capita, average annual income per employee, capital per capita, non-profit organizations, life expectancy at birth, provincial administrations (collection capacity, losses from municipal water supply, energy from renewable sources, soil sealing, patenting propensity, children who have benefited from municipal childcare services, seats-km offered by local public transport). To consider the full range of indicators, additional statistical surveys would be needed. Accordingly, it is proposed to use the following classes of indicators in Ukraine:

- Class 1. Health, education and teaching: mortality of children under 1 year of age (per 1.000 live births), number of graduates from vocational and higher education institutions.
- Class 2. Balance between work and personal life: the level of the employed population of working age as a % of the population of the corresponding age group.
- Class 3. Economic prosperity: GDP per capita, at current prices, UAH million.
- Class 4. Ecology and safety: the amount of disposed waste.
- Class 5. Innovation and quality of services: share of the amount of sold innovative products (goods, services) in the total amount of implemented products (goods, services) of industrial enterprises, %.
- Class 6. Politics and elections: the level of turnout in local elections.

Table 1. Main BESdT indicators in 2021

Indicator	Measurement	Data are available on the SSSU website (Y = Yes/N = No) (Ukraine)	Data are available on the GUS website (Y = Yes/N = No) (Poland)
Domain 1 – Health			
Life expectancy at birth	Average number of years	Y	Y
Infant mortality	Cases per 1000 live births	Y	Y
Road Traffic Accident Deaths (age 15–34)	Cases per 10.000 residents	N	Y
Mortality due to tumor (age 20–64)	Cases per 10.000 residents	N	Y
Mortality due to dementia and nervous system diseases (65+)	Cases per 10.000 residents	N	N
Number of indicators	5	2	4
Domain 2 – Education and training			
Persons with at least a diploma (age 25–64)	Percentages	N	Y
Graduates and other tertiary titles (25–39 anni)	Percentages	N	N (generally without outlining the years)
Transition to University	Percentages	N	Y
Neet (young people who are not in education, employment or training)	Percentages	N	Y (15–29 years)
Participation in lifelong learning	Percentages	N	Y
Literacy skills of students	Percentages	N	Y
Numeracy skills of students	Percentages	N	Y
Number of indicators	7	0	6
Domain 3 – Work and work-life balance			
Employment rate (age 20–64)	Percentages	Y	N (15–89 years)
Rate of non-participation in work	Percentages	N	Y
Rate of fatal accidents and permanent disability	Cases per 10.000 workers	N	Y
Rate of youth employment (age 15–29)	Percentages	N	N
Rate of youth non-participation in work (age 15–29)	Percentages	N	Y
Paid working days per year (employees)	Percentages	Y	Y

Indicator	Measurement	Data are available on the SSSU website (Y = Yes/N = No) (Ukraine)	Data are available on the GUS website (Y = Yes/N = No) (Poland)
Number of indicators	6	2	4
Domain 4 – Economic prosperity			
Average income per head	Euro	Y (UAH)	Y
Average annual income per employee	Euro	Y (UAH)	Y
Average annual pension income per capita	Euro	N	Y
Pensioners with low pension	Percentages	N	Y
Capital per capita	Euro	Y (UAH)	Y
Rate of bank loans non-performing entries to households	Percentages	N	Y
Number of indicators	6	3	6
Domain 5 – Social relationships			
Average annual pension income per capita	euros	N	Y
Non-profit organizations	Organizations per 10.000 residents	Y	Y
Accessible Schools	Percentages	N	Y
Number of indicators	3	1	3
Domain 6 – Politics and institutions			
Voter turnout (European Elections)	Percentages	N	Y
Voter turnout (Regional Elections)	Percentages	N	Y
Female city managers	Percentages	N	Y
Under 40 city managers	Percentages	N	N
Detention centers crowding	Percentages	N	Y
Municipalities: collection capacity	Percentages	N	N
Provincial Administrations: collection capacity	Percentages	Y	Y
Number of indicators	7	1	5
Domain 7 – Security			
Murders	Cases per 100.000 residents	N	Y

Indicator	Measurement	Data are available on the SSSU website (Y = Yes/N = No) (Ukraine)	Data are available on the GUS website (Y = Yes/N = No) (Poland)
Other reported violent crimes	Cases per 100.000 residents	N	Y
Reported widespread crimes	Cases per 100.000 residents	N	Y
Road mortality in suburban areas	Percentages	N	Y
Number of indicators	4	0	4
Domain 8 – Landscape and cultural heritage			
Density and Relevance of Museums Heritage	Standardized rate per 100 km^2	N	Y
Diffusion of tourist farmhouses	Standardized rate per 100 km^2	N	Y
Density of historic gardens	Standardized rate per 100 m^2	N	Y
Number of indicators	3	0	3
Domain 9 – Environment			
Losses from municipal water supply	Percentages	Y	Y
Disposal of municipal waste to landfill	Percentages	N	Y
Urban air quality – PM10	Percentages	N	Y
Urban air quality – Nitrogen Dioxide	Percentages	N	Y
Urban green spaces	m^2 per resident	N	Y
Energy from renewable sources	Percentages	N	Y
Separate collection of municipal waste	Percentages	N	Y
Soil sealing	Percentages	Y	Y
Number of indicators	8	3	8
Domain 10 – Innovation, research and creativity			
Patenting propensity	Patents per 1,000,000 residents	Y	Y
Employees in cultural companies	Employees per 1000 graduate residents	N	Y
Mobility of young Italian graduates (age 25–39)	Percentages	N	N (20–29 years)
Number of indicators	3	1	2
Domain 11 – Quality of services			
Children who have benefited from municipal childcare services	Percentages	Y	Y

Indicator	Measurement	Data are available on the SSSU website (Y = Yes/N = No) (Ukraine)	Data are available on the GUS website (Y = Yes/N = No) (Poland)
Irregularities in electricity supply	Average number of irregularities per user	N	Y
Seats-km offered by local public transport	Seats-km per resident	Y	Y
Hospital emigration to another region	Percentages	N	N
Number of indicators	4	2	3
Total	56	15	48

Source: Bellantuono et al. 2021.

In the rest of the section, we first present information on the Volyn Region and Lublin, and then we identify and measure the available BESdT indicators for the region.

Volyn case study

Based on the socio-economic development of Ukrainian regions, Volyn ranked 19th out of 24 in 2021, while the city of Kyiv was 17th (in 2020), indicating a weak position in socio-economic development. Based on the level of investment and foreign economic activity, Volyn ranks 25th; it is 24th in the labor market, 20th in the consumer market, and 19th in terms of economic development. Accordingly, Volyn is an outsider in the development of these indicators (Figure 2).

The Volyn region is a western region of Ukraine characterized by the following:

1. It does not have a stable tradition of open political processes due to historical preconditions;
2. Any positive changes in the region are not due to its internal self-development but to the actions of the central government;
3. Centralism, which stands in the way of the authorities forming public policy, is no less concerning to political organizations;
4. Public organizations and business structures are ineffective. Their leaders consider them primarily tools to satisfy personal interests rather than self-sufficient structures that can positively influence the political system of the country.

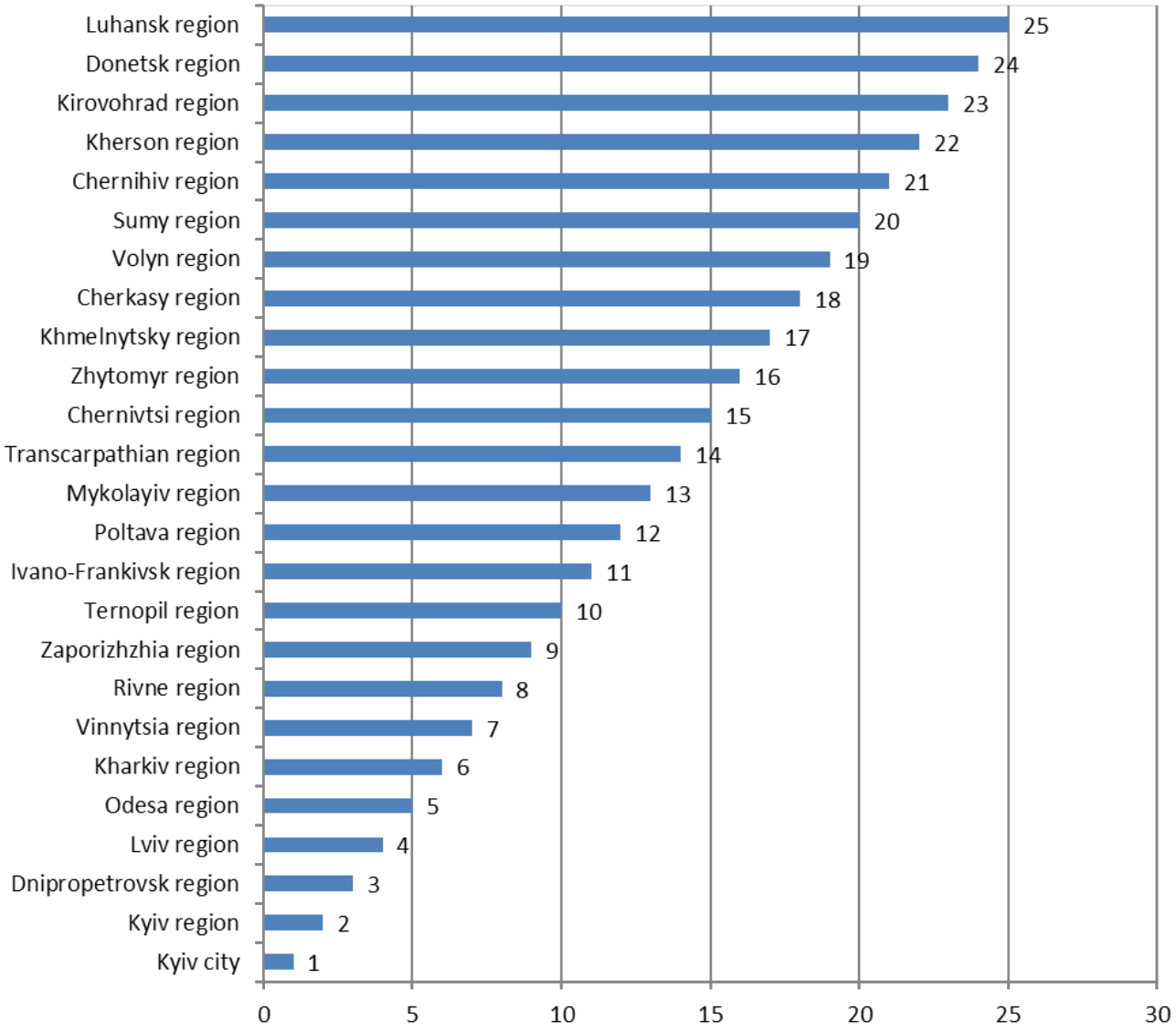

Figure 2. The overall place of the region in socio-economic development in 2021

Source: *Monitoring of socio-economic development of the regions of Ukraine* 2021.

Volyn has a clear European orientation. It participates in the Border Cooperation Program "Poland–Belarus–Ukraine 2007–2013", implemented as part of the EU under the European Neighborhood and Partnership Instrument. Currently, 32 regional cross-border direction projects with a total cost of €13 million are being implemented in Volyn. The most important projects in terms of socio-economic development of the region were:

1) the construction of a sewerage system in Shatsk, which will largely solve the problem of preserving the ecosystem of the Western Bug River valley in the border areas of Ukraine, Poland, Belarus, and Lake Svityaz (grant for the Ukrainian side: €2.0 million);

2) the construction of a hydrotherapy sanatorium in Gremyachensk village in the Kivertsy district and the purchase of equipment for it (grant for the Ukrainian side: €1.7 million);

3) the construction of 5.3 km of paved municipal roads in three settlements of Zabrodivka village in Ratniv district (grant for the Ukrainian side: €0.5 million);

4) the modernization of zoos in Lutsk and Zamość (grant for the Ukrainian side: €1.4 million);

5) construction of new buildings of the Lutsk City Hospital responsible for treating severe burns by purchasing equipment and medical equipment and through the exchange of knowledge and experience; conducting preventive and explanatory measures among the population (grant for the Ukrainian side: €0.25 million);

6) purchasing the necessary equipment for road maintenance in Shatsk and Wlodaw, preparing an interactive map and installing GPS systems on highways, conducting seminars for employees of organizations responsible for good condition of road infrastructure (grant for the Ukrainian side: €0.4 million);

7) implementing joint measures to increase the investment attractiveness of the cross-border area by establishing a cross-border agency to work with foreign investors (grant for the Ukrainian side: €0.2 million).

The Volyn region is also a participant in 4 infrastructure projects to modernize the state border, which is financed by the EU under the auspices of the Cross-Border Cooperation Program "Poland–Belarus–Ukraine 2007–2013":

1. The reconstruction of the "Ustyluh" international checkpoint for road connections;

2. Provision of new equipment and equipment to border service departments at the "Krakivets," "Shehyn," and "Yagodyn" checkpoints;

3. The development of IT infrastructure of the State Customs and Border Services of Ukraine on the Ukrainian-Polish border.

In total, Volyn received about €25 million from the EU to implement 32 regional and four national projects.

The implementation of the project "Restoration of the reclamation network to promote economic growth in rural areas of Volyn region" within the framework of the EU Program "Support to Regional Development of Ukraine" continues in the region. The EU has provided €1,171,859 in financial support for the implementation of the project.

The main activities of the project include restoring 240 km of reclamation network in 8 villages in the Kovel and Ratniv districts; purchasing equipment to analyze soil, water,

and agricultural products; conducting agrochemical surveys of soils; developing scientifically based recommendations on methods of agricultural management on drained lands; preparing measures to prevent soil degradation in reclaimed areas.

In particular, within the TACIS Program, large-scale projects were implemented, such as the construction of the "Yahodyn" International Road Checkpoint, which included constructing a second bridge over the Western Bug River, and the project "Reconstruction and Expansion of the International Road Checkpoint "Yahodyn" (first phase) on the Ukrainian-Polish border", thanks to which the infrastructure of the exit zone mentioned by international checkpoint was modernized. Between 2009 and 2011, the entrance zone to Ukraine at this border crossing was reconstructed.

Decentralization continues in Ukraine, and united territorial communities are being created. In particular, 39 United Territorial Communities have already been established in 45% of the Volyn region. Volyn is the leader in the number of communities that cover the maximum amount of territory.

In the Volyn region, four districts (rather than 16) were created, namely Volodymyr-Volynsky, Kovel, Kamin-Kashirsky, and Lutsk (Figure 3).

1. Lutsk – formed from the united Rozhysche, Kivertsy, Gorokhiv, and Lutsk districts. Includes 15 territorial communities (351 settlements). Population: 457,300; area: 5,248 square kilometers.
2. Volodymyr-Volynskyi – formed from the united Ivanychivskyi, Lokachynskyi and Volodymyr-Volynskyi districts. Includes 11 territorial communities (201 settlements). Population: 174,700; area: 2,558 square kilometers.
3. Kovel – the largest, formed from the united Turia, Shatsk, Starovyzhiv, Ratniv, Luboml and Kovel districts. It includes 23 territorial communities (380 settlements). Population: 271,000; area: 7,647 square kilometers.
4. Kamin-Kashirsky – formed from the united Manevychi, Lyubeshiv and Kamin-Kashirsky districts. Includes five territorial communities (155 settlements). Population: 132,400; area: 4,693 square kilometers.

Volyn region

Volodymyr-Volynskyi – 174,700 people, Kamin-Kashirsky – 132,400 people, Kovel – 271,000 people, Lutsk – 457,300 people

Figure 3. Areas of Volyn region in 2021

Source: *New rayons: maps and structure* 2020.

The stages of financing the City Comprehensive Program "Safe City of Lutsk" in 2019–2021 are in Figure 4.

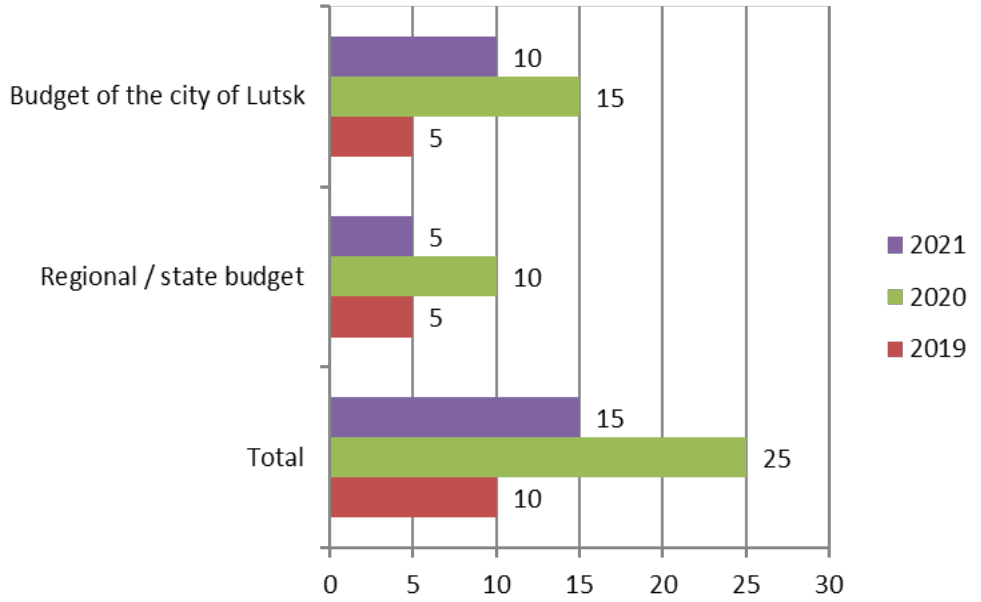

Figure 4. Stages of financing the City Comprehensive Program "Safe City of Lutsk" in 2019–2021, million UAH

Source: official site of Lutsk City Council 2019.

The project provides 50,000 UAH, of which 30,000 UAH is from the city budget and 20,000 UAH is from the state budget. The main technologies to increase security include video surveillance of strategic objects and public places, traffic control, and safety devices with high functional capabilities (alert sensors, police call buttons), technologies of a single fiber-optic network for law enforcement agencies to receive the information, a control center with software and equipment for control, analysis, and emergency prevention, and a system for alerting city residents about potential threats. The program's ultimate goal is to strengthen the security of the city's residents.

The amount of funding by source is given in Table 2.

Table 2. Financing of the City Comprehensive Program "Safe City of Lutsk" in 2019–2021 divided into areas, million hryvnias

Direction of spending within the program "Safe City of Lutsk"	City budget	State budget
Construction of fiber-optic communication lines with the installation of video surveillance cameras, 2019	2.4	4.1
Purchase and installation of software and hardware of intelligent video analytics system, 2019	2.6	0.9
Construction of video surveillance and notification systems in 55 microdistricts, Memorial, 900th Anniversary Park, schools, and educational institutions, 2020	9.0	6.3
Purchase and installation of video surveillance cameras and other elements of the Safe City system on newly built segments (air quality monitoring stations, police call buttons, SMART cameras for recognizing license plates of motor vehicles). Purchase and installation of software and hardware of intelligent video analytics system, 2020	6.0	3.7
Installation of additional SMART-stops in the city. Installation of "smart" boards, "Security Islands" and Alert System, 2021		2.0
Deployment of a video surveillance system in the city's public transport with a connection to the Situation Center		3.0
Construction of a new Crisis Management Center in Lutsk	10.0	
Together	30.0	20.0

Source: official site of Lutsk City Council 2019.

Lviv, Kyiv, and Odesa are also implementing "smart" technologies for remote automatic control of sensors, and data reading systems from metering devices to minimize costs, and with using a GSM communication channel. These technologies were integrated into Municipal Enterprise Lutskvodokanal's wells. It is planned to implement a "live" network management system at the Lutsksvitlo enterprise. This latest technology will be available for use in urban systems within the innovative smart city program.

In 2021, as part of the "Safe City" program, 670,000 UAH was spent installing 14 video surveillance cameras in Kovel at the entrance roads to Kovel, problematic crossroads, and in crowded places. At the Kovel station of the Lviv Railway regional branch, 100,000 UAH was spent installing 11 video cameras. The Safe City program in Kovel was presented in 2018.

In Volodymyr-Volynskyi, the Safe City program has been running since 2016 and includes 60 video surveillance cameras, which have proven their effectiveness.

In Kamen-Kashirskyi, within the Safe City program, it is planned to create a new video surveillance system with 14 cameras that can read vehicle license plates; 547,646 UAH was spent on this in 2022. The system will provide external video surveillance, real-time video streaming from video cameras, data collection and storage, information storage on hard drives, automatic synchronization of local video data with the archive of the centralized platform for collecting and accumulating information, detection of objects such as parked cars, dimensional objects, control and observation of crowds. Also, by the end of 2022, it was intended to renovate the street lighting network in Kamen-Kashyrskyi: installation of new reinforced concrete single-post supports and lighting fixtures, installation of a complete transformer substation, cable laying, and earthing installation; 1,466,975 UAH was to be allocated for these works.

Lublin case study

Lublin is the center of Lubelskie Province in Poland. The idea of a "Smart City" in Lublin and increasing the city's intelligence began with the adoption and implementation of the Lublin 2020 Strategy. It laid the foundations for the creation of the city's own smart development model. In the creation of a smart city 3.0, in which residents jointly create the city and have a real influence on decision-making, preference is given to social projects. This began in 2020, although the first attempts to implement a smart city were in 2016. The signs of the smart city of Lublin are the digitalization of economic, social, political, and administrative activities based on the principle of City as a Platform – CaaP (city geoportal, Lublin 3D, open data, participation portal, Mesh 3D model, point cloud, DMT and NMPT), overcoming transport and environmental problems (hybrid transport, Hajdów Photovoltaic Power Plant, remote reading of water meters, the management of water supply and sewage networks, programs to optimize heat networks, ekoAPP, a participation budget, a green participation budget, CityCard), Lublin virtual library, integrated IT systems for educational institutions, Let's Fix It Platform, free Wi-Fi, and smart city benches (Roman 2018, pp. 138–145).

The city of Lutsk and other cities of the Volyn region are characterized by Smart City 1.0, the signs of which are the development and increase in the number of technology firms and the lack of identified needs for new technological developments,

due to which cities use ready-made information solutions and products. It is important to create a strategy for the transition to Smart City 2.0, in which cities are interested in modern solutions; there are many individual projects on the market. For the countries of North-Eastern Europe, the transition to Smart City 4.0, which is complemented by spatial and technological intelligence with non-standard solutions, is important.

The main indicators of the development of Smart City 3.0 in North-Eastern Europe include more than 100 indicators that determine various aspects of the functioning of the city, grouped into 17 categories: economy, education, environment, finance, transport, energy, recreation, administration, security, waste, telecommunications and innovation, sewage, water and sanitation, health, spatial planning, shelter, and fire safety. Table 6 shows the main indicators of the development of Smart City 3.0 in Lublin.

Table 3. Separate indicators of the development of Smart City 3.0 in Lublin

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
1. Economy						
The level of unemployment, %	7.2	6.2	5.5	5.0	5.6	Employment rate (age 20–64)
Percentage of city residents living in poverty, %	2.88	2.46	2.07	1.69	1.67	
Percentage of people employed full time, %	36.52	36.92	37.4	37.38	37.04	
Unemployment rate among young people, %	8.4	7.6	8.1	8.0	9.0	Rate of youth non-participation in work (age 15–29) Rate of youth employment (age 15–29)
Number of firms per 100,000 population	13,062.68	13,354.72	13,350.13	13,590.99	14,200.82	
Number of new patents per 100,000 population per year	45.23	38.84	36.50	54.45	33.96	Patenting propensity

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
2. Education						
Percentage of girls attending school, %	99.7	99.86	99.83	N/A	N/A	Literacy skills of students Numeracy skills of students
Percentage of pupils who graduated from primary school: completion rate, %	99.9	N/A	N/A	N/A	99.75	
Percentage of pupils who graduated from high school: graduation rate, %	98.15	98.77	N/A	N/A	99.2	
Ratio of the number of school pupils to the number of primary school teachers	8.26	8.90	8.90	8.15	8.12	
Percentage of boys attending school, %	99.8	99.21	99.75	N/A	N/A	
...						
3. Energy						
Total electricity consumption by households per capita, kWh/year	99.98	99.98	99.98	99.948	99.999	Energy from renewable sources
Total energy consumption per capita, kWh/year	2.792	2.821	2.921	2.944	2.874	
...						
4. Environment						
Concentration of NO_2 (nitrogen dioxide).	21.7	21.7	21.6	19.0	17.2	Urban air quality – Nitrogen Dioxide
Concentration of SO_2 (sulfur dioxide)	3.8	5.2	4.8	4.8	4.4	Urban air quality – PM10
...						

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
5. Finances						
Debt service rate (debt service costs as a percentage of the commune's own income), %	2.84	2.89	2.77	2.78	2.16	Capital per capita Rate of bank loans non-performing entries to households (sic)
Capital costs as a percentage of total costs, %	11.76	16.32	20.16	13.81	11.81	
...						
6. Responding to emergency situations						
Number of freelance and volunteer firefighters per 100,000 residents	3.52	3.53	3.53	2.94	3.25	
Response time of the fire department from receiving the first call, min	7:06	7:00	7:00	7:23	7:29	
7. Administration						
Percentage of women employed in municipal administration, %	67.72	68.56	67.74	67.90	67.75	Female city managers
The number of registered voters as a percentage of the voting-age population, %	N/A	97.91	97.43	98.40	98.40	Voter turnout (European Elections) Voter turnout (Regional Elections)
...						
8. Health						
Average lifespan	78.5	78.34	78.1	78.15	77.00	Life expectancy at birth
Number of hospital beds per 100,000 population	1114.94	1130.79	1136.36	1018.29	1171.93	
Mortality under the age of 5 per 1,000 live births	3.5	4.75	6.08	4.15	5.02	Infant mortality
...						

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
9. Recreation						
The number of m^2 of closed public recreation places per resident	0.16	0.17	017	0.17	0.17	
The number of m^2 of outdoor public recreation area per resident	1.65	1.72	174	1.74	1.76	Diffusion of touristic farmhous-es Density of Historic Gardens
...						
10. Security						
The number of crimes against life per 100,000 residents	4.7	2.06	3.53	1.77	2.95	Other re-ported vio-lent crimes Reported widespread crimes
Crimes against prop-erty per 100,000 res-idents	1107.89	1240.55	906.85	892.92	912.03	Murders
...						
11. Shelter						
Percentage of urban residents living in slums, %	0.14	0.12	0.13	0.8	0.9	
The number of home-less people per 100,000 residents	91.93	81.55	N/A	81.52	116.66	
...						
12. Waste						
The total amount of solid household waste collected per capita, tons	0.34	0.35	0.36	0.4	0.4	Separate collection of municipal waste
Percentage of munici-pal solid waste that is recycled, %	9.63	9.28	16.95	17.04	16.52	
...						

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
13. Telecommunications and innovations						
The number of Internet connections per 100,000 residents	28,650	29,196	30,242	29,838	32,004	
...						
14. Transport						
Number of kilometers of high-capacity public transport system per 100,000 residents, km	9.02	12.06	11.31	13.59	13.64	Seats-km offered by local public transport
The number of kilometers of the public transport system per 100,000 residents, km	61.86	65.03	64.77	66,8	66.51	
...						
15. Spatial planning						
Green areas per 100,000 residents, ha	401.57	406.22	408.12	407.05	418.95	Urban green spaces
The annual number of trees planted per 100,000 residents	151.26	285.42	223.74	197.77	593.65	
...						
16. Sewage						
Percentage of city residents who have access to sewerage, %	96.63	96.1	95.95	95.82	95.11	
Percentage of municipal wastewater that has undergone primary treatment, %	100	100	100	100	100	
...						
17. Water and sanitation services						
Percentage of city residents who have access to drinking water, %	96.36	95.84	95.7	94.94	N/A	

Indicator	2016	2017	2018	2019	2020	Indicator BESdT
Total water consumption per person in the household, liters/day	95.62	93.97	94.54	93.15	92.88	
...						

N/A – no data available
Source: Smart City Lublin n.d.

Comparing Tables 1 and 2, it can be concluded that only some of the indicators from the proposed BESdT indicators used in Southern Europe (Italy) are calculated in Lublin. However, as evidenced by the data in Table 1, 48 of the proposed indicators can be calculated for cities in Eastern Europe.

BESdT assessment

BESdT indicators whose data are available for Ukraine are reported in Table 4.

Table 4. Adapted BESdT indicators for Ukraine in 2003–2021

Indicator (measurement unit)	2003	2008	2019	2020	2021
Class 1. Health, education and teaching					
Mortality of children under 1 year of age (per 1,000 live births)	9.6	10	7	6.7	N/A
Number of graduates from vocational education institutions (1,000 people)	275.6	269.6	124.0	114.1	112.4
Number of graduates from Higher Education Institutions (1,000 people)	579.4	623.3	383.8	386	262
Number of graduates from vocational education institutions and institutions of higher education (1,000 people)	855	892.9	507.8	500.1	374.4
Class 2. Balance between work and personal life					
Level of the employed population of working age as a % of the population of the corresponding age group	64.5	67.3	67.6	55.3	53.9
Class 3. Economic prosperity					
GDP per capita, at current prices (UAH million)	5.801		94.633		N/A
Class 4. Ecology and safety					
Waste disposal rate	2.06	2.50	4.09	4.60	N/A

Indicator (measurement unit)	2003	2008	2019	2020	2021
Class 5. Innovation and quality of services					
Part of the amount of implemented innovative products (goods, services) in the total amount of implemented products (goods, services) of industrial enterprises, (%)	5.8	4.8	1.3	1.9	N/A
Class 6. Politics and elections					
Level of turnout in local elections, (%)	69.3[a]	48.7[b]	46.6[c]	36.9[d]	N/A

[a] 31.03.2002; [b] 31.10.2010; [c] 25.10.2015; [d] 25.10.2020; N/A – no data available
Source: *Local elections in Ukraine…* 2020; Official data of the Main Department of Statistics in Volyn region n.d.; Official data of the State Statistics Service of Ukraine n.d.

Based on Table 3, it can be concluded that the number of graduates of higher education and vocational institutions has decreased rapidly. The working-age employed population also decreased, as did some implemented innovative products and the turnout in local elections. The following indicators achieved a positive trend: mortality of children under one year of age, waste disposal, and GDP per capita.

Table 5 shows the BESdT available indicators are assessed for the Volyn region.

Table 5. Adapted BESdT indicators for the Volyn region in 2003–2021

Indicator	2003	2008	2019	2020	2021
Class 1. Health, education, and teaching					
Mortality of children under 1 year of age (per 1,000 live births)	8.1	7.3	7.5	6.3	N/A
Number of graduates from vocational education institutions, 1,000 people	8	8.2	4.7	4.3	4.2
Number of graduates from Higher Education Institutions, 1,000 people	10.2	7	6.7	6.5	5.6
Number of graduates from vocational education institutions and institutions of higher education, 1,000 persons	18.2	15.2	11.4	10.8	9.8
Class 2. Balance between work and personal life					
The level of the employed population of working age as a % of the population of the corresponding age group	56.7	58.8	50.9	55.8	55.5
Class 3. Economic prosperity					
GDP per capita, at current prices, UAH million	3.339	12.34	73.192	75.193	N/A
Class 4. Ecology and safety					
Waste disposal rate	0.43	0.29	0.18	0.18	N/A

Indicator	2003	2008	2019	2020	2021
Class 5. Innovation and quality of services					
Part of the amount of implemented innovative products (goods, services) in the total amount of implemented products (goods, services) of industrial enterprises, %	N/A	24.7	0.7	1.4	N/A
Class 6. Politics and elections					
Level of turnout in local elections, %	N/A	N/A	55.29[a]	41.89[b]	N/A

[a] 25.10.2015; [b] 25.10.2020; N/A– no data available
Source: *Local elections in Ukraine...* 2020; Official data of the Main Department of Statistics in Volyn region n.d.; Official data of the State Statistics Service of Ukraine n.d.

From Table 4, it can be concluded that in the Volyn region, as in Ukraine as a whole, the number of graduates of higher education and vocational institutions has decreased rapidly, as did the mortality of children under one year. The working-age employed population decreased, as did some implemented innovative products and the level of turnout in local elections. The following indicators achieved a positive trend: waste disposal and GDP per capita. However, voter turnout is higher than the average data in Ukraine. In 2008, the implementation of some innovative products was the highest, and exceeded the Ukrainian average for 2008 five-fold. However, in 2019 almost all indicators fell below the national average.

We will compare Poland based on the individual BESdT indicators from 2003–2021 (Table 6).

Table 6. Selected indicators of BESdT for Poland in 2003–2021

Indicator	2003	2008	2019	2020	2021
Domain 1 – Health					
Life expectancy at birth, years	74.6	75.54	77.9	76.6	75.6
Infant mortality (per 1000 live births)	N/A	N/A	3.180	3.089	2.996
Domain 2 – Education and training					
Neet (young people who are not in education, employment or training), %	N/A	N/A	17.7	19.4	16.9 (women)
Literacy skills of students, %	N/A	N/A	99.8	99.8	99.8
Domain 3 – Work and work-life balance					
Rate of fatal accident and permanent disability, cases per 1,000 workers	N/A	N/A	N/A	4.62	5.1

Indicator	2003	2008	2019	2020	2021
Domain 4 – Economic prosperity					
Average income per head, PLN	N/A	1,046	1,819	1,919	2,062
Domain 6 – Politics and institutions					
Murders, number of cases	1,039	759	524	641	625
...					
Domain 9 – Environment					
Urban air quality – PM10	N/A	N/A	31.0	13.1	20.0
Domain 10 – Innovation, research and creativity					
Patent proposal, number of cases			3,946	4,058	3,430
Domain 11 – Quality of services					
Children who have benefited from municipal childcare services (up to 3 years), persons	N/A	N/A	143,574	142,355	163,416

N/A – no data available
Source: European Environment Agency n.d.; Global Data n.d.; GUS n.d.; Macrotrends n.d.; Nałęcz n.d.; Patent Office of the Republic of Poland n.d.; *Ilość zabójstw w Polsce...* 2020; GUS 2022; Rudke 2022; Eurostat 2023.

The table shows that in Poland and Ukraine, life expectancy in 2021 decreased to 75.6 years, the number of patents decreased to 3,430 units, and child mortality decreased. The development and implementation of Smart City strategies can be an impetus for development both in Poland and Ukraine.

Conclusions

The four generations of smart cities differ in density and use of digital technologies. Southern Europe has implemented Smart City 4.0. However, like some EU member states, Eastern Europe is developing and implementing strategies for third-generation smart cities. Meanwhile, other Eastern European cities still implement the Smart City 1.0 strategy. Such cities include the cities of Ukraine. The paper has established that about 48 BESdT indicators for assessing the well-being of smart cities can be used for the cities of Eastern Europe, using the example of Lublin. However, Lublin uses a different system to evaluate Smart City 3.0. In particular, it uses 110 indicators that are combined into 17 groups. Using the Italian methodology, it was established that out of the 48 indicators in Poland, 24 indicators were calculated. The other half can be calculated based on statistical data.

The differences in evaluation methods are primarily related to the difference in generations of smart cities. Since smart cities in Ukraine are of the first generation, it is

possible to calculate only 15 of the indicators proposed by the BESdT methodology. The smart city program in Lutsk, Volodymyr-Volynskyi, Kamin-Kashyrskyi, and Kovel provides the implementation of mobile projects that ensure the safety of citizens and make a convenient urban transport system. In Lutsk, "smart city" applies to economies and the introduction of "living" network management systems. However, they do not have projects that fully comply with the concept of a "smart place": 1) management – the introduction of technology in policy and strategy, e-office, and open self-government; 2) the economy (entrepreneurship and innovation) – finding solutions to stimulate entrepreneurship and innovation, and increase labor productivity and the communication of local and global markets; 3) the way of life of society – the interaction of people in society and the search for solutions in interaction; 4) human capital (creativity and innovation) – the formation of citizens' ingenuity and creativity; 5) education – investments in education and knowledge, including the education of the elderly and entrepreneurship education; 6) mobility – integrated transport system, ICT and support for environmentally friendly transport; 7) infrastructure – infrastructure solutions and technologies; 8) environment – sustainable development of the city through proper resource management, investment in green technologies, public and pedestrian transport.

The implementation of Smart City programs in Ukraine should occur by integrating technologies in energy, water supply, sewerage, transport, a city security system, medicine, and education. Smart technologies increase security by controlling and preventing possible risks in these areas. These processes are implemented together with the process of decentralization and the formation of a new structure of territorial communities.

To evaluate the smart city programs adopted by cities in the Volyn region based on well-being assessment, we used BESdT indicators (ISTAT 2019). However, considering the availability of data in the State Statistics Service of Ukraine, not all of them can be measured. Of the 55 proposed indicators, data can be obtained for only seven (infant mortality, the employment rate (ages 20–64), paid working days per year (employees), average income per capita, average annual income per employee, capital per capita, and the number of non-profit organizations). These indicators were used to assess smart city programs in developing territorial communities.

Analysis of BESdT indicators, which are adapted for Ukraine, showed the following trends:

1. A reduction in mortality rates among the population of Ukraine and Volyn region, improved health, and fewer graduates, but this is not related to the level of education and studying;
2. Imbalances in the relationship between work and personal life. Most Ukrainians of working age prefer to work abroad or rely on self-employment in subsidiary farms;

3. Increased economic prosperity, as indicated by the growth of GDP (GRP) per capita;
4. An improvement in the environmental component and security of society in the regional context;
5. Less innovation implementation in enterprises. The implementation of innovative products decreased in 2020 compared to 2018 by five times in the Volyn region;
6. A lower turnout in elections, which indicates a loss of confidence in the government. However, in the Volyn region, trust in the regional context is quite high;
7. Volyn region does not have a stable tradition of open political processes due to historical preconditions;
8. The positive changes in the Volyn region are not due to its internal self-development, but the actions of the central government, and centralism that applies to all spheres of activity;
9. Public organizations and business structures in the Volyn region are inefficient due to the lack of a single vector of development.

The vector of development and balancing the interests of public organizations, businesses and local authorities is the policy of reforming the territorial organization and creating four districts, the centers of which will become "smart" cities. Such an approach will accelerate the implementation of innovative products and revive the business reputation and welfare of local communities.

It is important to develop a unified methodology for assessing the well-being of smart cities of generations 1.0, 2.0, 3.0, and 4.0. The point of choosing indicators and conditions of their application is debatable. In further research, it would be worth paying attention to the BESdT indicators, which can be grouped into four blocks depending on the generation of Smart City.

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Inteligentne miasta dla zrównoważonego rozwoju społeczności lokalnych na przykładzie Wołynia i miasta Lublin

Koncepcja „inteligentnego miasta" jest aktywnie wdrażana przez kilka europejskich miast w celu poprawy jakości życia obywateli i zrównoważonego rozwoju na poziomie społeczności lokalnych. Celem artykułu jest ocena programów „smart city" przyjętych przez ukraińskie miasta na Wołyniu na podstawie oceny ich dobrostanu. W tym celu dokonano przeglądu literatury w celu zidentyfikowania wskaźników służących do oceny dobrostanu na poziomie lokalnym i przyjęto podejście *Benessere equo e sostenibile dei Territori* (BESdT, Sprawiedliwy i trwały dobrobyt obszarów). BESdT to instytucjonalne ramy pomiarowe opracowane przez Włoski Narodowy Instytut Statystyczny (ISTAT), mające na celu pomiar dobrostanu na poziomie lokalnym poprzez zbiór wskaźników obejmujących różne obszary dobrostanu. Wskaźniki BESdT dostępne dla Ukrainy i Polski zostały zebrane, a następnie zmierzone. Głównym celem badania jest wyjaśnienie możliwości wykorzystania wskaźników BESdT w ocenie inteligentnych miast w Europie Południowej dla krajów Europy Północno-Wschodniej na przykładzie Wołynia i miasta Lublin. W pracy przeanalizowano wskaźniki inteligentnych miast i przykłady ich rozbudowy w latach 2003–2021. Wyniki świadczą o tendencji wzrostowej w realizacji programów „inteligentnych miast" w kontekście regionalnym. Na Wołyniu priorytetowymi obszarami realizacji projektu są bezpieczeństwo, transport i energia elektryczna. W regionie tym można wyróżnić takie tendencje, jak zmniejszenie śmiertelności ludności, poprawa równowagi między pracą a życiem osobistym, wzrost dobrobytu gospodarczego

oraz poprawa komponentu środowiskowego i bezpieczeństwa społeczeństwa. Z drugiej strony zidentyfikowano również zmniejszenie wdrażania innowacji i utratę zaufania do władz. Z analizy wynika, że pozytywne zmiany, o których mowa powyżej, wydają się wynikać z działań władzy centralnej, a nie regionalnej. Na podstawie analizy ustalono, że kraje Europy Północno-Wschodniej wykazują poziom rozwoju inteligentnych miast Smart City 3.0, z wyjątkiem Ukrainy z poziomem rozwoju Smart City generacji 1.0 i Europy Południowej z poziomem rozwoju Smart City generacji 4.0.

Słowa kluczowe: inteligentne miasto, społeczność lokalna, zrównoważony rozwój, *Benessere equo e sostenibile dei Territori* (BESdT), budżet miasta

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Poverty in Selected European Countries A Spatio-temporal Analysis from 2003–2020

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Abstract

The problem of poverty, both in theory and practice, gained a new meaning with the beginning of the transformation of selected European economies from being centrally planned to market economies. The transition and the accompanying ownership changes resulted in significant shifts in the income distribution, which affected the increase in the stratification of society in terms of material situation and the deterioration of the living conditions of some social groups. Developing and evaluating anti-poverty programs should be preceded by identifying who is considered poor. Defining poverty is the first and a key step in measuring its characteristics, e.g., its intensity. Hence, the choice of a specific definition of poverty is of fundamental importance for the results of this measurement. The aim of the paper is to assess the material situation of European societies in terms of poverty change in a holistic approach – considering all the information available in international statistics on the problem. To achieve the research objective at the regional data level, we used the URi measure to decompose changes in structure and estimate the direction and intensity of poverty recorded. Further, we evaluated whether the transformations coincide temporarily and spatially. Applying the Hellinger distance (HD) allowed us to identify the significance of trends in changes in the poverty structure, especially in the years of the COVID–19 pandemic, when an increase in the importance of individual structural components of poverty was observed in the analysed European NUTS–2 spatial units. For some economies, the transition was also a consequence of European economic crises or major events of international importance, e.g., sports events or countries acceding to the EU.

Keywords: poverty, deprivation, spatial similarity, structural changes

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Introduction and literature review

The United Nations defines poverty as a reduction in choice and life chances, which is perceived as a violation of human dignity. It means that people are unable to participate effectively in society. It also indicates a scarcity of food and clothes that a family needs, no possibility to go to school or use health services, and no access to land to farm or work to earn and meet a living standard. Poverty also hides within powerlessness and exclusion of individuals, families and communities. It denotes a vulnerability to violence and is often associated with precarious living conditions without access to clean water and sanitation (Hunt, Nowak, and Osmai 2004, pp. 13–19).

The most common measurement of poverty is to establish a line (known as a poverty line) in terms of household income or expenditure. Then, any person or household with comparable income or expenses (expressed *per* equivalent person) lower than this limit is considered poor (or in poverty). Much of the discussion about measuring poverty has focused on defining the poverty line. In the past, there were problems with defining income – should it be disposable or gross/net, expressed in monetary or physical units, counted per day, month, year, etc. (Spicker 2007; 2012).

Equivalence scales were used to determine comparability between households, i.e., the second person and subsequent people are less important in the household. Further, how should income be distributed within a household, assuming that there is no inequality in this dimension? Should additional statistical indicators be considered in relation to the overall number of poor people and their share in the population, or the expenditure gap, which estimates the depth of poverty (Jewczak and Korczak 2019)?

White (2002) claims that poverty is defined and assessed from the perspectives of quantitative and qualitative approaches. In the quantitative approach, individuals consider themselves poor when their standard of living falls below the poverty line. It can be determined based on a certain minimum income level or household expenditure for basic needs or other desires of everyday life. From a qualitative perspective, the poor are individuals who define what they understand by poverty or being in poverty. It broadens the significance of poverty and connects it with deprivation caused by other factors, not necessarily in the material sense, expressed by the level of missing income or consumption (Saltkjel and Malmberg-Heimonen 2017). This is in line with the theory that income poverty does not consider aspects connected to well-being (Dhongde, Pattanaik, and Xu 2019). On the one hand, they are important for those who claim to be in poverty, but on the other, they are non-monetary determinants such as housing status or access to services.

Myck, Najsztub, and Oczkowska (2015) believe it is necessary to include other dimensions of poverty. They propose expanding material deprivation, which is perceived as

a primary variable that represents poverty. It illustrates the proportion of the population that cannot afford at least four of the nine predefined material needs that most people consider desirable or even necessary to lead a decent life. It covers indicators of items related to participating in everyday life or social activity, age, work intensity, and disposable income. This is convergent with Sen's concept of abilities and functioning (Sen 1976), in which attention was paid to the multidimensionality of human needs and that fulfilling these needs depends on external conditions. The deprivation indicators were primarily aimed at identifying those conditions that make it impossible to meet the various needs of people.

Townsend (1987) defined deprivation as the lack of access to opportunities and resources seen as common in each society. He further distinguished two types of deprivation, i.e., material and social. The former focuses on access to resources and services, but also on environmental conditions that allow a decent standard of living. The latter, on the other hand, refers to an individual's ability to participate fully in the life of the community. Sowell (2016) claims that it is necessary to define the surroundings/environment in which society, a household or individuals exist. It is possible to indicate both the environment, understood as socio-economic or geographic conditions, as well as historical experiences that societies accumulated over time. This leads to the conclusion that influence on the processes occurring in one spatial object is not a result of geographic and non-geographic determinants separately, but a consequence of interactions between them, both inside the unit and between neighbouring facilities. This is in line with Tobler's (1970) First Law of Geography. In this approach, what seems crucial for one unit will not necessarily have a similar effect in other locations of even one economic and social system. Therefore, the proposed approach introduces a lower level of spatial data aggregation, as the tendencies/impacts observed for a phenomenon at the national level are not always consistent with the local/regional level (Suchecki 2010; Krzysztofik et al. 2017).

The considerations demonstrate that poverty is a multifaceted issue. Depending on the research methodology, which determines when a person/household is viewed as poor, it is possible to obtain an ambiguous poverty indicator. It was possible to assess the overall transformation of the structure of poverty by not focusing on only one poverty criterion (income or unmet needs) and by taking advantage of all the circumstances when a person/household is considered poor or living in poverty.

The study assesses the significance of individual components of poverty in terms of its structure between 2003 and 2020. To this end, a measure of the decomposition of changes in structure (*URi*) is proposed, which made it possible to estimate the intensity of changes both in terms of direction and value. Compared to other research on poverty, which mainly focuses on one indicator (see, e.g. Spicker 2012; Saunders 2013), this study uniquely broadens the scope of interest by considering all the aspects of poverty available in in-

ternational statistics. Then, using the Hellinger distance (*HD*), the similarity/differences in the distribution of the changes in the poverty level among selected European NUTS–2 regions were assessed, with emphasis on global turbulences such as the COVID–19 pandemic. The combination of the analysis of structural changes over time for individual components that describe a given aspect of poverty with an assessment of changes in distributions makes this study exceptional. In this way, it was possible to verify the actual impact of the pandemic on the poor in Europe, with special attention to the lower level of spatial data aggregation.

Data and methods

The source of statistical data on poverty categories by NUTS–2 regions was Eurostat. For the analysis, only complete records for the selected period were used; thus, some NUTS–2 spatial units had to be considered "no data available". They are not, as it may seem from the graphic visualisations presented later in the paper, "unimportant areas". The selection of objects to be investigated was, therefore, intentional and dependent on the complete availability of records in the Eurostat database. Overall, the number of spatial NUTS–2 units selected was 253 regions, which allows the analysis to be considered quite detailed and, in its completeness, in some way exceptional.

The evaluation of poverty in European NUTS–2 regions in the selected years was described by a set of variables that illustrate most aspects related to poverty. The dataset consisted of different poverty concepts described and defined in the Europa 2020 strategic documents (COM 2010), such as:

- overall poverty rate – the share of people with an equivalent disposable income (including social transfer) below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalent disposable income after social transfers;
- severe material deprivation rate – a proportion of the population who experience an enforced lack of at least four of the nine deprivation items (i.e., ability to pay their rent, mortgage, or utility bills; keep their home adequately warm; face unexpected expenses; eat meat or protein regularly; go on holiday; have a television; be equipped with a washing machine; own a car; use a telephone);
- the share of people aged up to 59 years living in households with very low work intensity – defined as the number of people living in a household where the members of working age worked a time equal to or less than 20% of their total work-time potential during the previous year;
- the share of people at risk of poverty or social exclusion – the share of people with an equivalent disposable income before social transfers that is below the at-risk-of-pov-

erty threshold calculated after social transfers. This concept is related to minimum social standards and a relative understanding of poverty.

The structure is then a computational effect that exists only as a result of comparing parts with the whole, which could indicate the shape of a complex phenomenon. The values of the elements of a structure define its size. For a non-trivial structure to exist, at least two components are needed.

Because the data set consisted of determinants describing poverty that focus on different perspectives, to capture the changes in the structure and to identify the tendencies in the poverty level, the data was first reduced to a common denominator. Here the technique for structural changes was introduced. The concept of structure can be used in two ways. Firstly, it is a configuration of points in a multidimensional space. Secondly, it is a sequence of non-negative numbers summing up to unity – it is in this sense that we consider structure in the research. For comparing structures in two objects (or periods), following Markowska (2016), the measure of the share of structural components was used, which can be defined as:

$$UR_i = \frac{x_{2i} - x_{1i}}{\sum_{i=1}^{m} |x_{2i} - x_{1i}|}, \tag{1}$$

where:

- i – the structural component number,
- m – the number of structural components,
- x_{1i} – the value of the i-th structural component in the first moment/period,
- x_{2i} – the value of the i-th structural component in the second moment/period.

The total value of decomposition measure UR_i modules is equal to one, while the sign shows whether the value of a given structure element has increased (positive value) or decreased (negative value). In that matter, the UR_i makes it possible to define a component's contribution to overall changes in the phenomenon.

When assessing changes in the structure, three possibilities should be expected: stabilisation or an increase or decrease in the share of a given element(s) in the total sum. However, there are several variants for each of these possibilities. For two components of the structure (e.g., employed/unemployed), the result of the assessment of changes that indicates the stabilisation of the structure may result from the lack of changes in both components, but also from the simultaneous increase (and decrease) of both components by a relatively equal value. That was the motivation to investigate the trends, assess the structural decomposition by applying the UR_i measure, and compare the structural changes in terms of the distributions in the NUTS–2 regions using the Hellinger distance.

The Hellinger distance measures the distance between two discrete probability distributions, let us say p_1 and p_2 – distributions that are contained in the space of probability distributions common to them. The Hellinger distance is defined as follows:

$$HD(V_1,V_2)=\sqrt{\frac{1}{2}\sum_{i=1}^{K}\left(\sqrt{\frac{n_{1i}}{N_1}}-\sqrt{\frac{n_{2i}}{N_2}}\right)^2}, \tag{2}$$

where:

- V_1 and V_2 are comparable 1st and 2nd data sets,
- K is the parameter of the total number of valid fields in the contingency table,
- n_{1i} and n_{2i} are the frequencies of the i-th field in the 1st and 2nd data sets, respectively,
- N_1 and N_2 are the total sizes of the data sets.

The Hellinger distance is a metric in the space of probability distributions that takes values between zero and unity and is used to measure the degree of similarity between two distributions. When the distance equals 0, the distributions are identical, and when it strives for unity, the variation between the distributions increases. Usually, an *HD* value greater than 0.5 indicates differences between the two distributions.

The *HD* distance meets the criteria assigned to distance measures such as the positivity condition: $HD(p_1, p_2) > 0$ and supports symmetry ($HD(p_1, p_2) = HD(p_2, p_1)$) and identity properties: $HD(p_1, p_2)$ equals 0 if and only if $p_1 = p_2$. It also meets the conditions of triangular inequality: $HD(p_1, p_2) < HD(p_1, p_3) + HD(p_3, p_2)$. The advantage of this distance measure is that the estimate is a metric. This quality is not supported in the Bhattacharyya coefficient (*BC*), for example (Kailath 1963). Although there is a link between the Hellinger distance and the *BC* coefficient $\left(HD(p_1,p_2)=\sqrt{1-BC(p_1,p_2)}\right)$, the latter does not necessarily meet the condition of triangular inequality, and the Bhattacharyya parameter is not a metric. Therefore, for ease of interpretation, the Hellinger distance was used in the research instead.

The data was first evaluated in terms of structural changes in poverty components. The UR_i measure was calculated both for the national level and the NUTS–2 Europe regions. Further, the results were compared regarding spatial similarities with the *Geographic Information System* tools and the cluster analysis.

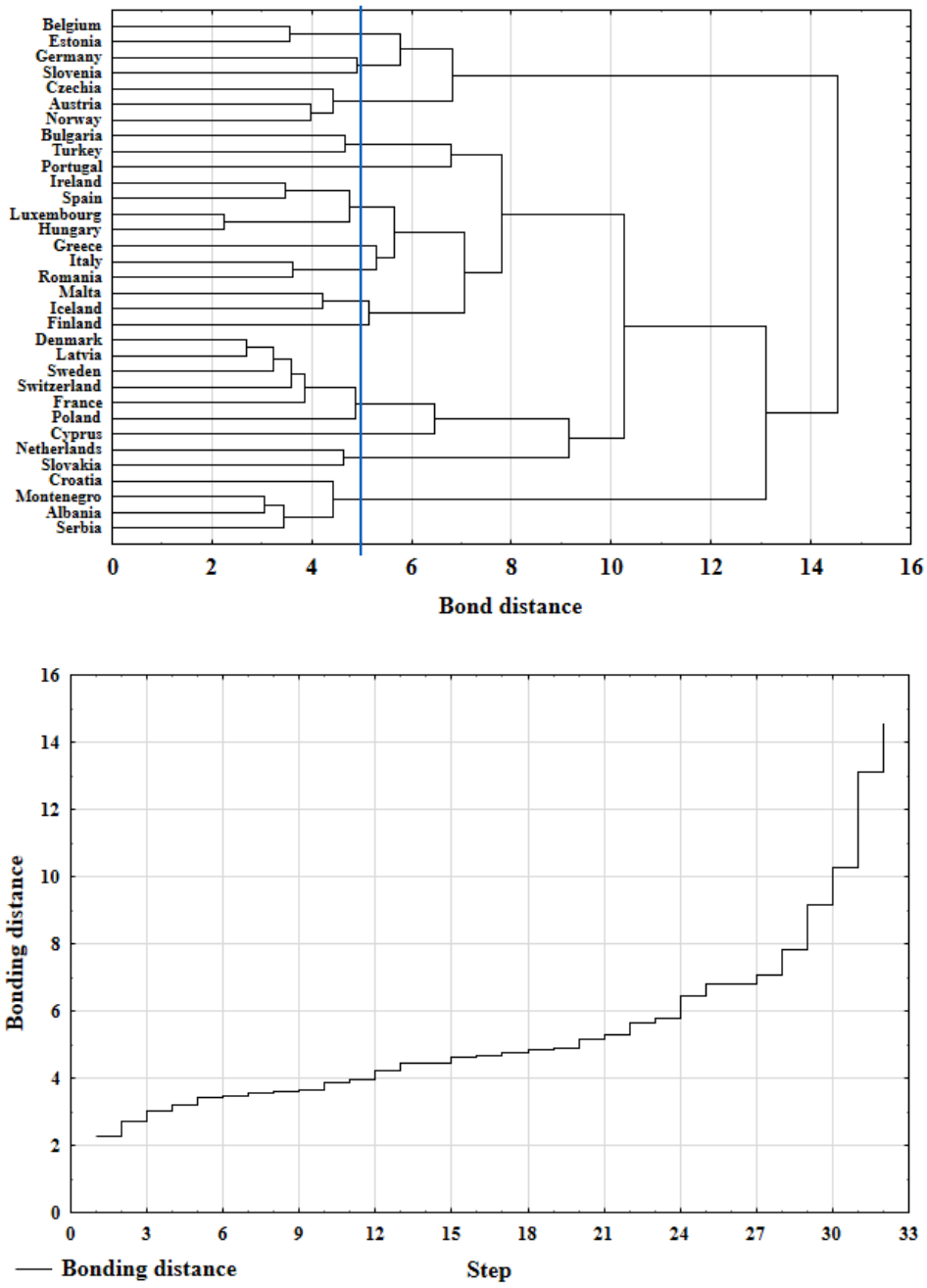


Figure 1. Tree diagram and bonding steps for Euclidean distance and Ward's grouping

Source: own elaboration.

Agglomeration methods were used to group European countries in clusters of similar changes in the overall poverty structure (Figure 1). The results were used as a background for regional assessment. Finally, the changes in the poverty structure estimated for selected European NUTS–2 regions were assessed in terms of the temporal similarity of tendencies with the Hellinger distance.

Results and discussion

Clustering

The research focuses on European countries and the NUTS–2 data aggregation level, although, as has already been pointed out, estimates are presented only for all available data records for reasons of comparability. The cluster analysis carried out at the national level was intended to indicate general tendencies in the countries concerned. The results allowed us to group countries that demonstrated similar trends of changes in the poverty structure throughout the analysed time horizon.

In the diagram of the agglomeration path (Figure 1), it is easy to see fragments of flattening, which indicates a decrease in the differentiation of subsequent objects included in the classification. This distance should be approx. 4.82, but for interpretational simplicity, it has been rounded to the nearest whole number. With a bond length of 5 (indicated by the straight blue line), 14 clusters are created, including three single elements. The tree diagram indicates when there is sufficient distance between objects/clusters to join another object/group of objects.

On the tree diagram (Figure 1), the more similar objects are in terms of changes in the distribution of the poverty structure over the time horizon, the sooner they are combined into a cluster (moving from the zero-bond distance to the right, with a lower bond distance). In this perspective, the most diverse group of countries is included in the last step (at the bond distance of 14.53). As can be seen, this cluster includes countries considered to be among the richest, such as Belgium, Germany, Austria, and Norway, but also Estonia, Czechia, and Slovenia. This cluster was the biggest outlier in the study. Considering changes in poverty, Poland formed a cluster with France, Switzerland, Sweden, Latvia, and Denmark. Although it was the last to join this group, this similarity should be perceived as exceptional.

Comparing the *HD* values that represent the changes that occurred in two time periods, it is possible to access the trends. Taking into account the most numerous cluster, Figure 2 presents the compilation for the selected economies.

When comparing 2018 and 2020, for instance, the changes in Poland were similar to the structural ones noted in 2017 and 2019, which can be summarised by the value of $HD = 0.13$. The Hellinger distance (Figure 2) indicated that the overall tendencies in the components of poverty between 2018 and 2020 were quite like in 2017 and 2019. However, the metric shows only the similarity. To have a closer look at what the changes in poverty mainly resulted in and where they originated from, it is necessary to investigate the UR_i values for comparable time points. Between 2018 and 2020, there was a 21% decrease in the structural share in the overall poverty rate, with a 14% decrease in the structural share of poverty, which resulted from the share of people aged up to

59 years living in households with very low work intensity. During this period, the structural share in overall poverty included in the factor of severe material deprivation rate dropped by 34%, and the significance of the structural component of people at risk of poverty or social exclusion decreased by 31%. The tendencies should be evaluated as a positive result of social policy and the increased welfare level.

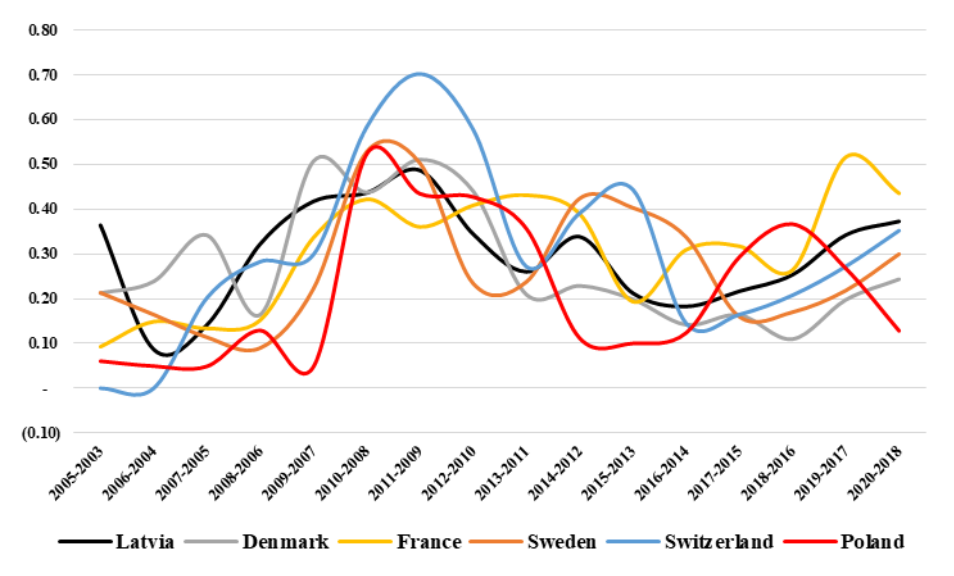


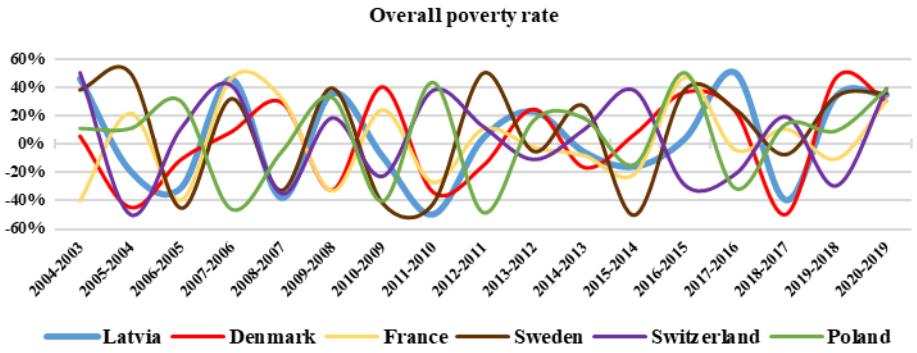
Figure 2. Cluster similarity in terms of tendencies in *HD* level by period

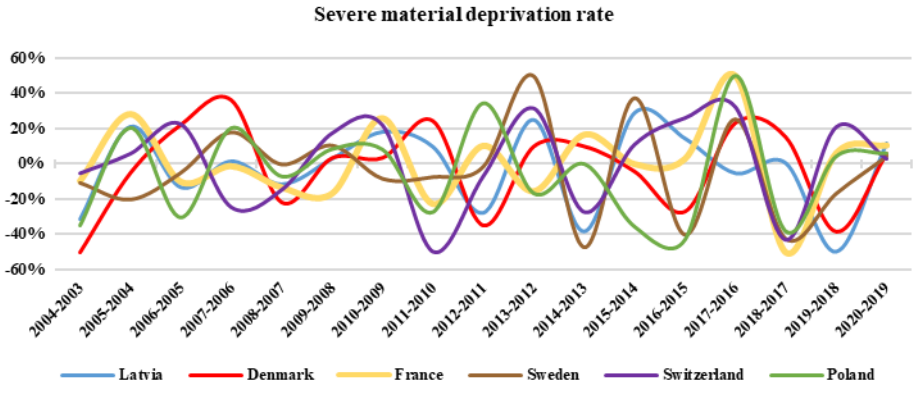
Source: own elaboration.

The curves of the *HD* index change for selected countries indicate quite comparable similarities in the level of recorded poverty. The biggest peak during the economic crisis in 2010 is noteworthy, although it was not a record level in the difference's distribution for France, where the highest level of dissimilarity was recorded in 2018. It may have been the result of the influx of immigrants and the deterioration (increase in weights) of structural indicators for poverty. When investigating the period between 2017 and 2020, the results of the *HD* index indicated dissimilarity: $HD_{2019-2017} = 0.52$ and $HD_{2020-2018} = 0.44$. The estimates are a consequence of changes noted in the influence of structural components of overall poverty in France. In the first period, these changes resulted mainly from a 25% increase in the share of people in the structure of the overall poverty rate, a 63% increase in the share of people at risk of poverty or social exclusion, a 13% increase in the share of people aged up to 59 years living in households with very low work intensity, and no change in severe material deprivation rate. In the second period, there was a slight change in the structural significance of individual poverty components. These changes resulted mainly from a 13% increase in the share of people in the structure of the overall poverty rate, a 20% increase in the share of people at risk of poverty or social exclusion, and a 60% increase in the share of people aged up

to 59 years living in households with very low work intensity. Changes also occurred in severe material deprivation rate – a 7% increase was noted.

The changes in the structure of poverty might not necessarily be considered spectacular, but they indicate which components weighed down on the structure of poverty and changed over time the most. This specific information can be quite useful in developing social policies at the regional level to counteract, for example, social exclusion or material deprivation. Following that, the Hellinger distance allowed us to assess whether the dynamic changes in the structure of poverty stimulated similarly or whether they should be assessed differently. The evaluation with the *HD* coefficient makes it possible to assess whether the long-term poverty-related social, demographic, and economic changes are proceeding in the desired direction or not. One should also remember that the last periods of the analysis were influenced by the policies adopted during the SARS-COV–2 virus pandemic when countries introduced different regulations for their societies.





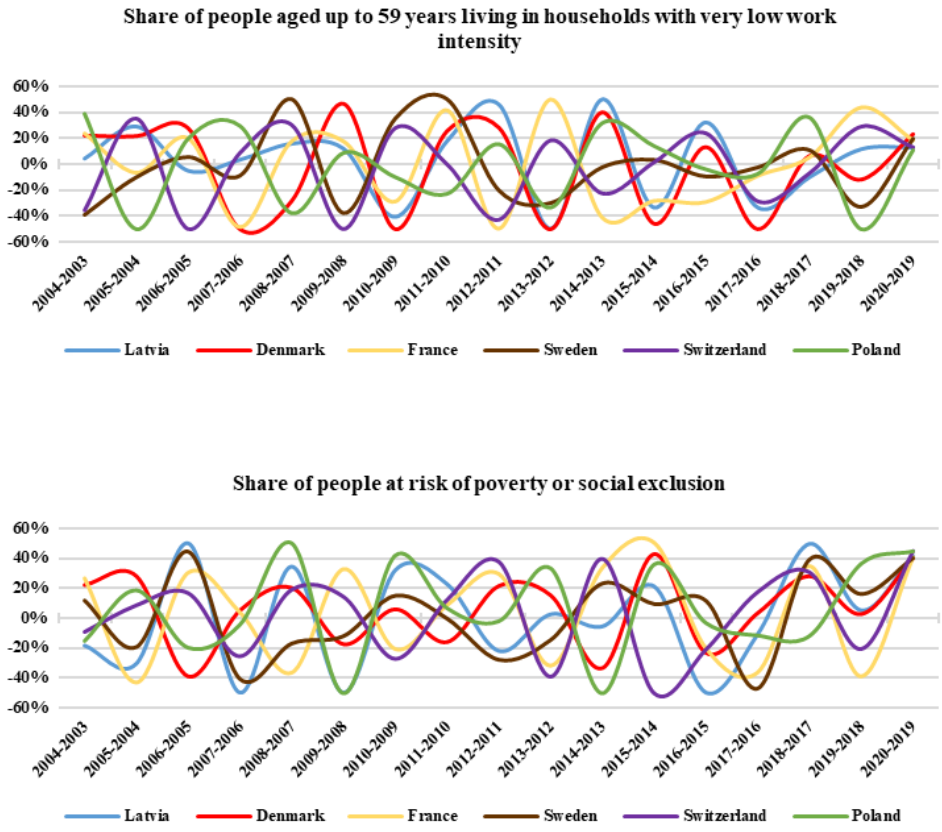


Figure 3. Shares of poverty determinants in selected countries

Source: own elaboration.

The summary for selected countries (cluster including Poland) in Figure 3 indicates how difficult it is to design a social policy in different countries, not to mention at the lower regional or local levels. The higher the differentiation, the higher the fluctuations in the tendency of changes in the share of a given aggregate in the structure. Further, the social policy should be effective and react quickly to changes. The results show, however, that the variability of poverty is dynamic (in order to be easy to control, it should take the form of a straight line with a structure variability of approximately 0%). This is especially visible in the crisis years 2008–2010, initiated by the collapse of the high-risk mortgage market, and from 2019, as a result of the COVID–19 pandemic.

Spatio-temporal changes in poverty structure

Looking at the NUTS–2 level in the assessment of the trends in changes in the poverty structure, the Hellinger distance values were determined for all possible consecutive periods analogously to the procedure for the national level. The values of the tendency compliance assessment are presented as graphical maps with the same value ranges. The most significant value from the point of view of the study, $HD \geq 0.5$, in-

dicates the incomparability of the distributions; they are marked with shades of red. It is in these NUTS–2 objects that a change in the poverty structure was observed, and UR_i measures allowed for the assessment of these objects in terms of changing trends. Time intervals (six time periods) characterised by the highest variability of the distribution of the poverty structure were selected for the visualisation.

Between 2004 and 2006, 12 regions had an *HD* value greater than or equal to 0.5, with the vast majority in Norway (6 regions). Of these, the Trøndelag region was characterised by the highest variability, with an *HD* of 0.712 (Figure 4). This results in a disproportion in this region. The share of people included in the poverty rate in the structure increased from 16% to 38%, with a simultaneous decrease in the importance of the structure of people in severe material deprivation in the poverty structure by 40% and by 10% for households with low work intensity. The changes should be assessed as significant.

In the next period, the number of regions that differ from the convergence of the distribution of changes increased to 16. Additionally, the highest noted value slightly increased between 2007 and 2009, with an HD of 0.718 noted in the Centro region in Italy. Comparing the visualisations for these periods, one can clearly see a change in the spatial distribution/location of regions with the highest disproportions of changes in the poverty structure. In the Centro region, a change in the structure of the components of poverty was clearly identified – in fact, the tendencies were reversed in each of the analysed structural elements. For example, in earlier periods, there were declines in the structure share for the poverty rate (25%), those at risk of poverty or social exclusion (9%), and material deprivation (19%), with a significant increase in households with low work intensity (50%). However, from 2007–2009, a decrease in the importance of the structure of poverty was identified for households with low work intensity (–50%) with a simultaneous increase in poverty rate (10%), those at risk of poverty or social exclusion (31%), and material deprivation (9%).

Interestingly, during the economic crisis of 2008–2010, there were no significant changes in the distribution of the poverty structure. However, it was possible to indicate nine regions with a measure of the consistency of the structure distributions greater than 0.5, with the highest value of $HD = 0.736$ for the Spanish region of Illes Baleares. The periods of the COVID–19 pandemic showed a greater impact on 13 individual spatial units in 2019 and 12 in 2020. In the Région Wallonne in Belgium, between 2018 and 2020, the last analysed period, the highest Hellinger distance of 0.895 was recorded. Such a high value is the result of the growing importance in the structure for all four elements of poverty: 34% for poverty rate, 42% for people at risk of poverty or social exclusion, 9% for households of low work intensity, and 15% for material deprivation share.

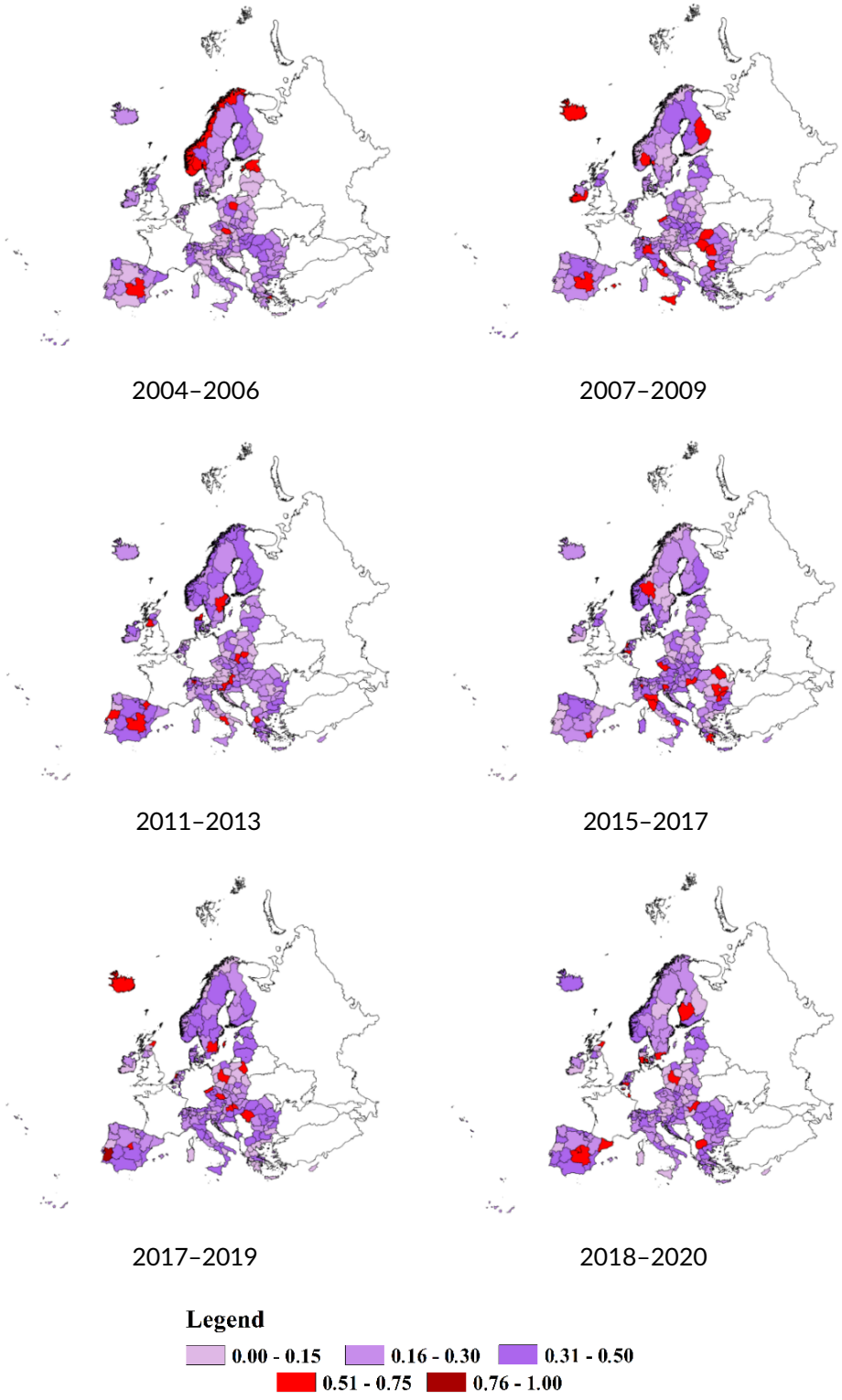


Figure 4. Hellinger distance for NUTS–2 regions

Source: own elaboration.

In selected European regions, the dissimilarity of structures was also identified. Table 1 summarizes the changes in tendencies.

Table 1. Extreme Hellinger distance values for selected NUTS–2 regions

Country	NUTS–2 region	Hellinger distance values
Czechia	Praha	$HD_{2015-2013} = 0.547$
	Jihozápad	$HD_{2017-2015} = 0.628$; $HD_{2018-2016} = 0.507$
	Severozápad	$HD_{2009-2007} = 0.532$; $HD_{2019-2017} = 0.526$
	Jihovýchod	$HD_{2006-2004} = 0.502$; $HD_{2019-2017} = 0.574$
	Střední Morava	$HD_{2008-2006} = 0.646$
	Moravskoslezsko	$HD_{2011-2009} = 0.694$; $HD_{2014-2012} = 0.509$
Denmark	Syddanmark	$HD_{2020-2018} = 0.690$
	Midtjylland	$HD_{2010-2008} = 0.545$
	Nordjylland	$HD_{2012-2010} = 0.536$; $HD_{2013-2011} = 0.665$
Estonia		$HD_{2006-2004} = 0.506$; $HD_{2007-2005} = 0.575$; $HD_{2012-2010} = 0.538$; $HD_{2017-2015} = 0.623$
Hungary	Közép-Magyarország	$HD_{2019-2017} = 0.557$
	Közép-Dunántúl	$HD_{2019-2017} = 0.643$
	Nyugat-Dunántúl	$HD_{2013-2011} = 0.707$; $HD_{2014-2012} = 0.614$
	Észak-Alföld	$HD_{2020-2018} = 0.720$
	Dél-Alföld	$HD_{2017-2015} = 0.675$; $HD_{2018-2016} = 0.631$
Poland	Śląskie	$HD_{2013-2011} = 0.555$
	Świętokrzyskie	$HD_{2013-2011} = 0.561$
	Podlaskie	$HD_{2018-2016} = 0.580$; $HD_{2019-2017} = 0.533$
	Kujawsko-Pomorskie	$HD_{2006-2004} = 0.510$; $HD_{2014-2012} = 0.514$
Slovakia	Bratislavský kraj	$HD_{2007-2005} = 0.506$
	Stredné Slovensko	$HD_{2012-2010} = 0.782$; $HD_{2014-2012} = 0.518$; $HD_{2014-2012} = 0.549$

Source: own elaboration.

The dynamics of structural changes were rapid in Estonia and Hungary. The most intensive changes in the structure of poverty, which occurred during the COVID–19 pandemic, took place in the region of Észak-Alföld. This is a result of swapping the tendencies in structural intensity. In the 2018–2020 period, the *HD* amounted to 0.720. The dissimilarity was a result of the growing importance of every element of the structure: the poverty rate increased by 29%, people at risk of poverty or social exclusion increased by 44%, material deprivation increased by 21%, and the share of households with low work intensity increased by 6%. The Hellinger distance noted a high value, while in the previous period, only households with low work intensity grew (by 50%). The other poverty components decreased in importance, e.g., the share of the poverty rate dropped by 32%.

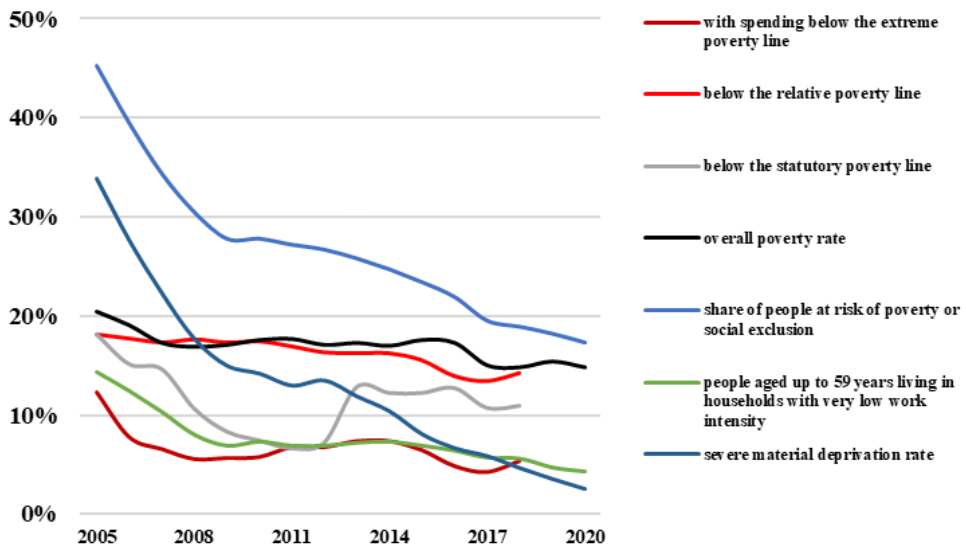
The case of Poland

In Poland, only four regions recorded significant changes in the poverty structure. In Świętokrzyskie and Śląskie, it happened once as a result of the economic crisis. Podlaskie and Kujawsko-Pomorskie recorded a change twice. Kujawsko-Pomorskie recorded a change in structure caused by Poland's accession to the EU and later, perhaps because of the European Football Championships organised in 2012 in Poland and Ukraine. Here, the region recorded increases in the importance of people at risk of poverty or social exclusion by 42%, while in 2012, this share was 43% lower. Podlaskie, especially at the beginning of the COVID–19 period, recorded an increase in the structure of poverty for people at risk of poverty or social exclusion of 45%.

Statistics Poland presents information on poverty only on an annual basis and in terms of expenditure, based on household budget surveys. If household expenses, calculated per person, are lower than the subsistence minimum (in 2020, it was PLN 640 for a single-person household), then we are dealing with extreme poverty. If relative poverty is assessed, then a 50% criterion of average expenditure is introduced (e.g. in 2019, it was less than PLN 858 per single-person household). In addition, for several years, Statistics Poland has re-published data on the scale of social exclusion, which reflects the scarcity sphere, where the social minimum is the limit. Within this concept, it is not only human survival that is taken into consideration, but also the goods and services necessary for work, education, and maintaining family and social ties, as well as modest participation in culture and recreation. The limit based on this criterion was PLN 1218 for a working single-person household and PLN 1195 for farmers, retirees, and pensioners.

The multitude of categories creates problems in assessing the phenomenon on a general level, the more so that not all data are published below the national level of data aggregation. One could say that, depending on which category is selected for the assessment, it is possible to obtain different poverty scores for a given spatial unit and its changes over time. For Poland, the graph presents different categories of poverty, both from public statistics and Eurostat data.

Of course, based on Figure 5, it can be concluded that poverty is decreasing, regardless of the selected category. However, it would be difficult to assess the problem considering all categories at the same time point without an initial assessment of the weight of a given aggregate in the overall structure of the problem.



Note: for data published by Statistics Poland, there is no information on statutory, extreme, or relative poverty for 2019–2020 which is unfortunately unfavourable as it makes it impossible to conduct comparative analyses for the years of the COVID–19 pandemic.

Figure 5. Poverty coverage indicators of people in a household in Poland

Source: own elaboration.

Conclusions

Evaluating poverty as a complex phenomenon is justified by different approaches to the issue, as well as different ways of defining the poor. The paper first introduced a determination of the weight for each component in the structure of the overall poverty level, considering simultaneously all the statistics published at the national level and selected NUTS–2 spatial units in European countries. In this way, it was possible to assess which category in each period was important for the overall poverty level in the regions. It provided an opportunity to identify the direction of this change for the tendency analysis. Finally, using the Hellinger distance and comparing the distribution of change tendencies, we verified whether the changes in the poverty structure at the national/regional levels were consistent or significantly different.

The sense of cumulative analysis of poverty is emphasised by, among others, Szarfenberg (2021), who pointed out a decrease in poverty levels, e.g., in relative poverty in the first year of the COVID–19 pandemic. However, these declines are due to the overall reduction of 50% in average spending and not to an improvement in the financial situation of households. In addition, Eurostat data on material and social deprivation describe the impossibility of meeting at least five out of nine (or seven out of thirteen according to the Europe 2030 Strategy) needs for financial reasons, not to mention people living in low work intensity households. The EU2030 Strategy has introduced new measures of poverty but

only changed the definitions and perception of two of the poverty categories used, such as the severe material deprivation and low work intensity indicators. They extended the age range of the respondents from 59 to 64 years.

Notwithstanding, these changes do not affect the analytical capabilities of the proposed tools for assessing changes in the poverty structure in general terms, thanks to the possibility of normalising unit indicators and their share in the total level of the structure. Applying a structure decomposition measure circumvents the layout requirements of a contingency table-like database. In conjunction with an analysis of changes in the multivariate distribution using the Hellinger distance, the analysis allowed for a multivariate assessment of the distributions of hitherto non-summable variables that shape multivariate phenomena. It may allow a better understanding of this phenomenon as well as others not yet analysed. What is noteworthy is that, as expected, high values for the disproportion of change were recorded in different parts and different regions of Central and Eastern European countries. Here, one may mention the regions of Poland, Estonia, the Czech Republic, Slovakia and Hungary (Table 1). At some of the analysed time points, they showed extreme changes in the distribution for the analysed poverty aggregates according to the Hellinger Distance measure. Poverty transitions have not spared regions in countries considered to be more developed, such as Norway, Spain or Italy, which have not undergone a socio-economic transformation, unlike Central and Eastern European countries.

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Ubóstwo w wybranych krajach Europy
Analiza przestrzenno-czasowa w latach 2003–2020

Problem ubóstwa, zarówno w teorii, jak i w praktyce, nabrał nowego znaczenia m.in. wraz z początkiem transformacji wybranych gospodarek europejskich z centralnie planowanej do gospodarki rynkowej. Transformacja systemowa i towarzyszące jej zmiany własnościowe wywołały zmiany w rozkładzie dochodów, co wpłynęło na wzrost rozwarstwienia społeczeństwa pod względem sytuacji materialnej i pogorszenie warunków życia niektórych grup społecznych. Projektowanie i ocenę programów walki z ubóstwem powinna poprzedzać identyfikacja, kto jest uważany za biednego bądź żyjącego w ubóstwie. Zdefiniowanie ubóstwa to zatem pierwszy i kluczowy krok w pomiarze jego cech, np. jego natężenia, stąd wybór konkretnej definicji zjawiska ma fundamentalne znaczenie dla uzyskanych wyników tego pomiaru.
Celem artykułu jest ocena sytuacji materialnej społeczeństw europejskich w kontekście zmian ubóstwa w ujęciu holistycznym, z uwzględnieniem wszystkich informacji dostępnych w krajowych i międzynarodowych statystykach dotyczących tego problemu. Realizując cel badawczy dla poziomu danych regionalnych, poprzez zastosowanie miary dekompozycji zmian struktury (*URi*), oszacowano kierunki i natężenie zmian w strukturze ubóstwa rejestrowanego. W dalszej kolejności oceniono, czy przemiany w sferze analizowanego zjawiska pokrywają się czasowo i przestrzennie. Zastosowanie odległości Hellingera (*HD*) pozwoliło na określenie znaczenia trendów zmian w strukturze ubóstwa, szczególnie w latach pandemii COVID–19, kiedy to w analizowanych regionach NUTS–2 zidentyfikowano wzrost znaczenia poszczególnych składowych strukturalnych ubóstwa. Dla niektórych gospodarek procesy transformacji były także konsekwencją pojawiających się w Europie kryzysów gospodarczych lub ważnych wydarzeń o znaczeniu międzynarodowym, np. sportowych czy przystępowaniu krajów do struktur UE.

Słowa kluczowe: ubóstwo, deprywacja, podobieństwo przestrzenne, zmiany strukturalne

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The Impact of Economic Equilibrium, Globalization, Human Development, and Market Competitiveness on the Sustainable Development of Manufacturing Enterprises – the Case of France, Germany, Italy and Poland

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Abstract

The paper presents the results of an analysis of the impact of economic equilibrium, the Human Development Index, the KOF Globalization Index and the Global Competitiveness Index on the sustainable development of manufacturing enterprises and their components in France, Germany, Italy and Poland from 2008 to 2021. We use the Ordinary Least Squares (OLS) and the Seemingly Unrelated Regression methods (SUR). The results show that these external factors significantly impact an enterprise's sustainable development. Our models also show a different strength and direction of relationships between the explained and explanatory variables. Our models confirm the need to coordinate macroeconomics and environmental policy. It is important to use effective tools of economic support, and greater pressure from European Union institutions on countries that emit harmful substances is essential.

Keywords: sustainable development, manufacturing enterprises, macroeconomic stabilization, globalization, market competitiveness

JEL: E01, F18, F61, Q01

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Introduction

Sustainable development is one of the most important trends in modern economics and politics. It presupposes the deliberate use of resources in such a way that they will be enough to build the prosperity of the current generation but also meet the needs of the future. Limiting the consumption of non-renewable resources, eliminating the processing of toxic or non-recyclable materials and, taking care of local communities' development, improving the quality of life, contribute to sustainable development.

Sustainable development requires active and effective efforts by enterprises whose role, due to their high share in pollution and impact on society, is essential to counteract climate change. Several factors impact enterprises' practical implementation of sustainable development, including social pressure (Kristjanson et al. 2014), changes in environmental protection policy (Fiorini and Hoekman 2018, pp. 1–12), the increasing level of competitiveness and customer requirements (Shiel, do Paço, and Alves 2020), macroeconomic conditions (Pieloch-Babiarz, Misztal, and Kowalska 2021), and the financial situation (Zhang and Chen 2017).

The article's main aim is to assess the strength and direction of the impact of economic equilibrium (MSP), globalization (KOF), human development (HDI) and the global competitiveness index (GCI) on the sustainable development of manufacturing enterprises (SD) and their components (economic: E, social: S, environment: Env) in France, Germany, Italy and Poland. We focus on the countries with the most enterprises in this sector.

The issues discussed in the paper are important in the era of climate change and social and geopolitical transformations. Identifying the factors that are fundamental to enterprises' sustainable development is crucial in terms of economic practice and the development of scientific theory.

Previous research shows that the strength and directions of the influence of the socio-economic factors on sustainable development are different. Analyses indicate a positive relationship between economic equilibrium and the sustainable development of enterprises (Pieloch-Babiarz, Misztal, and Kowalska 2021; Comporek, Kowalska, and Misztal 2022). Global competitiveness may contribute to implementing ecological innovations or impede such activity (Hermundsdottir and Aspelund 2021). The impact of globalization may be positive or negative, depending on the research assumptions (Jickling and Wals 2008; Stofkova and Sukalova 2020).

The article's novelty and contribution to the literature on the subject lie in the presentation of the research results devoted to the sustainable development of manufacturing enterprises using the developed synthetic indicators and modern econometric methods, including the Ordinary Least Square (OLS) and the Seemingly Unrelated Regres-

sion (SUR). We use tests to assess linearity, normality of distribution, homoscedasticity and autocorrelation.

The presented model can support economic decisions that respect the climate aspect. It will also help identify which type of socio-economic factors are essential for the sustainable development of manufacturing enterprises.

The article contains the following components: an introduction, a literature review, research methodology, research results, and a discussion. We use annual data from Eurostat, the World Bank, and KOF Swiss Economic Institute.

Literature review

Sustainable development is essential for improving the quality of life of current and future generations. In business practice, it means taking constant and effective actions toward the company's economic, social and environmental goals. It means generating profits on an ongoing basis, pursuing its goals and aspirations, and ensuring its implementation in the future (Gupta and Vegelin 2016, pp. 433–448; Mehmet and Soytas 2019, pp. 545–572; Comporek, Kowalska, and Misztal 2022).

According to the sustainable development philosophy, enterprises strive to maximize profits that will feed their owners' portfolios (short-termism) and check how, in the long term, a given activity affects the local community, the local labor market or the natural environment (Bilan et al. 2019; Umar et al. 2020; Pieloch-Babiarz, Misztal, and Kowalska 2021). The growth of natural, social and human capital should positively impact the enterprise's development. It is widely discussed that this approach will also benefit the financial and property situation of companies in the long run because it allows management boards to increase their investment of financial surpluses in innovation and R&D projects rather than allocating them to paying increasingly higher dividends (Hunt 2012, pp. 404–411; Levytska et al. 2018, pp. 122–127; Teng, Chang, and Wu 2021).

In the literature, sustainable enterprise development appears alongside corporate social or ecological business responsibility (Liczmańska-Kopcewicz, Mizera, and Pypłacz 2019; ElAlfy, Darwish, and Weber 2020). At the same time, sustainable development has a wider scope and is largely focused on ex-ante analyses. It should also be noted that enterprises' sustainable development is defined in several manners. Researchers indicate that it is development based on economic, social and environmental pillars, and the business owner's task is to maintain a balance between them (Elkington 1997). Sustainable development of enterprises is about achieving success today without compromising future needs, encompassing economic, social and environmental development (Boudreau and Ramstad 2005).

According to stakeholder theory, sustainable development is about meeting the present and future needs of a company's direct and indirect stakeholders (Dyllick and Hockerts 2002, pp. 130–141). It is an economic (financial factors), environmental (risk/requirement factors) and social (human factors) problem that is solved through the company's collaboration with its stakeholders (Lozano 2008, pp. 499–509). Sustainable enterprise development develops shareholders' worth through economic, social, and environmental perfection (Bansal, Garg, and Sharma 2019).

In the financial approach, sustainable enterprise development can mean "the capability of a corporation to last in time, both in terms of profitability, productivity and financial performance, as well as in terms of managing environmental and social assets that compose its capital" (Giovannoni and Fabietti 2013, p. 22).

The resource approach emphasizes the importance of sustainable resources, including people, infrastructure, durable and non-durable assets, and outgoing goods. Sustainable development means combining a balanced strategy in production, finance, logistics, marketing, sales, HR and other functional areas (Pabian 2017, pp. 11–16). Sustainable development is an innovative development in which favorable conditions are created (organizational and economic mechanisms, scientific and technical base, motivational and stimulating mechanisms) to generate and implement innovative activities, introduce scientific and technological developments in production, and promote high-technology products on the market (Tolstykh, Gamidullaeva, and Shmeleva 2020). It is the basis for developing future generations, and it constitutes opportunities and challenges for managers in terms of building socio-economic value (Stawicka 2021).

Some internal and external factors determine the sustainable development of enterprises, and researchers do not agree on the meaning or direction of the influence of these factors on sustainable development. Some analyses emphasize the significance of external factors, including macroeconomic conditions related to environmental protection policy, the level of globalization, and the economic or geopolitical situation (Finnveden et al. 2013; Kurniawan and Managi 2018, pp. 339–361). Others focus on the internal conditions of enterprise development, including business strategies and models, financial situation, intellectual capital, and managers' approaches to social and environmental issues (Zollo, Cennamo, and Neumann 2013, pp. 241–259; Teng, Chang, and Wu 2021).

Most research underlines that implementing sustainable development goals combines external and internal factors (Chen 2016; Koirala and Pradhan 2020). It is necessary to have a holistic approach to managing the development of enterprises that will skillfully respond to emerging opportunities and threats, both internal and external. Economic equilibrium (macroeconomic stabilization) should positively impact the sustainable development of enterprises (e.g., in the transport and manufacturing sector) in selected countries of Central and Eastern Europe (Pieloch-Babiarz, Misztal,

and Kowalska 2021; Comporek, Kowalska, and Misztal 2022). Macroeconomic stabilization refers to the overall improvement of a country's economic conditions, which encompasses various factors such as political stability, social well-being, and demographic trends. The country's position in the international arena is also important, especially in foreign trade. Therefore, the economic stabilization policy means restoring the economy to an internal and external state of equilibrium (Ćwikliński 2012; Agliardi and Xepapadeas 2019, pp. 1–14). There is also a positive relationship between the human development index and sustainable development because the more educated and aware society is, the greater the pressure of customers on the social and environmental responsibility of business (Boudreau and Ramstad 2005).

In turn, the impact of globalization on sustainable development may be twofold. Most researchers believe that globalization hurts the natural environment and that sustainable development is a response to the negative effects of globalization (Jickling and Wals 2008, pp. 1–21; Stofkova and Sukalova 2020; Adebayo and Kirikkaleli 2021). The increase in competitiveness may make it necessary to focus on the enterprise's economic performance. On the other hand, according to competition theory, companies that want to survive in the market must look for new ways to reach customers, including creating a friendly brand for society and the natural environment (Kuchinka et al. 2018; Shiel, do Paço, and Alves 2020; Kim and Hwang 2021, pp. 847–859).

Research methodology

The article's main aim is to assess the strength and direction of the impact of economic equilibrium (MSP), the Human Development Index (HDI), the KOF Globalization Index (KOF), and the Global Competitiveness Index (GCI) on the sustainable development of manufacturing enterprises and its components (economic: ECO, social: SOC, and environmental: ENV) in France, Germany, Italy and Poland from 2008 to 2021. The research covers the period from the beginning of the economic crisis and economic slowdown to the gradual recovery from it.

We chose countries with different levels of socio-economic development, including the three most developed economies in the European Union, France, Germany, and Italy, and the developing country Poland. These countries have the most manufacturing enterprises in the European Union. We focus on the manufacturing sector because of its enormous importance for the socio-economic development of these countries and its significant negative impact on the natural environment (high emissions of substances harmful to the climate).

The main hypothesis of the research is as follows: "In the studied countries, there is a significant variation in the directions and strength of the impact of individual so-

cio-economic factors on the sustainable development of manufacturing enterprises from 2008 to 2020." This hypothesis extends existing research (Pieloch-Babiarz, Misztal, and Kowalska 2021; Comporek, Kowalska, and Misztal 2022). Moreover, it endeavors to take a more comprehensive approach to the determinants of sustainable development. The research presupposes that the analyzed countries are diversified in economic development, structure, and environmental protection policies, even though they are obliged to comply with the regulations in the European Union.

We also formulate the following research questions:

- Does sustainable development have greater dynamism in higher-developed countries?
- Does economic development have higher dynamics than social and environmental development?
- Is economic equilibrium from previous periods crucial for the sustainable development of enterprises?
- Is there a relationship between the impact of socio-economic factors on the pillars of sustainable development of enterprises in the studied countries?

We conducted the research in four stages:

We created indicators of sustainable development of manufacturing enterprises and its three pillars We standardize the method based on the following formula

for the stimulants:

$$Z_{ij} = \frac{x_{ij}}{max\, x_{ij}}, Z_{ij} \in [0;1], \tag{1}$$

for the destimulants:

$$Z_{ij} = \frac{min\, x_{ij}}{x_{ij}}, Z_{ij} \in [0;1], \tag{2}$$

where Z_{ij} – the normalized value of the j-th variable in the i-th year; x_{ij} – the value of the j-th variable in the i-th year.

To calculate the indicator of sustainable development (*SD*) and its economic (*ECO*), social (*SOC*), and environmental (*ENV*) components, we use the following formula:

$$SD = \frac{\sum_{j=1}^{n}\left(ECO_{ij} + SOC_{ij} + ENV_{ij}\right)}{n}, Sus_{ij} \in [0;1]. \quad (3)$$

The *ECO* indicator was developed based on the indicators of stimulants, including turnover, production value, added value, gross operating surplus, total purchases of goods and services, gross investment, and investment rate.

The *SOC* indicator is calculated based on stimulants, including the number of employees, wages, social security costs, turnover per employee, labor productivity, investment per ployee, employment growth rate, gross value added per employee, and destimulants, including personnel costs, and the share of personnel costs in the production.

The *ENV* indicator is based on destimulants, including carbon, methane, nitrous oxide emissions, sulfur oxides, carbon monoxide, nitrogen oxides, and ammonia emissions.

1. We collected indicators of socio-economic development using the following:
   – the macroeconomic stabilization pentagon (Kołodko 1993):

$$MSP = [(\Delta GDP \cdot U) + (U \cdot CPI) + (CPI \cdot G) + (G \cdot CA) + (CA \cdot \Delta GDP)] \cdot k, \quad (4)$$

where $a = \Delta GDP \cdot U \cdot k$ – presents a triangle area called the real sphere triangle and characterizes the relation between the rate of economic growth and unemployment rate; $b = U \cdot CPI \cdot k$ – stands for the stagflation triangle, which depends on the unemployment rate and inflation rate; $c = CPI \cdot G \cdot k$ – defined as the budget and inflation triangle; $d = G \cdot CA \cdot k$ – the financial equilibrium triangle, which depends on the budget and the current account balance; $e = CA \cdot \Delta GDP \cdot k$ – the external sector triangle, which shows the variability

   – the Human Development Index (HDI). This indicator assesses countries on three levels: "long and healthy life," "knowledge," and "decent standard of living";
   – the KOF index. It has three dimensions: economic globalization, social globalization and political globalization. As a result, in addition to the general index of globalization, three sub-indices were created. Each is calculated based on several indicators and was assigned a specific weight;
   – the GCI. This was done by including a weighted average of many different components, each measuring a different aspect of competitiveness. The components

are grouped into 12 categories, the pillars of competitiveness: Institutions, Infrastrucre, Macroeconomic environment, Health and primary education, Higher education and training, Goods market efficiency, Labor market efficiency, Financial market development, Technological readiness, Market size, Business sophistication, and Innovation (the World Bank).

2. We created models using the classical method of least squares estimation. Our structural equation takes the following form:

$$SD = \propto_0 + \propto_1 GCI_t + \propto_2 HDI_t + \propto_3 KOF_t + \propto_4 MSP_t + \\ + \propto_5 GCI_{t-1} + \propto_6 HDI_{t-1} + \propto_7 KOF_{t-1} + \propto_8 MSP_{t-1} + \varepsilon_i \quad (5)$$

3. We created seemingly unrelated regression (SUR) models. The structural equations are as follows:

$$\begin{cases} EKO = \propto_0 + \propto_1 SOC_t + \propto_2 ENV_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \\ SOC = \propto_0 + \propto_1 ECO_t + \propto_2 ENV_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \\ ENV = \propto_0 + \propto_1 ECO_t + \propto_2 DOC_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \end{cases}$$

The results of the analysis

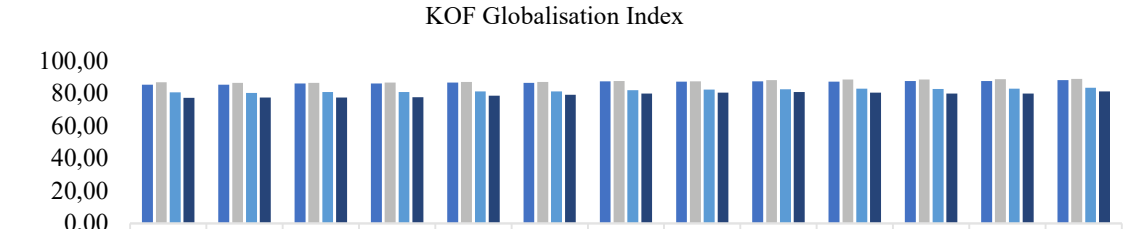
Graph 1 presents selected indexes describing the socio-economic situation (i.e., GCI, HID, KOF, and Economic Equilibrium) in France, Germany, Italy, and Poland, from 2008 to 2020.

In all countries, HDI, KOF, and the Macroeconomic Stabilization Index have an increasing trend. In Germany, Italy and Poland, the GCI has a decreasing trend, which may be due to the forecast from 2018 to 2020. In France, the GCI has an increasing trend.

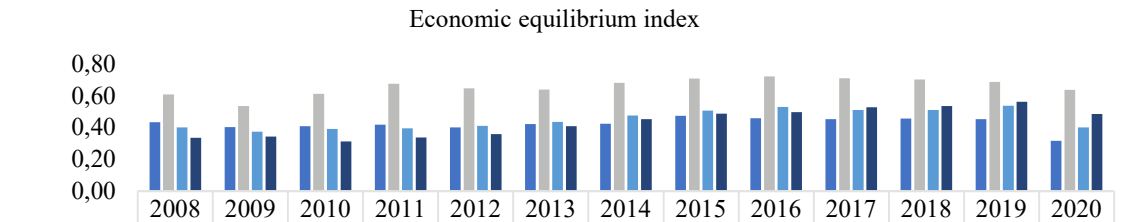
Selected indexes describing the socio-economic situation indicate stable development and improved conditions, and quality of life in all four countries are presented below.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	16	16	15	18	21	23	23	22	21	22	24	25	26
Germany	7	7	5	6	6	4	5	4	5	5	4	4	3
Italy	49	48	48	43	42	49	49	43	44	43	43	43	42
Poland	53	46	39	41	41	42	43	41	36	39	36	35	33

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	0,88	0,88	0,88	0,88	0,89	0,89	0,89	0,89	0,90	0,90	0,90	0,90	0,90
Germany	0,92	0,92	0,93	0,93	0,94	0,93	0,94	0,94	0,94	0,94	0,95	0,95	0,95
Italy	0,88	0,88	0,88	0,88	0,88	0,88	0,88	0,88	0,88	0,89	0,89	0,89	0,89
Poland	0,83	0,83	0,84	0,84	0,84	0,86	0,86	0,86	0,87	0,87	0,88	0,88	0,89



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	85,46	85,41	86,06	86,18	86,65	86,50	87,50	87,35	87,49	87,26	87,58	87,63	88,15
Germany	86,91	86,54	86,55	86,79	87,00	87,02	87,58	87,53	88,12	88,62	88,59	88,73	88,90
Italy	80,74	80,28	80,86	80,79	81,23	81,21	82,09	82,41	82,60	82,93	82,77	82,92	83,43
Poland	77,28	77,54	77,48	77,66	78,7	79,15	80,03	80,57	80,81	80,43	79,97	80,02	81,29



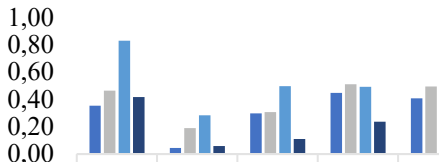
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	0,43	0,40	0,41	0,42	0,40	0,42	0,42	0,47	0,46	0,45	0,46	0,45	0,32
Germany	0,61	0,53	0,61	0,68	0,65	0,64	0,68	0,71	0,72	0,71	0,70	0,69	0,64
Italy	0,40	0,37	0,39	0,39	0,41	0,43	0,48	0,51	0,53	0,51	0,51	0,54	0,40
Poland	0,34	0,34	0,31	0,34	0,36	0,41	0,45	0,49	0,50	0,53	0,53	0,56	0,49

Graph 1. Socio-economic indexes – France, Germany, Italy, Poland (2008–2020)

Source: own elaboration based on: Eurostat database n.d., *GDP and main components*...; Eurostat database n.d., *HICP*; Eurostat database n.d., *International trade*...; Eurostat database n.d., *Unemployment by sex*...; Human Development Research n.d.; KOF Swiss Economic Institute n.d.; The World Bank database n.d.

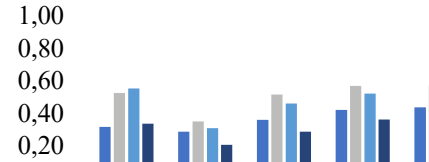
Graph 2 shows the sustainable development index of manufacturing enterprises (with the economic, social and environmental components) in all four countries from 2008 to 2020. The highest average value is in Germany, while the lowest is in Poland. In all countries, the index (with components) has an increasing trend (except for environmental development in Poland), which should be assessed positively. It means that between 2008 and 2020, manufacturing enterprises in France, Germany, Italy and Poland implemented programs and activities that are essential for sustainable development.

Economic development index of manufacturing enterprises



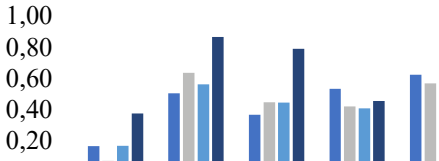
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	0,35	0,04	0,30	0,45	0,41	0,43	0,41	0,38	0,51	0,68	0,79	0,86	0,69
Germany	0,46	0,19	0,31	0,51	0,49	0,48	0,56	0,55	0,60	0,60	0,85	0,91	0,69
Italy	0,83	0,28	0,50	0,49	0,44	0,35	0,38	0,43	0,52	0,69	0,82	0,65	0,68
Poland	0,42	0,06	0,11	0,24	0,22	0,24	0,35	0,46	0,47	0,59	0,82	0,91	0,85

Social development index of manufacturing enterprises



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	0,32	0,29	0,36	0,42	0,44	0,38	0,42	0,45	0,49	0,63	0,67	0,69	0,72
Germany	0,53	0,35	0,52	0,57	0,57	0,57	0,63	0,69	0,62	0,73	0,78	0,78	0,51
Italy	0,55	0,31	0,46	0,52	0,46	0,44	0,49	0,48	0,48	0,62	0,72	0,76	0,69
Poland	0,34	0,21	0,29	0,36	0,44	0,37	0,38	0,42	0,40	0,48	0,52	0,56	0,69

Environmental development index of manufacturing enterprises



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
France	0,17	0,51	0,37	0,53	0,63	0,63	0,72	0,66	0,58	0,66	0,74	0,93	0,89
Germany	0,07	0,64	0,45	0,42	0,57	0,60	0,57	0,48	0,52	0,46	0,72	0,78	0,86
Italy	0,17	0,56	0,45	0,41	0,56	0,70	0,74	0,78	0,71	0,73	0,72	0,70	0,79
Poland	0,38	0,87	0,79	0,46	0,58	0,61	0,51	0,58	0,64	0,39	0,44	0,41	0,38

Graph 2. Sustainable development index of manufacturing enterprises (with components) – France, Germany, Italy, Poland (2008–2020)

Source: own elaboration on the basis Eurostat database n.d., *Enterprise statistics...*; Eurostat database n.d., *Net greenhouse gas emissions...*

Table 1 shows the results of the OLS estimation from 2008 to 2020. The models show different strengths and directions of the relationships between the explained and explanatory variables. In the analyzed countries, the sustainable development of manufacturing enterprises is most often influenced by the HDI (or the previous period's HDI) and KOF (or the previous period's KOF). The influence of the previous period's KOF on the sustainable development of manufacturing enterprises in Poland is negative. The negative impact may result from globalization increasing enterprises' competitiveness and focusing intensely on maximizing profits in the short term, which affects the social and environmental dimensions of their development. HDI has the highest positive impact on the sustainable development of manufacturing enterprises in France, while in Italy, it is KOF.

Table 1. Results of OLS regressions from 2008 to 2020:

$$SD = \propto_0 + \propto_1 GCI_t + \propto_2 HDI_t + \propto_3 KOF_t + \propto_4 MSP_t + \\ + \propto_5 GCI_{t-1} + \propto_6 HDI_{t-1} + \propto_7 KOF_{t-1} + \propto_8 MSP_{t-1} + \varepsilon_i$$

Country	Dependent variable	Independent variable	Coefficient	Std. error	p-value	R^2
France	SD	Const	−24.570	4.526	0.001	0.904
		HDI	28.980	5.383	0.001	
		GCI(−1)	0.034	0.014	0.039	
Germany	SD	Const	−12.906	2.053	0.001	0.830
		HDI(−1)	11.338	5.666	0.077	
		KOF(−1)	0.033	0.055	0.566	
Italy	SD	Const	−12.118	2.699	0.001	0.871
		HDI	8.692	4.722	0.096	
		KOF	0.061	0.024	0.028	
Poland	SD	Const	2.988	0.870	0.007	0.960
		KOF(−1)	−0.040	0.012	0.008	
		MSP(−1)	1.588	0.176	<0.001	

Source: own elaboration.

Table 2 presents the results of the SUR estimation from 2008 to 2020. The models show a different strength and direction of relationships between the explained and explanatory variables. The estimation indicates a strong differentiation of the impact of individual variables of the socio-economic situation on the economic, social, and environmental development of manufacturing enterprises in France, Germany, Italy and Poland.

The economic development of manufacturing enterprises in all countries is most often influenced by the social development of manufacturing enterprises, while the social development of manufacturing enterprises is most often influenced by the economic development of manufacturing enterprises. In France, Italy and Poland, the environmental development of manufacturing enterprises is most often influenced by the social development of manufacturing enterprises.

Table 2. Results of SUR regressions in the period from 2008 to 2020:

$$\begin{cases} EKO = \propto_0 + \propto_1 SOC_t + \propto_2 ENV_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \\ SOC = \propto_0 + \propto_1 ECO_t + \propto_2 ENV_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \\ ENV = \propto_0 + \propto_1 ECO_t + \propto_2 DOC_t + \propto_3 GCI_t + \propto_4 HDI_t + \propto_5 KOF_t + \propto_6 MSP_t + \varepsilon_i \end{cases}$$

Country	Dependent variable	Independent variable	Coefficient	Std. error	p-value	R^2
France	ECO	Const	−0.230	0.071	0.009	0.876
		SOC	1.757	0.182	0.001	
		ENV	−0.217	0.116	0.092	
	SOC	Const	−2.791	1.298	0.057	0.906
		ECO	0.513	0.066	0.001	
		HDI	3.340	1.483	0.045	
	ENV	Const	−0.530	0.135	0.004	0.878
		ECO	−0.600	0.236	0.032	
		SOC	1.025	0.381	0.025	
		GCI	0.045	0.006	0.001	
Germany	EKO	Const	−11.121	2.730	0.002	0.876
		SOC	0.774	0.214	0.005	
		HDI	11.964	3.978	0.003	
	SOC	Const	−0.309	0.195	0.144	0.848
		ECO	0.319	0.095	0.007	
		MSP	1.116	0.347	0.009	
	ENV	Const	−24.531	3.420	0.001	0.791
		HDI	45.464	8.706	0.001	
		KOF	−0.177	0.078	0.049	
		MSP	−3.084	0.644	0.001	

Country	Dependent variable	Independent variable	Coefficient	Std. error	p-value	R^2
Italy	ECO	Const	−10.181	3.071	0.009	0.869
		SOC	0.672	0.238	0.020	
		ENV	−0.921	0.158	0.001	
		KOF	0.134	0.040	0.008	
	SOC	Const	−11.918	1.395	0.001	0.948
		ECO	0.419	0.045	0.001	
		HDI	13.841	1.590	0.001	
	ENV	Const	−39.648	5.329	0.001	0.874
		SOC	1.761	0.251	0.001	
		HDI	32.938	7.150	0.001	
		KOF	0.148	0.027	0.001	
Poland	ECO	Const	8.354	2.183	0.004	0.942
		SOC	1.736	0.219	0.001	
		KOF	−0.124	0.030	0.003	
		MSP	2.745	0.460	0.001	
	SOC	Const	−2.529	0.773	0.014	0.950
		ECO	0.346	0.050	0.001	
		ENV	−0.232	0.050	0.002	
		GCI	−0.006	0.002	0.007	
		KOF	0.045	0.010	0.003	
		MSP	−0.998	0.207	0.002	
	ENV	Const	2.131	0.314	0.001	0.746
		SOC	1.613	0.239	0.001	
		GCI	−0.023	0.006	0.003	

Source: own elaboration.

HDI has the highest positive impact on the economic, social, and environmental development of manufacturing enterprises (economic development in Germany, social development in Italy, and environmental development in Germany). The environmental development of manufacturing enterprises has the highest negative impact on the economic development of those enterprises (Italy); environmental development requires costs and therefore reduces the financial result. The economic equilibrium index has the highest negative impact on the social and environmental development of manufacturing enterprises (social development in Poland, and environmental development in Germany).

The negative impact of the economic equilibrium index on the social and environmental development of manufacturing enterprises means that maintaining macroeconomic stability does not go hand in hand with social and environmental development.

Discussion

The sustainable development of enterprises means stable development in the three pillars: economic, social, and environmental. The sustainable development of manufacturing enterprises depends on several factors, including socio-economic conditions, as confirmed by our research (Kurniawan and Managi 2018; Bilan et al. 2019; Umar et al. 2020; Koirala and Pradhan 2020).

We positively verified the main research hypothesis, i.e., "In the studied countries, there is a significant variation in the directions and strength of the impact of individual socio-economic factors on the sustainable development of manufacturing enterprises from 2008 to 2020." At the same time, it should be noted that the economic equilibrium from the previous period has a statistically significant impact ($p < 0.05$) on the sustainable development of manufacturing enterprises in Poland. Thus, we confirm the research results which show the impact of stabilization or macroeconomic condition on sustainable development in developing countries (Kirikkaleli and Ozun 2019, pp. 351–367; Pieloch-Babiarz, Misztal, and Kowalska 2021; Comporek, Kowalska, and Misztal 2022).

In addition, we noted that the previous period's globalization impacted sustainable development in Poland's enterprises (Agliardi and Xepapadeas 2019). In Italy, the sustainability of manufacturing enterprises is influenced by globalization and social development. Similarly, in Germany, the influence of these factors from previous periods on the level of development was also noted (Kirikkaleli and Ozun 2019). In France, manufacturing enterprises' sustainable development is negatively influenced by the social development and competitiveness of the previous period, which may mean that these entities are primarily focused on market competition. We agree that education and globalization influence sustainable development (Jickling and Wals 2008; Stofkova and Sukalova 2020).

Answering the first research question, *Does sustainable development have greater dynamism in higher developed countries?*, we cannot state unequivocally that sustainable development has greater dynamics in developed countries than in Poland. The highest rate of growth of the index occurs in France, while in Poland, it is similar to the German level. We agree with researchers that sustainable development is a complex phenomenon (Mehmet and Soytas 2019; Shiel, do Paço, and Alves 2020; Adebayo and Kirikkaleli 2021). The country's level and dynamics may differ depending on the economic sector

(Chen 2016; Liczmańska-Kopcewicz, Mizera, and Pypłacz 2019; Pieloch-Babiarz, Misztal, and Kowalska 2021).

It cannot be said that economic development is more dynamic or at a higher level than social or environmental development in the analyzed countries. Moreover, increasingly higher environmental and social development results have been observed in developed countries in recent years. Although all the pillars of sustainable development have positive dynamics in Poland, economic development still seems essential. We agree that economically stable countries are more willing to make environmental and social investments (Kurniawan and Managi 2018; Bilan et al. 2019; Umar et al. 2020).

When answering the third research question, it should be noted that only economic equilibrium from the previous period had a statistically significant impact in Poland; this may be because, after joining the European Union, Poland had to introduce several changes in its fiscal and monetary policy (Misztal 2020, pp. 32–40).

The answer to the last research question can be found in the estimation results of the structural model with three equations. The SUR models indicate a high level of differentiation of factors that influence economic, social and environmental development in the studied countries. These results indicate that there is differentiation in terms of the impact of socio-economic factors, which may be the result of a different structure of economic entities, different development conditions, differences in size, structure, and different socio-economic conditions affecting the sustainable development of industrial enterprises (Bilan et al. 2019; Wang, Jiang, and Zhan 2019).

Our results indicate that sustainable development and its individual economic, social and environmental dimensions have positive dynamics in the studied countries. This phenomenon is positive as it indicates that actions taken by enterprises, external support for development, and more restrictive legal regulations are starting to bring positive results. However, it is necessary to introduce further changes, which are crucial for stable development in the era of socio-economic changes and geopolitical threats.

We confirm that socio-economic conditions have a statistically significant impact on the sustainable development of manufacturing enterprises. Their directions are different, meaning that the planet's future depends on actions taken in all socio-economic areas (Geels et al. 2019; Comporek, Kowalska, and Misztal 2022). Moreover, it is necessary to change the European Union's energy and environmental policy approach (Litavcová and Chovancová 2021).

Our research has limitations related to the selection of analytical indicators, the estimation method, and limited access to important statistical data. Of course, it should also be noted that the study omits some indicators, which may also affect the sustainable development of enterprises.

In further research, we will attempt to evaluate the sustainable development of enterprises from other sectors of the economy and assess external and internal determinants for sustainable development.

Conclusions

The sustainable development of enterprises is part of the idea of global sustainable development, as it provides opportunities for the development of the present and future generations. It means stable and sustainable development in three key economic, social and environmental areas.

The research results indicate that the sustainable development of industrial enterprises in France, Germany, Italy and Poland has positive growth dynamics and depends on various socio-economic factors. These factors have a diversified impact in terms of the strength and direction of their impact, which means that there is a large variation among the determinants of sustainable development in those countries.

In France, the sustainable development of enterprises is influenced by social development and competitiveness (negative), while in Germany, it is influenced by social development from the previous period and globalization from the previous period (positive impact). In Italy, it is influenced by social development and globalization (positive influence). Finally, in Poland, globalization from the previous period and the positive economic equilibrium from the previous period have a negative effect. The influence of factors on the pillars of sustainable development is much more diversified, and there was a correlation between the development of individual pillars.

The paper's contribution to knowledge is that it introduced linear and structural equation models, which describe the impact of socio-economic indicators on sustainable manufacturing development. The research has important theoretical implications, as it presents the author's innovative approach to defining and measuring sustainable development and explores how external factors affect the level. The empirical implications include that the results of the analyses can support company managers when making operational and strategic decisions.

State authorities that want to create the foundations for the sustainable development of enterprises must coordinate social, economic and environmental policies. Further activities should reduce the negative impact on the natural environment. It is necessary to change the approach, especially in the provision of energy sources for economic entities and further support from environmental protection funds.

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Wpływ równowagi ekonomicznej, globalizacji, rozwoju społecznego i konkurencyjności rynkowej na zrównoważony rozwój przedsiębiorstw produkcyjnych – przypadek Francji, Niemiec, Włoch i Polski

W artykule przedstawiono wyniki analiz wpływu równowagi ekonomicznej, Wskaźnika Rozwoju Społecznego, Wskaźnika Globalizacji KOF oraz Wskaźnika Globalnej Konkurencyjności na zrównoważony rozwój przedsiębiorstw produkcyjnych i ich komponentów we Francji, Niemczech, Włoszech i Polsce w latach 2008–2021. W naszych badaniach wykorzystaliśmy Klasyczną Metodę Najmniejszych Kwadratów (OLS) oraz Metodę Pozornie Niepowiązanych Równań (SUR). Wyniki analiz pokazują, że badane czynniki zewnętrzne znacząco wpływają na zrównoważony rozwój przedsiębiorstw. Ponadto nasze modele wykazują różną siłę i kierunek zależności między zmiennymi objaśnianymi i objaśniającymi. Nasze modele potwierdzają konieczność skoordynowania polityki makroekonomicznej i środowiskowej. Ważne jest stosowanie skutecznych narzędzi wsparcia gospodarczego, a także zwiększenie presji ze strony instytucji Unii Europejskiej na kraje emitujące szkodliwe substancje.

Słowa kluczowe: zrównoważony rozwój, przedsiębiorstwa produkcyjne, stabilizacja makroekonomiczna, globalizacja, konkurencyjność rynkowa

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Polish Adaptation Policy to Climate Change vs. EU Countries' Adaptation Policies

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Abstract

The purpose of this study is to compare the advancement of Poland's adaptation policy with the policy of other EU countries. Benchmarking was used, and the research was preceded by comparing the degree of climate change impact on the economies of individual EU countries. The study used 12 comparative quantities, forecast to 2100 for 27 countries. The added value of the analysis is the diagnosis that indicates whether the advancement of the adaptation policy of individual countries is appropriate for the projected climate change, together with the indication of the level of the adaptation policy in Poland compared to other member states. It was determined that, compared to Western countries, Poland has the lowest projected impact of climate change, as represented by selected indicators in the study, but it also has the lowest degree of adaptation policies. However, comparing Poland with the other countries that joined the EU in 2004 shows the opposite trend. The survey is a starting point for further analysis of adaptation in its broadest sense, at national, EU, and global levels. It indicates that despite the high rate of increase in the negative consequences of climate change, the implementation of adaptation policies is still insufficient and often at an early stage of planning.

Keywords: climate change, adaptation, adaptation policies

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Introduction

Climate change, in itself, is natural. However, the intensification of the greenhouse effect, caused by an imbalance of greenhouse gases in the atmosphere, has negative consequences for both humans and the environment (Hoegh-Guldberg et al. 2018). Man contributes to this imbalance, and in 2022, the New York Times reported alarming levels of human greenhouse gas emissions in 2021. This happened even though the Paris Agreement was adopted in 2015.

The following questions should therefore be asked: Why are we seeing this negative upward trend? Are countries across the globe failing to take appropriate action despite their declarations? Are these actions mitigating or adaptive, or perhaps both? The Intergovernmental Panel on Climate Change (IPCC) defines them as: "Mitigation: An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (Watson and the Core Team 2001); Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Klein et al. 2007, p. 750). These mitigation and adaptation actions are implemented using appropriate policies. According to the US Department of the Interior Bureau of Land Management (BLM): "The BLM Mitigation Policy establishes consistent principles and procedures for applying mitigation to address reasonably foreseeable impacts to resources and their values, services and/or functions, and directs the Bureau to consider mitigation well in advance of making decisions about anticipated public land uses" (BLM n.d.). In terms of adaptation policy, the United Nations Development Programme has developed the Adaptation Policy Framework, based on four principles (Lim and Spanger-Siegfried 2004):

- Adapting to short-term climate variability and extreme events is a starting point for reducing vulnerability to longer-term climate change;
- Adaptation occurs at different levels in society, including the local level;
- Adaptation policy and measures should be assessed in a development context; and
- The adaptation strategy and the stakeholder process by which it is implemented are equally important.

The purpose of this paper is to indicate how advanced Poland's adaptation policy is compared to other EU countries. The advancement of Poland's adaptation policy was verified against the background of the member states admitted after 2004 (hereinafter: new member states) and the EU countries from 2015. The following hypothesis was adopted: Despite the negative impact of climate change on the economy and society in Poland, the adaptation policy is at a low level compared to other EU member states.

As a research method, benchmarking was used. It is a management method that can be defined as a creative comparison with best practices. It involves learning from leaders in the field of best practices, not copying ready-made solutions but imitating and improving ways of dealing with them. The idea of benchmarking is to seek ideas and set standards for organizations and business entities by comparing and looking for good practices. The research was preceded by comparing the degree of climate change's impact on the economies of individual EU countries. A limitation of this study, however, is the lack of data for Croatia, Malta, Cyprus, and Luxembourg. Therefore, these countries were not included in the analysis.

Comparative analysis of adaptation measures to climate change – methodological assumptions

Two benchmarking studies were carried out to compare the degree of climate change impact on the economies of individual EU countries and to determine how advanced Poland's climate change adaptation actions are compared to other EU countries: 1) Poland and countries that joined the EU after 2004, and 2) Poland and EU–15 countries (Croatia, Malta, Cyprus, and Luxembourg were excluded due to the lack of data).

The comparative analysis presented below uses the following comparative quantities:

1) Projected climate change from 2071 to 2100 (compared to 1961 to 1990);
2) Projected changes in temperatures during the summer months (June–August) from 2000 to 2100;
3) Projected changes in temperatures during the winter months (December–February) from 2000 to 2100;
4) Projected changes in rainfall from 2071 to 2100 (compared to 1961 to 1990);
5) Total cost per capita of weather events from 1980 to 2015 (including three types of events: meteorological, i.e., storms; climatological, i.e., extreme temperatures and droughts; hydrological, i.e., floods, creek floods, storms, and lake freezing;
6) Projected annual GDP loss in millions of euros due to climate change by 2080;
7) Projected annual change in agricultural crops due to climate change by 2080;
8) Climate change vulnerability index;
9) Level of reported willingness to develop policies and take adaptation actions at the national level;
10) Increased level of public awareness of the need for adaptation;

11) Stage in the adaptation policy development process;

12) Recognition of the need to put climate change adaptation on the national policy agenda.

The unpredictability of weather conditions and the intensity and effectiveness of prevention efforts contribute to the lack of a single scenario for change progression (PESETA 2009, pp. 32–35). This study uses the breakdown of possible scenarios identified by the European Commission (PESETA, Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis) and the IPCC.

The benchmark data in rows one and four are presented for the four climate change scenarios extracted in the PESETA II report (PESETA 2009):

- *Reference Simulation* – a simulation that represents the main features of the entire set of 12 A1B simulations, not including the conduct of significant mitigation actions (it includes simulations A1B KNMI-RACMO2-ECHAM5, A1B ECHAM5-UKMO).
- Reference Variant 1 – warmer and drier than average values for the direction of climate change (it includes simulations A1B METO-HC-HadRM3Q0-HadCM3Q0, A1B ECHAM5-DMI).
- Reference Variant 2 – colder and wetter than average values for the direction of climate change (it includes simulations A1B DMI-HIRHAM5-ECHAM5, A1B EGMAM2006-FUB).
- 2°C – a simulation based on the E1 scenario, used to illustrate future climate change impacts if global mitigation actions are pursued (it includes simulations MPI-REMO-E4, E1 ECHAM5.4-MPI).

The IPCC has distinguished the following climate change scenarios from 2071 to 2100 (rows 6–10 Tab. 1, 2a, 2b) (Christensen, Carter, and Rummukainen 2007):

- B2 – Global model HadAM3H/HadCM3, Regional model – HIRHAM, concentration C02 561 ppm, temperature increase 2.5°C.
- A2 – Global model HadAM3H/HadCM3, Regional model – HIRHAM, concentration C02 709 ppm, temperature increase 3.9°C.
- B2 – Global model ECHAM4/OPYC3, Regional model – RCAO, concentration CO2 561 ppm, temperature increase 4.1°C.
- A2 – Global model ECHAM4/OPYC3, Regional model – RCAO, concentration CO2 709 ppm, temperature increase 5.4°C.

Croatia was omitted from the analysis due to the selectivity of available data. The lack of data for Malta, Cyprus, Luxembourg, and Croatia is explained by the fact that these countries are not single regions in the economic model.

GEM-E3 is a dynamic and computational general equilibrium model that includes interactions between the economy, the energy system, and the environment. It is designed to evaluate energy, climate, and environmental policies. The GEM-E3 model is used to assess the distributional and macroeconomic effects of policies on different economic sectors across countries (European Commission 2017). For changes in temperature and precipitation, due to their geographical locations, Malta is expected to experience changes similar to Italy, Luxembourg to France, and Cyprus to Greece.

The data collection process began with a comparative analysis of secondary sources, including, but not limited to, Polish and foreign publications, reports, materials, and internet sources. The collected data are presented in Tables 1 (EU countries that joined in 2004 and later), 2a, and 2b (EU–15). The following country designations (according to ISO 3166–1) were used: Austria – AT, Belgium – BE, Bulgaria – BG, Cyprus – CY, Czech Republic – CZ, Denmark – DK, Estonia – EE, Finland – FI, France – FR, Germany – DE, Greece – GR, Hungary – HU, Ireland – IR, Italy – IT, Latvia – LV, Lithuania – LT, Luxembourg – LV, Malta – MT, Netherlands – NL, Poland – PL, Portugal – PT, Romania – RO, Slovakia – SK, Slovenia – SL, Spain – ES, Sweden – SE, UK – GB.

Benchmarking results of the new EU member states

Table 1 presents the results of benchmarking for twenty-two variables listed above, obtained for the new EU member states (Croatia is not included due to a lack of data).

Table 1. Benchmarking results for new EU member states

Benchmarking size	PL	CY	CZ	EE	LV	LT	MT	SK	SL	HU	BG	RO
1a) Increase by [°C]	2.8	3.2	3.0	3.8	3.8	3.8	3.2	3.0	3.0	3.0	3.2	3.0
1b) Increase by [°C]	3.7	3.7	3.8	4.8	4.8	4.8	3.7	3.8	3.8	3.8	3.7	3.8
1c) Increase by [°C]	2.0	2.4	2.0	3.4	3.4	3.4	2.4	2.0	2.0	2.0	2.4	2.0
1d) Increase by [°C]	2.1	2.3	2.1	3.2	3.2	3.2	2.3	2.1	2.1	2.1	2.3	2.1
2) Change by [°C]	3.3–3.7	4.1–4.9	3.3–3.7	3.3	3.3–3.5	3.3–3.5	4.1–4.9	3.3–3.7	3.7–4.1	3.9–4.1	4.1 –4.3	3.7–4.1
3) Change by [°C]	3.4–3.8	2.2–3	3.4–3.8	4.6	4.2	4.2	–0.2 – + 2.6	3.4–3.8	1.8–2.6	3–3.4	1.8 –2.9	3
4a) Change by [%]	2.8	– 19	0	18	18	18	– 19	0	0	0	– 19	0
4b) Change by [%]	3.7	– 14	– 7	16	16	16	– 14	– 7	– 7	– 7	– 14	– 7
4c) Change by [%]	2.0	– 14	5	21	21	21	– 14	5	5	5	– 14	5
4d) change by [%]	2.1	– 14	– 3	11	11	11	– 14	– 3	– 3	– 3	– 14	– 3
5 [euro per capita]	376	514	940	71	149	270	156	308	738	556	288	486
6a) [bln euro]	15	6	– 2	– 6	– 6	– 6	6	– 2	– 2	– 2	6	– 2
6b) [bln euro]	19	18	0	– 6	– 6	– 6	18	0	0	0	18	0
6c) [bln euro]	12	8	3	– 5	– 5	– 5	8	3	3	3	8	3
6d) [bln euro]	22	42	9	– 9	– 9	– 9	42	9	9	9	42	9
7a) [%]	– 1	0	5	37	37	37	0	5	5	5	0	5
7b) [%]	– 3	– 12	5	39	39	39	– 12	5	5	5	– 12	5
7c) [%]	2	– 4	3	36	36	36	– 4	3	3	3	– 4	3
7d) [%]	– 8	– 27	– 3	52	52	52	27	– 3	– 3	– 3	27	– 3
8	0.21–0.37	0.37–0.52	0.3–0.37	0.26–0.3	0.26–0.3	0.21–0.26	=>0.52	0.21–0.37	0.21–0.26	0.37–0.52	0.37–0.52	0.26–0.52

Benchmarking size	PL	CY	CZ	EE	LV	LT	MT	SK	SL	HU	BG	RO
9	Average	High	Low	Average	Average	Average	High	Average	Low	Average	High	Average
10	Lack of growth	Growth	Lack of growth	Lack of growth	Lack of growth	Growth	Growth	Growth	Growth	Lack of growth	Growth	Growth
11	Decision phase	formulating phase	formulating phase	formulating phase	formulating phase	monitoring and evaluation	implementation	formulating phase	formulating phase	Decision phase	formulating phase	Decision phase
12	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES

Source: own work based on: European Commission 2009, p. 24; PESETA 2009, pp. 32–35; Ciscar, Iglesias, and Soria 2011, p. 2681; Norwegian Meteorological Institute 2013, p. 83; Eurostat 2014, pp. 24–27.

The projected average temperature increase for the EU countries, depending on the scenario, varies from 2.4 to 3.9°C. In the new member states, the highest increases, for all scenarios, will occur in Estonia, Latvia, and Lithuania. Changes in temperature in Poland (like the countries of Central and Southern Europe) are below the EU average.

Breaking down the months into summer and winter, June–August will see the highest increases in Cyprus and the lowest in Estonia, while December–February will see the highest increase in Estonia and the lowest in Malta. In Poland, the projected temperature changes in summer increased from 3.3 to 3.7°C, and in winter, from 3.4 to 3.8°C. The same increase is expected in the Czech Republic and Slovakia. Poland takes sixth place among new EU members in the projected temperature changes of the winter months.

The analysis of precipitation intensity for the new member countries indicates a change in precipitation ranging from a decrease of 2% to an increase of up to 6% (depending on the scenario). A shift from south to north will be observed. Accordingly, in the new member states, the greatest increases in precipitation will occur in Estonia, Latvia, and Lithuania, followed by Poland; the greatest decreases will be in Cyprus, Malta, and Bulgaria.

In the new member states, the highest level of per capita losses due to weather events from 1980 to 2015 occurred in the Czech Republic and Slovenia, with the lowest in Estonia. Poland, with a loss of €376 per person, ranked sixth.

The largest increases in annual GDP loss by 2080 are expected in Poland (between €12 billion and €22 billion), Cyprus, Malta, and Bulgaria (between €8 and €41 billion). In Estonia, Lithuania, and Latvia, annual GDP growth as a result of climate change is expected to be between €1 and 9 billion (ceteris paribus). In these countries, the beneficial impacts of climate change can be expected in agriculture, where climate change-induced increases in crops are projected to be between 36 and 52% by 2080, with agricultural GDP growth between 0.08 and 0.9%. In the remaining countries, a 2.5°C increase in temperatures will not result in significant changes. However, if the other scenarios come true, it will result in a clear northward shift in agricultural sector revenues. In Cyprus, Bulgaria, and Malta, declines will range from 4 to 27%. Polish agriculture may record a 2% increase with an increase in average temperatures of only 4.1°C; in other cases, decreases of between 1% and 8% are estimated.

Analyzing the changes in atmospheric conditions in the new member states, the following common features can be observed:

- Lithuania, Latvia, and Estonia: there will be an increase in temperature well above the global average, a decrease in ice cover (including lake and river ice), an increase in river flow, the northward movement of species, an increase in crop yields, a decrease in energy demand for heating, an increase in hydropower potential, the risk of increased damage from winter storms, and an increase in summer tourism.

- Poland, Slovakia, Slovenia, Hungary, Bulgaria, and Romania: there will be an increase in extreme temperatures, a decrease in summer precipitation, an increase in water temperature, an increased risk of forest fires, and a decrease in the economic value of forests.
- Cyprus, Malta, and Croatia: there will be an increase in temperature well above the European average, a decrease in annual precipitation and annual river flow, an increase in the risk of biodiversity loss, an increased risk of desertification, decreasing agricultural yields, an increased risk of forest fires, an increase in heatwave mortality, and a decrease in summer tourism income and a potential increase in other seasons.

Climate change impacts on European countries are presented in the form of a synthetic index. This climate change index combines information on drought vulnerability, populations affected by river flooding and exposed to coastal erosion, and the agriculture, fisheries and tourism sectors' exposure to climate change. The index shows an asymmetric peripheral core pattern for the EU. The regions under greatest pressure tend to be in the south and east of Europe. This is mainly due to changes in rainfall and rising temperatures, which affect vulnerable economic sectors. Among the new member states, the highest values were indicated for Malta, followed by Cyprus, Bulgaria, and Romania. The value of the index has been presented in ranges because it may differ within one country. Thus, the southern part of Poland has the same value as the northern part of Bulgaria, Romania, and the north-western part of the Czech Republic.

The adaptation policies of the new EU member states

The *National Adaptation Strategy* (NAS) and *National Adaptation Programs of Action* (NAPA) provide a general and non-binding policy framework for guiding the adaptation efforts of state authorities and non-state actors. At the national level, they play a key role in creating the "right environment" for planning and implementing specific actions. At this level, mid-term adaptation objectives are formulated, political support is obtained, and coordination mechanisms are established to ensure the involvement of key actors. In general, the development of a national adaptation policy (strategy and/or plan) is an instrument to provide the necessary framework for adaptation and/or adaptation to climate change by coordinating the consideration of climate change across different sectors, latitudes, and levels of decision-making (World Bank 2010, p. 334).

Critics of NAS and NAPA point to three main problems that must be overcome. First, NAPA introduces similar projects in different countries without considering their other specific adaptation needs. Second, many adaptation projects are hard to distinguish from standard development projects. Third, NAPA is not linked to ministries in individual countries, focusing mainly on local institutions. The reasons for these problems include insufficient funding to prepare adaptation plans, an emphasis on the impor-

tance of adaptation in sectors that are most vulnerable to the negative impacts of climate change around the world, i.e., agriculture and natural resources, and the assumption that adaptation actions are more effective when carried out at the local and regional levels, thus reaching a wider audience (World Bank 2010, p. 334).

A survey conducted by *The European Environment Agency* (EEA) showed that a decline in "willingness to develop policies and take adaptation measures at the national level" was observed in EU member states. "Low readiness" was indicated by the Czech Republic and Slovenia, "medium readiness" was declared by Poland, Estonia, Lithuania, Latvia, Hungary, and Romania, and "high readiness" by Cyprus, Bulgaria, and Malta (Eurostat 2014, pp. 24–27).

The adaptation plans of the seven new member countries are in the early stages of "formulation" (although the first phase of the study is "scheduling"). Poland, along with Hungary and Romania, is at the "decision" stage. Malta and Latvia declared the most advanced phase, implementing planned adjustment measures. Seven countries declared an increase in public awareness of the need for adaptation measures; however, Poland, the Czech Republic, Estonia, Latvia, and Hungary were among the countries where public awareness remained unchanged at a low level (Eurostat 2014, pp. 24–27).

All of the countries recognize the problem of gradual climate change, but their adaptation plans and strategies are at different stages of implementation. The Czech Republic, Hungary, Bulgaria, Lithuania, and Estonia have limited adaptation to mitigating and reducing carbon emissions (e.g., a low-carbon economy, a reduction in energy consumption, and using alternative energy sources). The adaptation strategies in Cyprus, Latvia, Malta, Slovakia, Slovenia, Romania, and Poland assume the need for preventive action and adaptation in key sectors of the economy. The strategies of these countries indicate the need for adaptation measures not only at the central level, but also at the local level. In addition, actions are needed in vulnerable sectors such as agriculture, forest protection, fisheries, and coastal management.

Moreover, the strategies of Latvia, Poland, Slovenia, and Romania emphasize the importance of education and dialogue between all economic actors. It is possible to implement a national climate change adaptation strategy through inter-ministerial cooperation. Therefore, appropriate joint actions of ministries or departments to adapt to the new climate reality can bring tangible benefits. The countries that will be most negatively affected by climate change are Cyprus, Malta, Bulgaria, and Poland. These countries have the highest rates of climate change, the largest losses in estimated GDP, and the highest income declines in the agricultural sector. Among the most vulnerable countries, only Bulgaria's plan focuses on mitigation with adaptation.

Member State benchmarking results for the EU–15

Tables 2a and 2b present the results of the collection of respondents obtained for the EU–15.

Table 2a. Benchmarking for the EU–15 compared to Poland

Benchmark volume	PL	AT	BE	DK	FI	FR	LU	GR	ES
1a) Growth by [°C]	2.8	3.0	2.8	3.8	3.8	3.0	3.0	3.2	3.2
1b) Growth by [°C]	3.7	3.8	3.7	4.8	4.8	3.8	3.8	3.7	3.7
1c) Growth by [°C]	2.0	2.0	2.0	3.4	3.4	2.0	2.0	2.4	2.4
1d) Change by [°C]	2.1	2.1	2.1	3.2	3.2	2.1	2.1	2.3	2.3
2) Change by [°C]	3.3–3.7	3.3–3.7	3.3–3.7	3.3–3.7	3.3–3.7	3.3–4.1	3.3–4.1	4.1–4.9	4.1–4.9
3) Change by [°C]	3.4–3.8	3.4–3.8	3.4–3.8	3.4–3.8	4.2–5.8	1–2.6	1–2.6	2.2–3	–0.2 – +2.6
4a) Change by [%]	2.8	0	8	18	18	0	0	– 19	– 19
4b) Change by [%]	3.7	– 7	1	16	16	– 7	– 7	– 14	– 14
4c) Change by [%]	2.03	5	15	21	21	5	5	– 14	– 14
4d) Change by [%]	2.1	– 3	3	11	11	– 3	– 3	– 14	– 14
5 [euro per capita]	376	1535	364	1815	352	948	1519	677	812
6a) [billion euro]	15	– 2	15	– 6	– 6	– 2	– 2	6	6
6b) [billion euro]	19	0	19	– 6	– 6	0	0	18	18
6c) [billion euro]	12	3	12	– 5	– 5	3	3	8	8
6d) [billion euro]	22	9	22	– 9	– 9	9	9	42	42
7a) [%]	– 1	5	– 1	37	37	5	5	0	0
7b) [%]	– 3	5	– 3	39	39	5	5	– 12	– 12
7c) [%]	2	3	2	36	36	3	3	– 4	– 4

Benchmark volume	PL	AT	BE	DK	FI	FR	LU	GR	ES
7d) [%]	– 8	– 3	– 8	52	52	– 3	– 3	– 27	– 27
8	0.21–0.37	0.26–0.37	0.26–0.37	0.26–0.37	0.21–0.26	0.21–0.37	lack of data	0.37–0.52 and more	0.37–0.52 and more
9	Average	High	Average	High	Average	High	lack of data	average	High
10	lack of growth	growth	growth	growth	growth	growth	Lack of data	growth	Growth
11	decision phase	imple-menta-tion	imple-menta-tion	imple-menta-tion	moni-toring and eval-uation	moni-toring and eval-uation	lack of data	schedul-ing	imple-menta-tion
12	YES	NO	YES	YES	YES	YES	lack of data	NO	YES

Source: own work based on: European Commission 2009, p. 24; PESETA 2009, pp. 32–35; Ciscar, Iglesias, and Soria 2011, p. 2681; Norwegian Meteorological Institute 2013, p. 83; Eurostat 2014, pp. 24–27.

Table 2b. Benchmarking EU–15

Benchmark volume	PL	NL	IR	DE	PT	SE	GB	IT
1a) Growth by [°C]	2.8	2.8	2.1	2.8	3.2	3.8	2.1	3.2
1b) Growth by [°C]	3.7	3.7	2.9	3.7	3.7	4.8	2.9	3.7
1c) Growth by [°C]	2.0	2.0	1.7	2.0	2.4	3.4	1.7	2.4
1d) Growth by[°C]	2.1	2.1	1.4	2.1	2.3	3.2	1.4	2.3
2) Change by [°C]	3.3–3.7	3.3–3.7	3.3–3.7	3.3–3.7	4.1–4.9	3.3–3.7	3.3–3.7	4.1–4.9
3) Change by [°C]	3.4–3.8	3.4–3.8	1.4–3	3.4–3.8	–0.2 – +2.6	4.2–5.8	1.4–3	–0.2 – + 2.6
4a) Change by [%]	8	8	8	8	– 19	18	8	– 19
4b) Change by [%]	1	1	2	1	– 14	16	2	– 14
4c) Change by [%]	15	15	12	15	– 14	21	12	– 14
4d) Change by [%]	3	3	7	3	– 14	11	7	– 14

Benchmark volume	PL	NL	IR	DE	PT	SE	GB	IT
5 [euro per capita]	376	412	1009	1159	579	466	976	1129
6a) [billion euro]	15	15	6	15	6	– 6	6	6
6b) [billion euro]	19	19	7	19	18	– 6	7	18
6c) [billion euro]	12	12	2	12	8	– 5	2	8
6d) [billion euro]	22	22	2	22	42	– 9	2	42
7a) [%]	– 1	– 1	– 9	– 1	0	37	– 9	0
7b) [%]	– 3	– 3	– 11	– 3	– 12	39	– 11	– 12
7c) [%]	2	2	15	2	– 4	36	15	– 4
7d) [%]	– 8	– 8	19	– 8	– 27	52	19	– 27
8	0.21–0.37	0.3–0.37	below 0.21	0.19–0.3	0.37–0.52 and more	0.21–0.37	0.21–0.37	over 52
9	Average	high	Average	high	average	average	high	high
10	Lack of growth	Lack of growth	Lack of growth	Lack of growth	growth	lack of growth	growth	growth
11	decision phase	implemen-tation	Decision phase	implemen-tation	Decision phase	Formulat-ing phase	implemen-tation	formulat-ing phase
12	YES	YES	YES	YES	YES	YES	YES	YES

Source: own work based on: European Commission 2009, p. 24; PESETA 2009, pp. 32–35; Ciscar, Iglesias, and Soria 2011, p. 2681; Norwegian Meteorological Institute 2013, p. 83; Eurostat 2014, pp. 24–27.

The projected average temperature increase for EU countries, depending on the scenario, ranges from 2.4 to 3.9°C. In the "old" member states, the highest increases, in all scenarios, will occur in the northern European countries (i.e., Sweden, Finland, Denmark) and the lowest in the UK and Ireland. Changes in temperature for Poland (as well as for other Central European countries) are below the EU average.

The highest increase in temperatures in the summer months is expected in Greece, Spain, Portugal, and Italy. However, while in Spain, Italy, and Portugal, the highest increases (4.9°C) may occur only in some regions, in Greece, practically the whole country is expected to have the maximum possible increase. Poland is in the group of most countries, with an expected temperature increase of 3.3–3.7°C. A similar situation is forecast for the winter months: the biggest changes are expected in Spain, Portugal, Italy, and Greece.

The analysis of precipitation intensity for the EU countries indicates a change in precipitation, ranging from a decrease of 2% to an increase of up to 6% (depending on the scenario). In the EU–15, the highest increases will be in Denmark, Finland and Sweden, and the highest decreases will be in Spain, Portugal and Greece. Poland, Germany, the Netherlands and Belgium can expect increases of between 1 and 15%.

Among the EU–15, the highest total per capita loss due to weather events between 1980 and 2015 was recorded in Denmark, Austria, and Luxembourg (a loss of more than €1500 per capita), while the lowest was recorded in Finland, Belgium, and Poland (a loss of €350–380 per capita). The number of people forecast to be affected by floods is highest for Poland, Germany, Belgium, the Netherlands, Greece, Spain, Italy, and Portugal.

Among the EU–15, the highest annual agricultural production losses for all four scenarios are expected in Italy, Spain, Greece, and Portugal. The positive dimension of climate change is reflected in increases in agricultural production in Denmark, Sweden, and Finland. The agricultural sector in Poland, like in Belgium, Germany, and the Netherlands, is only likely to see increases in the 4.1°C scenario, with the other scenarios predicting decreases of between 1 and 8% per year. Depending on the scenario in the UK and Ireland, changes in agriculture could be either positive (increases of 15 to 19% per year) or negative (decreases of 9 to 11% per year).

Analyzing changes in atmospheric conditions for the EU–15, the following common features can be observed:

- Finland, Denmark, and Sweden: there will be an increase in temperature well above the global average, a decrease in ice cover (including lake and river ice cover), an increase in river flow, the movement of species in the north, an increase in crop yields, a decrease in energy demand for heating, an increase in hydropower potential, a risk of increased damage from winter storms, and an increase in summer tourism.
- Poland, Germany, Belgium, and the Netherlands: there will be an increase in extreme temperatures, a decrease in summer precipitation, an increase in water temperature, an increase in the risk of forest fires, a decrease in the economic value of forests, a decrease in agricultural yields, and an increase in summer tourism.
- The United Kingdom and Ireland: there will be an average increase in temperature and precipitation close to the European average; the profitability of agricultural production will be dependent on the advancement of climate change progress – there will be no unidirectional impact: depending on the implementation of the scenario, there will be decreases or increases; an increase in profitability of the tourism industry, lower frost mortality, and in the absence of adaptation, a high percentage of land loss due to sea level rise.

- Greece, Italy, Spain, and Portugal: there will be an increase in temperature well above the European average, a decrease in annual precipitation and the annual flow of rivers, an increase in the risk of biodiversity loss, an increased risk of desertification, a decrease in the supply of agricultural products, an increased risk of forest fire, an increase in mortality caused by heat waves, a decrease in summer tourism revenues but a potential increase at other times of the year.

In the accepted division of the survey, all of the EU–15 countries recognize the problem of climate change. However, the degree of implementation of adaptation policies, their implementation into national policies, as well as the commitment to financing global action varies. Greece is characterized by a low level of sophistication and commitment to implementing adaptation measures, with high values determining the negative impact of climate on the country. France and Finland's adaptation strategies are at the highest level of implementation. Germany is distinguished by its high contribution to international climate-related expenditures and Sweden by its more than 50% share of Renewable Energy Sources (RES). Germany and France have high levels of primary energy use, while only Poland has an upward trend in its use.

Analyzing the losses resulting from weather events between 1980 and 2015, it is clear that the burden is not evenly distributed. The average for the whole EU is 779 euros per person, although ten countries were above this value, including the Czech Republic. Estonia, which has the lowest cost of all European countries, incurred a cost more than 25 times lower than the country with the highest cost – Denmark.

Analysis of the values of the synthetic climate change index shows that the greatest negative economic and social impacts of climate change are expected in Italy, Spain, Portugal, and Greece. The index has been presented in ranges because it can vary within a country, especially for vast countries. The lowest index is shown for Ireland. In Poland, as in the UK, France, and Sweden, it reaches moderate values (but not low, with values in the south-western regions of these countries estimated to be similar to those for Italy or Spain). Most worrying is that despite the high values for this indicator for Greece, the country has the lowest level of adaptation activity, despite increased public awareness of the need to adapt. The analysis of this indicator also shows that all EU–15 Member States will be affected to a greater or lesser extent by the negative impacts of climate change, with the negative consequences becoming more serious and severe the further south-west in Europe one goes.

Adaptation policy of the EU–15

In most EU–15 countries (eight countries), the level of commitment to policy development and adaptation measures at the national level was described as high. Poland was among those countries that were rated medium. In addition, a greater number of coun-

tries reported increased public awareness of the need to adapt (10 countries). Poland was in the small group of countries where the level of awareness had remained low. Only two countries (Belgium and Greece) indicated that there was no need to adapt their national policies to climate change.

The earliest stage of the adaptation policy-making process (called timetabling) was found only in Greece. Of the EU–15, most are in the "implementation" phase (7 countries), three are one stage lower (including Poland) – in the "decision" phase – and two more (Italy and Sweden) are at an even earlier stage – the "formulation" phase. The highest level of monitoring and evaluation (evolution) was declared in France and Finland.

Conclusions

Regarding negative climate impacts, Europe is divided into North and South, where the negative consequences of climate change become more severe the further south one goes. Indicators such as the total per capita cost of weather events, funding, and the sophistication of adaptation policies divide Europe into East and West, with the higher the level of development, the higher these indicators reach.

Having achieved the goal of the study, it can be stated that Poland has the lowest projected impact of climate change but also the lowest degree of advancement of adaptation policy. However, comparing Poland with the other new member states shows the opposite tendency. Among those countries, Poland has the highest expected impact of climate change on the economy and society, but with a more advanced adaptation policy. For most of these countries, the first stage of implementation, the "formulation phase," is indicated, while Poland has reached the second stage, the "decision phase." Thus, this highest level is not commensurate with the advancement of climate change impacts.

A comparative analysis of all the member states indicates that France, despite the moderate impact of climate change (as measured by the variability of selected indicators in the study), is in the advanced (last) stage of adaptation measures. Meanwhile, Finland can be identified as a country that recognizes climate change and is actively trying to mitigate and adapt to it. Greece, on the other hand, has one of the highest expected impacts of climate change while also having the lowest level of adaptation policy sophistication. Poland, due to its geographic location, is in a slightly better position. However, it is also in the group of countries with the greatest vulnerability to climate change and climate impacts on macroeconomic variables – the highest projected levels of GDP loss and annual change in crops due to climate change. At the same time, it is at an early stage of adaptation policy development, with a medium level of reported willingness to develop policy and take adaptation action at the national level. However, there has been no increase in public awareness of the need for adaptation.

The results indicate that for Polish businesses to be increasingly unaffected by the negative consequences of climate change, following the example of Western countries, they should not only plan for adaptation, but practically implement it on a large scale. And not tomorrow but today. The added value of the presented research results is the preliminary diagnosis of the advancement of the adaptation policy of the Member States against the background of the forecasts of progressing climate change, which will be the basis for many further studies in this area.

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Analiza porównawcza działań adaptacyjnych do zmian klimatu podejmowanych przez kraje członkowskie Unii Europejskiej

Celem niniejszego opracowania jest wskazanie, jaki jest poziom zaawansowania polityki adaptacyjnej Polski w stosunku do polityki innych krajów unijnych. Dokonano analizy sytuacji Polski na tle krajów członkowskich Unii Europejskiej. Wykorzystaną metodą badawczą był benchmarking. Badania zostały poprzedzone porównaniem stopnia wpływu zmian klimatycznych na gospodarkę poszczególnych krajów Unii. W badaniu wykorzystano 12 jednostek porównawczych, prognoza do 2100 roku dla 27 krajów. Wartością dodaną przeprowadzonej analizy jest diagnoza wskazująca, czy zaawansowanie polityki adaptacyjnej poszczególnych krajów jest adekwatne do prognozowanej zmiany klimatu. Na podstawie przeprowadzonych badań ustalono, że na tle państw zachodnich Polska jest krajem o prognozowanym najniższym wpływie zmian klimatu reprezentowanych przez wybrane wskaźniki badania, ale także najniższym stopniu zaawansowania polityki adaptacyjnej. Porównanie Polski z pozostałymi krajami przyjętymi do struktur UE, począwszy od 2004 roku, wskazuje na odwrotną tendencję.

Przeprowadzone badania stanowią punkt wyjścia do dalszych analiz szeroko rozumianej adaptacji o zasięgu zarówno krajowym, unijnym, jak i światowym. Wskazują bowiem, że mimo wysokiego tempa wzrostu negatywnych konsekwencji zmiany klimatu stopień realizacji polityki adaptacyjnej jest wciąż niewystarczający, często na wczesnym etapie planowania.

Słowa kluczowe: adaptacja, polityka adaptacyjna, zmiany klimatu

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The Mundell-Fleming Model and Macroeconomic Stabilization Policies

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Abstract

This paper analyzes the fiscal policy implications set in the Mundell-Fleming (M-F) model and its effectiveness in emerging economies. It also widens the scope of the policy mix with alternative exchange rates. The empirical evidence about the economies of Chile (1991–2003) and Colombia (1994–2004), about institutions, fiscal policy rule, and the eurozone conditions (1999), were considered relevant The paper has three sections a. The budget-surplus fiscal policy rule and policy effectiveness, b. The role of institutions in setting policy rules, c. The experience of the Chilean and Colombian economies concerning fiscal policy rules within the M-F framework. The main conclusion is that as long as country risk is lower due to countercyclical fiscal policy rules, governments have an alternative means of getting funds at a lower international interest rate. The fiscal policy effect on GDP (output)becomes positive.

Keywords: policy rules, monetary policy autonomy, fiscal policy setting

JEL: E5, E6, F3, G2

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Introduction

The standard Mundell-Fleming (M-F) model gives a binary outcome concerning macroeconomic policy effectiveness (Maitra 2017). Thus, fiscal policy is more effective with a fixed exchange rate (1, 0). The opposite is true for monetary policy, which is more effective with a flexible exchange (0, 1) (De Gregorio 2001). This was the key foundation for setting the conditions of the eurozone in 1999. While the euro was in place as the common currency, the fiscal policy was the first policy tool. So, to sustain its value, it was necessary to provide an institutional framework for fiscal discipline concerning the fiscal deficit rule at 3% of GDP.

Nevertheless, understanding the policy implications of this outcome will require a better understanding of the importance of countercyclical fiscal policy, how it is coordinated with monetary policy, as well as the quality of institutions. This argument extends beyond the issue of policy options to make it a proper institutional setting that can fit policy alternatives for controlling output fluctuations (Wang 2005). With monetary policy focused on external balance, fiscal policy focused on the internal balance, and free capital flows, the exchange rate policy, becomes relevant for dealing with the output gap (De Gregorio 2001; Sachs and Larrain 2002).

On the other hand, when it comes to being a reliable player in global financial markets, any government may be interested in improving its reputation (Stokey 1991), showing commitment to policy rules as a credible guideline to shape expected decisions (Bassetto 2005). Most emerging economies, compared to developed ones are characterised by a wide variety of institutional settings and quality standards. Therefore, an institutional gap arises in implementing policy rules. Those countries with higher quality institutions are better positioned to define policy rules than those with weaker institutional settings (Céspedes and Soto 2005). Fragile institutions lead to higher volatility, so it is harder to keep both the stability of the output path and low country risk (Ennis 2007). In fact, given a free capital flow, fiscal and monetary policies are not independent of one another (Vargas 2005; Lozano 2010).

The paper has three sections a. The budget-surplus fiscal policy rule and policy effectiveness, b. The role of institutions in setting policy rules, c. The experience of the Chilean and Colombian economies concerning fiscal policy rules within the M-F framework. The main conclusions are: the fiscal policy concerning output should be reset given free capital flow, flexible exchange rate, and economic agents which diversify their portfolio. As long as the country's risk is lower due to countercyclical policy rules, governments have an alternative source of funds at a lower international interest rate.

The budget-surplus fiscal policy rule and policy effectiveness

There are numerous examples and case studies regarding the experience of fiscal policy rules in Latin American economies: Brazil (1995) (Moreira, Mendonca, and Sachsida 2021), Colombia (2000, 2011), Chile (2000), Mexico (2006), and New Zealand (Grûnwald 2018).

New Zealand gives more weight to transparency than the law (New Zealand Government, 2015). According to IMF (International Monetary Found) data, the fiscal policy rule has become increasingly relevant. In 1990, it registered nine countries with fiscal policy rules. In comparison, in 2015, there were 96 countries (International Monetary Fund 2017). These rules, coordinated with the Central Bank, make a policy framework aimed at reducing output volatility and improving credit worthiness. Moreover, within a rational expectation framework, a monetary policy rule requires a fiscal policy rule (Favero and Monacelli 2005; Moreira, Mendonca, and Sachsida 2021).

The B-S (Budget-Surplus) rule means that given output fluctuations, a fiscal policy follows a countercyclical pattern of spending behaviour. So, when national incomes increase above the expected spending trend, savings increase. When incomes fall below the spending trend, accumulated savings allows people to keep spending. So, when the economic cycle is on the expansion path, savings smooth the expansion such that output growth becomes more stable and less inflationary. On the other hand, when the economic cycle is in a downward trend, spending may keep its pace, softening the impact of output contraction (Grûnwald 2018). The expected outcome is lower output volatility along the different stages of the economic cycle (Piasecki and Wulf 2014).

Other positive externalities of a fiscal policy rule, such as lower country risk level, lower sovereign risk premiums measured by the EMBI (Emerging Market Bond Index), and higher credit worthiness, lead to higher-grade investment status. Governments get more autonomy for alternative sources of financial resources to fund their social programs aside from domestic debt or tax increases. Therefore, a government may issue bonds in the international financial markets at a lower international interest rate, as has been the case in the Chilean economy since 2008 (Fuentes, Schmidt-Hebel, and Soto 2021). How does this countercyclical setting of fiscal policy fit into the M-F model? Let us consider a policy framework with different exchange rate regimes.

The flexible exchange rate

The standard case with perfect capital mobility assumes that fiscal policy does not affect output. However, given that the B-S rule allows a government with a better investment status to obtain funds from external markets while maintaining the parity

condition, there is no impact on the domestic interest rate. With external government sources, other foreign private resources coming in, and with the net inflow of resources higher than the outflow, appreciation of the domestic currency will occur. It may be assumed that the government may use low price elasticity to boost exports. Therefore, some exports of goods with high price elasticity will fall, but others with low price elasticity will keep their growth path. So, output expands, the IS (Investiment Saving) moves along the line of the interest rate parity condition). In order to return to equilibrium in the money market, the LM (Liquidity Money) moves to the right, as a domestic currency is needed.

The Chilean economy in 2008–2009, with the global subprime recession and inflation above the target of 3%, followed a path of expenditure expansion (17% as a share of GDP in 2009) to compensate for the restrictive monetary policy (Fuentes, Schmidt-Hebel, and Soto 2021). The net outcome was a decrease in output because of the strong stand of monetary policy against inflation (Céspedes and Soto 2005). However, the fiscal policy countercyclical expansion made a case for mitigating the expected deeper recession (there was only a –1.5% drop in Chilean GDP growth) (Fuentes, Schmidt-Hebel, and Soto 2021).

The fixed exchange rate

A basic financial wealth model (W_t) is useful to outline the framework of a portfolio with two assets issued in the domestic economy with free flow capital: bonds issued in the domestic currency (*Bd*), and bonds issued in foreign currency (*Bf*), e.g., USD. Both are positively correlated to one another and are risk-free. Investors allocate their resources to either one, following their risk preferences so that by dividing by half their resources, they have 50% of each. Thus, the wealth equation for one period "t" becomes:

$$Max W_t = \alpha_1 B_t d + \alpha_2 B_t f \quad \alpha_1 + \alpha_2 = 1. \tag{1}$$

Additionally, both firms and banks operate in the so-called forward rate market, which means that they decide based on the forward exchange rate (Wolnicki and Piasecki 2021).

Equation (1) says that any domestic investor will react to changes in the expected return of both *Bd* and *Bf* to maximize their wealth in one period. So, an expansive monetary policy would make domestic investors react, increasing their demand for foreign assets. The forward exchange rate expectation puts pressure on the fixed exchange rate, which becomes overvalued. So, the central bank sells its international reserves as needed. However, as domestic investors also sell their Bf to get cash in the domestic currency, the exchange rate moves back endogenously over time to its previous fixed level. However, the outcome is more money in the economy, which puts pressure on the ex-

change rate, which must have monetary policy rules, otherwise, the fixed exchange rate is short-lived. Thus, monetary policy may become effective while the exchange rate is fixed as investors diversify their financial portfolio between *Bd* and *Bf*. Therefore, although a fraction of the initial money supply increase was sterilized, it is the portfolio allocation taking place that is the key variable in the effectiveness of the monetary policy on output (Lozano 2010). It follows that macroeconomic policy rules widen the scope of its effectiveness, given alternative exchange rates.

The eurozone crisis in 2010 is probably within this scenario, with the European Central Bank applying an active monetary policy and buying government and small saver bonds. It simultaneously worked with a monetary policy tied to a 2% inflation rate and an active countercyclical fiscal policy, as the fiscal deficit was restricted to 3% of GDP (Sachs and Larrain 2003; Calderon, Duncan, and Schmidt-Hebel 2004).

The key assumption and weakness in the standard model is that, following a decrease in the interest rate, the portfolio deals with one financial instrument, i.e., bonds issued in the domestic currency (De Gregorio 2001). Given the foreign currency forward market and the portfolio diversification set by equation (1), an expansionary monetary policy will lead to endogenous exchange rate fluctuations around its fixed value. It will also lead to fluctuations in the forward exchange rate, either above (undervalue the fixed exchange rate) or below (overvalued the fixed exchange rate) its expected fixed value, which is a constraint on holding the exchange rate fixed for a long time unless there are monetary policy rules.

It follows that, given the B-S rules for fiscal policy, the interaction between exchange rate stability, capital mobility, and autonomous monetary policy, works properly either with the flexible or fixed exchange rate. With a flexible exchange rate, a sudden but transitory capital outflow would lead to a depreciation that would increase the interest rate. A fixed exchange rate and the expected depreciation would require the Central Bank to reduce its reserves. The aggregate demand contraction due to lower money supply and the higher interest rate would be supported by the countercyclical fiscal policy, making the monetary policy less contractive in the short term. On the financial side, as equation (1) suggests, a portfolio allocation would take place, selling domestic bonds issued in foreign currency to get high-power money, leading to an endogenous increase in money supply, coupled with a less contractive effect on output.

The role of institutions in setting policy rules

Considering the relevance of macroeconomic policy rules and their implications for the M-F model design for policy effectiveness, it is helpful to analyze institutional factors as a boundary for policy design. Do institutions play a role in supporting policy rules? What difference does having stronger or weaker institutions make?

The situation concerning institutional quality is different, whether it deals with developed countries or emerging economies. Developed countries with a higher rate of institutions have better conditions for countercyclical policies than emerging economies with weaker institutions (Calderon, Duncan, and Schmidt-Hebel 2004).

Between 1990 and 2003, 14/20 countries in the sample had an ICRG (Institutional Credit Risk Group) above the breaking point level (58.9 for fiscal policy and 57.5 for monetary policy) to apply countercyclical macroeconomic policies, both fiscal and monetary. South Korea had an ICRG of 74.9, Chile – 73.19, Malaysia – 72.21, and Argentina – 70.59. These countries were among the highest in the ranking.

The ICRG index considers 12 measures of institutional quality: government stability, socioeconomic conditions, investment profile, internal and external conflict, corruption, law and order, ethnic tensions, democratic accountability, religious tensions, military in politics, and bureaucracy quality. Its value goes from 0 (the lowest quality of institutions) to 100 (the highest).

It follows that any particular set of macroeconomic policies is somehow a proxy of the quality of institutions that policymakers have as a constraint. In particular, a cyclical pattern of fiscal behaviour is more sensitive to changes in the quality of institutions, so higher-quality institutions have a higher probability of countercyclical fiscal policy (Calderon, Duncan, and Schmidt-Hebel 2004).

The Chilean economic experience

The Chilean economy had two periods that fit the analysis of countercyclical policies, 1991–2003 and 2003–2008:

- 1991–2003
  - Due to the Asian economic crisis (1997) and the recession in the U.S. (2001), the autonomous Central Bank started to apply its monetary policy based upon an explicit annual inflation target (15–20%), measured by the CPI (Consumer Price Index) Then following a step-by-step approach, it moved to get the necessary credible status before implementing the current format of 2–4% inflation. During this period,

Chilean fiscal policy had a surplus because of increased taxes, which made higher spending possible (Fuentes, Schmidt-Hebel, and Soto 2021).

- To achieve the objective of external payment stability, the initial monetary framework (1991–1999) was complemented with current account targets and a half-flexible exchange rate (dirty floating) within a range defined by the Central Bank. This focus on exchange rate management was a key variable for inflation targets.
- Most of the emerging economies in the 1990s faced inflationary pressures arising from exchange rate fluctuations because of "high pass-through". While the pass-through in Latin American economies was 47%, in average emerging economies, it was 33%, and in developed economies, it was only 9%.
- In Chile, the pass-through was 35%, while in Colombia, it was 38%. This means that both Chile and Colombia were below the average for Latin American economies, but above the average for emerging economies. This factor made the exchange rate a relevant variable for inflation-targeting purposes. Moreover, exchange rate fluctuations had a shorter inflationary channel through tradable goods, which makes it suitable for inflation targeting given an expected depreciation (Céspedes and Soto 2005).
- Concerning the current account, the Chilean central bank also set a target for its deficit. Besides getting the exchange rate within sight of monetary autonomy, the capital account was also regulated by adding a percentage of the reserve (30%) for incoming capital inflows. So, this approach looks like the M-F at its best. The "trilemma" was taken into account in this design: the half-flexible exchange rate, current account deficit targets, and tax for capital inflows allowed the monetary policy to be autonomous enough to achieve the inflationary target.
- The Asian economic crisis (1997–1998) tested this setting. Some data are useful for evaluating the outcomes. The inflation rate moved from 6% (1997) to 4.7% (1998) and 2.3% (1999). In 1998, the real GDP was 3.9%, and in 1999, it was –1.1% (Central Bank of Chile 2001). So, a rigid mix of policy options to get inflation under control as a priority restricted the policy alternatives for the Chilean economic when facing the consequences of the Asian economic crisis.

- 2003–2008
  - With the U.S. recession taking place (2001), the Chilean GDP was 3.3% (2001) and 3.1% (2002) (World Bank 2020). This recession (2001) meant that inflation of 4.5% in 2000 decreased to 2.8% in 2002, but it kept within the level from 1999 (Céspedes and Soto 2005). In 2000, the Chilean economy moved further, setting a budget structural surplus target of 1%. The new fiscal policy approach was complementary to the monetary policy, making a completely different frame-

> work. The inflation target became flexible within the 2–4% range. The exchange rate policy was free-floating, and the capital account was fully open. This update in the policy framework was possible because of the fiscal policy rule, which provided the necessary autonomy to the monetary policy to keep inflation in check, as was the case in the financial recession of 2008.

So, this pattern of improving the quality of macroeconomic tools for stabilization accompanied the increasing credibility of the Central Bank to cope with inflation within the context of free capital flows and its disciplinary stance (Calderon, Duncan, and Schmidt-Hebel 2004).

As the Central Bank's credibility became stronger, its new policy framework was more flexible, allowing it to cope with shocks. At the same time, it allowed higher autonomy to the monetary policy so that free capital flows, flexible exchange rates, and more independent monetary policy became possible. The fiscal policy rule has some positive aspects (Calderon, Duncan, and Schmidt-Hebel 2004; Fuentes, Schmidt-Hebel, and Soto 2021). The 1% budget structural surplus rule made it the "fourth element" of this new policy setting.

The implementation of fiscal policy rules was a high-value innovation for a comprehensive toolkit for dealing with cyclical fluctuations and internal targets for output performance and inflation.

If the interest rate had to move upward, the budget surplus rules were ready to provide the backup: a countercyclical expenditure expansion financed by past savings, reducing output fall and further volatility.

This setting was the one that was applied against the US financial recession of 2008 caused by the subprime financial markets. Additionally, there was empirical evidence that between 2000 and 2005, that there was a positive correlation between the US economy fluctuation and other economies. The Chilean economy had to wait almost one year to register positive impact (Garcia 2008). Moreover, with the global financial sector at risk of collapse, there were difficult choices for policymakers in Chile, given the inflation level of 7,8% in 2007, which was above the target zone (3%). There were two problems to be solved simultaneously. First, there were the food price shocks, which lasted for six to twelve months, coupled with the important share of food in the CPI. There was also the expected recession due to the subprime crisis (Garcia 2008). Therefore, to cope with such a persistent threat to the inflation target, in the last quarter of 2008, the Central Bank increased the prime interest rate from 6.25% to 8.25%.

On the fiscal policy side, the Chilean economy had an accumulated savings of 27% of its GDP. It allowed public spending to increase at a very high rate (12.5% in 2008 and 17% in 2009) to back up the impact of the higher interest rate. So, monetary policy autonomy was fully granted by the fiscal policy rule of a 1% budget surplus, which had been

applied in the Chilean economy since 2001 and updated to 0.5% of GDP growth after the recession, which prevented the need to support domestic activity.

The performance of inflation and Chilean GDP growth in 2008 and 2009, in the middle of a global financial recession, justified the relevance of this complementarity. The inflation rate in 2008 was 7.5%, and GDP growth was 3.5%.

In 2009, the inflation rate (6.3%) was still above target, and GDP growth was –1.6%, which is close, although slightly higher than during the recession of 1999 (–1.1%).

Thus, even though the Asian economic crisis (1999) was different from that of the US (2008), the available policy tools to cope with each one (ceteris paribus) and especially its flexibility account for the difference between the outcomes. In fact, the scope of the 2008 recession was both wider and deeper. Moreover, it was a global recession involving the global financial system, and it lasted almost ten years before returning to normal policy status. Even so, the updated fiscal policy rule (0.5% instead of the original 1% surplus) allowed a faster recovery in the next three years (2010–2012), with average GDP growth of 5.7% and inflation mostly within the target zone of 2–4%. The post-Asian economic recovery (2000–2002), with no B-S rule, was slower, with an average of 3.9%, although inflation was within the target.

The Colombian economic experience

The Colombian economy without fiscal policy rule

If weak institutions do not allow fiscal policy rules, the exchange rate rule becomes the "second-best" plan. It means that to get inflation under control, a target zone for exchange rate depreciation is set.

This is what happened with Colombia's economy (1990–2010). Lacking a fiscal policy rule, the exchange rate rule based on changes in international reserves was implemented to mitigate the pass-through from depreciation to inflation (Vargas 2005). Moreover, the relatively lower "pass-through" factor (38%) (Céspedes and Soto 2005) made the exchange rate a reliable tool for controlling inflation in Colombia's economy.

The institutional situation of the Colombian economy in those years was below the necessary standard to have credible fiscal and monetary policy rules. Countries with a low ICRG (International Country Risk Guide) index are not able to increase government spending while the downside of cyclical fluctuations is taking place (Calderon, Duncan, and Schmidt-Hebel 2004). Thus, between 1990 and 2003, the ICRG for Colombia (55.2) was below the breaking point (58.9 for fiscal policy and 57.5 for monetary policy) to apply countercyclical macroeconomic policies, either fiscal or monetary. By contrast,

Chile had an ICRG of 73.2% (Calderon, Duncan, and Schmidt-Hebel 2004). These factors make it more difficult to evaluate the Mundell-Fleming implications. It depends on a strong institutional environment that provides the conditions for macroeconomic policy to be fully effective.

The exchange rate policy rule in Colombia did not mean a risk-free policy. The question about which rule was more important – the monetary policy or the exchange rate rule – implied credibility considerations on the one hand, and on the other, whether the real commitment was to get inflation or the exchange rate under control. This was mostly because the Central Bank's sterilization policies also meant a risk in terms of its debt position.

The distributional effect of exchange rate fluctuations also had complications. While appreciation was a gain for consumers, it implied a loss for exporters. The opposite was true for depreciation, which was a gain for exporters, but a loss for consumers. So implementing this rule meant the Central Bank's neutrality about its distributive preferences, more so given that between 1991 and 1993, capital controls were lifted.

How did it work? Let us consider two different periods, 1994–1999 and 2000–2004, before the Colombian economy started its fiscal policy rule (2010).

In the first period (1994–1999), the Colombian economy had a large external imbalance which led it to move away from the exchange rate policy rule in 1999 as a consequence of the Asian economic crisis, which led to the GDP falling by –4.2%, coupled with the financial crisis. Moreover, this disequilibrium meant a depreciation of 22% in the middle of the crisis and a drop in external reserves of 18%. Inflation fell from 16.3% in December 1998 to 9.3% in December 1999, as evidence that the policy anchor was the monetary policy and its explicit inflation target, complemented by the exchange rate regime. This would suggest that the free capital flow, exchange rate changes, and monetary policy worked together correctly, with the exchange rate rule playing a key role.

From 2000, an inflation-targeting rule was set, complemented by a floating exchange rate regime aimed at increasing international reserves while keeping volatility under control (Vargas 2005). Between 2000 and 2004, the spillover effects of the uncertainty in Brazil's economy (2002), and its currency depreciation by 30%, hit the Colombian economy while the inflation targeting was fully in place. It led to a series of conventional actions, such as increasing interest rates and reducing external reserves. The intervention in the exchange rate market was a very effective complement to the monetary policy to get output volatility under control. As a result, inflation expectations in Colombia fell in 2001, improving the credibility of the rule as the year-by-year inflation converged toward the target zone of 5–6% in 2004, while the average GDP growth was positive, at 2.9% (Vargas 2005).

The appreciation situation in 2003 led to a similar policy combination between increasing international reserves and inflation target policy. However, the monetary policy effect is stronger regarding the portfolio balance effect.

The Colombian economy with a fiscal policy rule

In mid–2010, the Colombian economy set a fiscal policy rule which was conceived to have a countercyclical fiscal policy, i.e., for a 1% increase in the output gap, the primary surplus increased by 0.3%.

Another purpose was to anchor economic expectations making the adjustment to any shock smoother. There was also the problem of confronting the "Dutch disease" while Colombia improved its productive matrix with mining and energy-related exports. The final goal was to get a more stable economy through a sustainable government budget in the long run and to complement other countercyclical policies.

Some data show how the fiscal policy rule works in terms of GDP growth performance and its impact on creditworthiness in external financial markets. The Colombian economy's average GDP growth between 2014 and 2018 was 2.7%. Another indicator, such as the debt to GDP share, shows that once the fiscal rule was applied (2010), the government debt/GDP ratio increased steadily from 12.5% to 22.5% between 2012 and 2015 (Statista n.d.). This outcome suggests that the fiscal policy rule makes it less risky for international financial markets to grant loans to economies. In Chile, between 2012 and 2018, following the adjustment in the fiscal policy rule, the Government Debt/GDP ratio rose from 11.9% to 25.6% (Statista n.d.).

Conclusions

This paper has allowed us to go deeper into the main setting of the Mundell-Fleming model, which is relevant to emerging economies. They are constrained by macroeconomic policy rules, the behaviour of the economic agents in terms of their portfolio allocation, and the quality of institutions. The positive impact of such a rules on improving credit worthiness and access to international financial markets were analyzed. The main conclusions are: a. given free capital flow, flexible exchange rate, and economic agents which diversify their portfolio, the GDP effect of fiscal policy should be reset, b. as long as the country's risk is lower due to countercyclical policy rules governments have an alternative source of funds at a lower international interest rate, making fiscal policy eligible for GDP in case of the financial crisis like 2008.

The eurozone experience and its 3% limit for the fiscal deficit are considered relevant of the fiscal policy within rules. However, for emerging economies, it requires

institutional conditions that not all meet adequately. This represents a constraint for the Mundell-Fleming model to be applied in the emerging economies, if such institutional conditions do not meet the necessary requirements measured by the ICRG (Institutional Credit Risk Group).

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Model Mundella-Fleminga a polityka stabilizacji makroekonomicznej

W artykule analizowane są implikacje polityczne i gospodarcze wynikające z modelu M-F w odniesieniu do gospodarek wschodzących. Ich zróżnicowane warunki instytucjonalne i kulturowe utrudniają zdefiniowanie prawidłowych reguł polityki fiskalnej w odniesieniu do wyboru reżimów kursowych i ich dopasowania do wymogów polityki makroekonomicznej. Na podstawie doświadczeń z Chile, Kolumbii i Unii Europejskiej podjęta została próba wyjaśnienia, w jaki sposób zasady polityki fiskalnej poszerzają zakres możliwości wykorzystania polityki kursowej. Zasadniczym problemem jest wykorzystanie polityki fiskalnej do stawienia czoła szokom finansowym przy utrzymaniu autonomii polityki monetarnej.

Słowa kluczowe: polityka fiskalna, model M-F, reżimy kursowe, autonomia monetarna

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Analysis of the Impact of Innovative Economic Conditions on the Flow of Workers in the Labour Markets of the European Union Countries

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Abstract

The main purpose of the work is to present the results of empirical research on the impact of innovation levels in the economy on the structure of labour market flows. The analysis of the directions and scale of these flows makes it possible to discover important characteristics of the labour market and thus makes it possible to better construct and target policies to reduce unemployment or activate economically inactive people. The study uses data from the Labour Force Survey (LFS) and experimental job-to-job statistics for the European Union (EU) countries, covering the 2011–2019 period. We conducted research separately for selected groups of economies classified by their level of innovation, i.e. Innovation Leaders, Strong Innovators, Moderate Innovators, and Emerging Innovators. The results demonstrate that the structure of flows in a labour market depends on the innovation level of the respective economy. The main contribution of the study is that it identifies employee flow patterns in the labour markets of individual EU countries from the perspective of the innovation levels of their respective economies. Panel error correction models (ECM) and panel causality tests were used. In countries that are Innovation Leaders, an increase in participation in lifelong learning leads to a parallel increase in employee flow (EE) and job-to-job employee turnover. In countries that are Emerging Innovators, increasing participation in lifelong learning increases turnover, mainly among young people (15–24 age group).

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JEL: J21, O30

Introduction

The increase in economic innovativeness is widely recognised as the key driving force behind the transformative changes occurring in societies. The ongoing changes strongly affect the labour market as they change the rules of how it functions and the ways people perform work. Identifying what is happening in the labour market is essential for designing and implementing active labour market policies. To identify the adjustments taking place in the labour market in full detail, we will use stream analyses that allow for dynamic analysis. Analysing flows involves studying the shifts in individuals' labour market activity across the three primary states of economic activity: employment (E), unemployment (U), and economic inactivity (I). This analysis enables a thorough evaluation of the actual transitions between these states and provides estimates for the probable transitions between them. Thus, it helps to understand and interpret changes in labour market indicators. Labour flows and transition rates underlie the latest unemployment models, based on Mortensen-Pissarides' search-and-matching theory (Mortensen and Pissarides 1994), especially in markets with search frictions. A thorough analysis of flows is essential not only for a scientific description and understanding of the economic reality, but also for rational public intervention in the labour market.

The subject literature includes papers that present the results of research on the impact of the general economic situation and labour markets' flexibility on the dynamics and structure of flows in the labour market. It is assumed that employee flows result mainly from demand-vs.-supply factors (Davis, Faberman, and Haltiwanger 2006, pp. 3–26). The research carried out so far focused on changes in labour market flows that result from the general economic situation (Blanchard and Diamond 1990, pp. 85–143; Fujita and Nakajima 2013), from wage levels (Moscarini and Postel-Vinay 2017, pp. 364–368), from labour market flexibility (Elsby, Hobijn, and Sahin 2011), and from institutional changes (Cournède, Denk, and Garda 2016).

As the results are ambiguous and do not fully explain the labour market changes, this study attempts to obtain more complete knowledge of the adjustments taking place there. Understanding the economic facet of these phenomena is crucial not only for the scientific description of economic reality, but also for planning and optimal public intervention. The international variation of the scale of flows in the labour market is the springboard for the considerations presented in this paper, which focus on the innovation levels of individual economies and their impact on the flows of people in the national labour market. The analysis was conducted separately for four groups

of countries that were distinguished by their respective levels of innovation as measured with the European Innovation Scoreboard (EIS), i.e. Innovation Leaders, Strong Innovators, Moderate Innovators, and Emerging Innovators.

The main purpose of the work is to present the results of empirical research on the impact of the level of innovation in the economy on the structure of flows in the labour market. The main contribution of the study is that it identifies flow patterns in the labour markets of individual European Union (EU) countries from the perspective of the levels of innovation of their respective economies. We demonstrate how the scale and direction of employee flows in the labour market are determined by the economy's level of innovation. Consequently, understanding the structure and direction of workers' flows between individual statuses of economic activity allows us to identify flow patterns in the labour market.

Empirical regularities regarding the flows of labour

Flows of people in the labour market between the three statuses (i.e. employment, unemployment and economic inactivity) depend on the economic cycle. It is one of the issues most frequently described in the literature on labour market flows (Fujita and Nakajima 2013). Most of the published results show that flows from employment to unemployment are countercyclical, while the flows from unemployment to employment are procyclical (Shimer 2010). Research conducted in the wake of the 2008–2009 economic crisis confirmed that employment is characterised by high, procyclical volatility within the economic cycle. Using 1993–2010 quarterly data from the Labour Force Survey for Great Britain, Gomez (2012, pp. 165–175) showed that "every quarter, 6% of all employees are searching for a different job. Job-to-job transition probability is strongly procyclical, but the number of employees searching for a different job is countercyclical." In the United States, however, the rate of people employed but seeking another job was twice as high, at 15%. Balmaseda, Dolado and Lopez-Salido (2000, pp. 3–23) indicate that the type of economic shock is responsible for the cyclical volatility of employment. The dominant role of the negative demand shock caused by the financial crisis of 2008–2009 was of great importance for both the course of the adjustments in the labour market and for the direction of the economic policies pursued.

The existing analysis of theoretical approaches and results of empirical research also indicates that adjustment mechanisms in the labour market are determined by the character of the labour market institutions in individual countries (Blanchard 2005; Cournède et al. 2016; Boeri and van Ours 2021). Labour market institutions, which create a system of norms, incentives and restrictions for the behaviour of labour market actors, influence the economic decisions made by these actors and, consequently, they af-

fect the scale of the labour market's quantitative (in the form of employment changes) and qualitative adjustments to economic shocks (Boeri and van Ours 2021).

The institutional environment of the labour market affects the adjustments that follow economic shocks, and institutional differences are considered the key source of variations in individual countries (Bassanini and Duval 2006). In the subject literature, the labour market's capability to adapt to changing conditions is most often referred to as "flexibility". In macroeconomic terms, labour market flexibility means the ability to recover from economic shocks. Countries with rigid labour markets are characterised by a low probability of people moving between different statuses in the labour market. The existence of restrictions on employee dismissal induces companies to reduce employment as the expected cost of future layoffs increases. The same refers to the cost of adjusting the size of the workforce to changing conditions and needs (Mortensen and Pissarides 1994, pp. 397–415). This is in line with studies that demonstrated that overly restrictive provisions on permanent employment contracts reduce flows to employment (Haltiwanger, Scarpetta, and Schweiger 2013, pp. 11–25). However, Cournède, Denk, and Garda (2016) arrived at different conclusions. They did not find a significant long-term impact of labour market regulations on the probability of transitioning between particular statuses in the labour market. This applies especially to employees with low income and poor qualifications, whose situation does not depend on labour market flexibility but on the quality of vocational activation programs.

Research by Pieroni and Pompei (2008, pp. 325–347) on the Italian economy showed that higher employee turnover negatively affects the innovative activity of enterprises in technologically advanced regions, while the impact is positive in regions with a low level of technological advancement. Increased staff turnover in the traditional sectors of the economy enhances the flows of knowledge and contributes to the intensity of innovative activities.

The analysis of changes in individuals' past statuses in the labour market makes it possible to predict the differentiation of their future positions in this market (i.e. the probability of retaining or changing a given status). Understanding the structure of flows between individual statuses of economic activity allows inferences about the probability of starting (or maintaining) employment, the level of unemployment risk or the tendency for economic deactivation in the population groups identified by specific characteristics (Socha and Sztanderska 2002).

Data and methods

The study makes use of secondary data from the Eurostat database. The spatial scope of the research covers the EU area, i.e. the 27 European countries, divided into four groups by their level of innovation as measured by the Summary Innovation Index (SII), i.e., Innovation Leaders, Strong Innovators, Moderate Innovators, and Emerging Innovators. The SII indicator is based on Community Innovation Surveys (CIS) data and published annually as the European Innovation Scoreboard (*European Innovation Scoreboard 2021* 2021). Many authors use the SII indicator to assess economies' levels of innovation (Janoskova and Kral 2019, pp. 68–83). Data on flows between the employed, unemployed and inactive statuses come from the Labour Force Survey. As the statistics on labour market flows do not capture people who have not changed their status in the labour market, the study additionally includes data on job-to-job rotation. The time range of the data covers 2011–2019.

Correlation analysis was used to make a preliminary assessment of the impact of innovation indicators on the flows in the national labour markets within the EU. In the core research on the relationship between labour market flows and innovation indicators, panel error correction models (ECM) were used. These types of tools, as well as other macroeconomic variables, were also applied in studies on the relationship between the national levels of innovation and direct foreign investment (Akbas, Senturk, and Sancar 2013, pp. 791–812; Erdala and Göçer 2015, pp. 749–758). However, in research on employee flows in the labour market and innovation, no such methods have been used in the available scientific publications. Therefore, the methodological approach used in our study of the relationship between innovation indicators and employee flows in the European labour markets should be considered innovative.

The panel ECM combines the econometric tools from dynamic time series analysis with panel data analysis. The use of this approach was determined by the nature of the data, the need to take into account the impact of historical values of variables (autoregressive processes) on their current values, and the intent to identify a long-run relationship between the labour market indicators and the innovativeness of enterprises. The proposed approach makes it possible to determine a time-independent equilibrium path for cointegrated economic processes along with short-term deviations from this state of equilibrium. This research methodology requires examining the existence of a unit root of the respective time series (Baltagi and Kao 2000, pp. 7–52).

A key element in modelling long-term relationships is to investigate the existence of the following cointegrating relationship:

$$\ln y_{its} = \beta_{i0} + \sum_{j=1}^{4} \beta_{itj} \ln X_{itj} + u_{it}, \quad (1)$$

where:
y_{its} – s-th dependent variable in the i-th cross-section (here: country) in period t,
X_{itj} – j-th explanatory variable in the i-th cross-section (here: country) in period t,
u_{it} – random error terms which are uncorrelated white noise processes.

The following *ys* dependent variables were proposed:

y_1 – transition employment–employment (EE),
y_2 – transition employment–unemployment (EU),
y_3 – transition employment–inactivity (EI),
y_4 – transition unemployment–employment (UE),
y_5 – transition inactive–employment (IE),
y_6 – employee "job-to-job" turnover in the 15–24 age group (JJ_1),
y_7 – employee "job-to-job" turnover in the 15–74 age group (JJ_2).

The following explanatory variables *Xj* were used in the models:

X_1 – percentage of the population aged 25–34 with tertiary education,
X_2 – percentage of the population aged 25–64 involved in lifelong learning,
X_3 – enterprises that provide training to develop or upgrade their personnel's ICT skills,
X_4 – employment in knowledge-intensive activities (% of total employment).

For stationary variables, it is possible to build ECM models and thus estimate short-term relationships. The single-equation model of error correction for stationary variable increments used when analysing short-term relationships for panel data can be written as follows:

$$\Delta y_{it} = \alpha_0 + \sum_{j=1}^{p} \alpha_{1j} \Delta y_{i,t-j} + \sum_{j=1}^{q} \alpha_{2j} \Delta x_{i,t-j} + \gamma ECT_{i,t-1} + \varepsilon_{it}, \quad (2)$$

where:
$ECT_{i,t-1}$ – error-correction term representing the long-term relationship,
p, q – orders of lagged differences in variables (selected using the Schwarz information criterion),
ε_{it} – standard error of the model.

The stationary nature of the time series was ensured by considering logarithmic variables in the models and calculating their first increments. The stationary nature of the time series of logarithmic variables was investigated using panel tests of the unit root – Fish-

er type (PP) and Breitung unit root test (Breitung 2000, pp. 161–178). In the investigation of time series cointegration, the panel tests of Pedroni (1999, pp. 653–670) and Kao (1999, pp. 1–44) were used.

The test results confirmed cointegration in the time series. Therefore, the fully modified ordinary least squares (FMOLS – *Fully Modified Least Squares*) method was used to estimate long-term relationships between seven explanatory variables according to Model 1. The analysis was conducted separately for groups of Innovation Leaders, Strong Innovators, Moderate Innovators and Emerging Innovators.

Results

Countries were grouped in terms of innovation level according to the European Innovation Scoreboard 2021:

- Innovation Leaders: Belgium, Denmark, Finland, and Sweden.
- Strong Innovators: Austria, Estonia, France, Germany, Ireland, Luxembourg, and the Netherlands.
- Moderate Innovators: Cyprus, Czechia, Greece, Italy, Lithuania, Malta, Portugal, Slovenia, and Spain.
- Emerging Innovators: Bulgaria, Croatia, Hungary, Latvia, Poland, Romania, and Slovakia.

Tables 1–4 present the results of estimating long-term correlation models that show the impact of the X_1–X_4 variables on employee flows and turnovers in the four groups of EU countries.

The data in Table 1 show that among the Innovation Leader countries, a long-term increase in the value of the X_1 variable (the percentage of the population aged 25–34 with tertiary education) simultaneously causes a significant (significance level – 0.05) decrease in EI flows, but a significant increase in all EE flows and in the employee rotation JJ_1 and JJ_2, at the same level of significance, ceteris paribus. An increase in the X_2 variable (the percentage of the population aged 25–64 involved in lifelong learning) significantly decreases IE employee flows (significance level – 0.01) and the volume of EI and EU employee flows (significance level – 0.05) while increasing the volume of EE flows and both JJ turnovers (significance level – 0.01), ceteris paribus. An increase in the X_3 variable (enterprises that provide training to develop or upgrade their personnel's ICT skills) decreases EE employee flows (significance level – 0.05) and JJ_2 employee turnover (significance level – 0.01), ceteris paribus.

A long-term increase in the X_4 variable (employment in knowledge-intensive activities (% of total employment)) significantly increases (significance level – 0.01) EE flows and both JJ employee turnovers, ceteris paribus. Moreover, an increase in this variable at the significance level of 0.05 leads to a significant decrease in the value of other flows, ceteris paribus.

Table 1. Evaluation of long-term relationship parameters in models estimated with the FMOLS estimator for the group of countries classified as Innovation Leaders (data from 2011–2019)

Variable	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
const	β_0	2.022 (2.036)	22.024 (15.165)	15.224 (16.217)	15.762 (6.742)	– 20.022 (26.227)	5.156 (4.158)	– 8.054 (7.884)
lnX_1	β_1	0.221*** (0.072)	– 5.270 (8.493)	– 2.771** (1.152)	5.057* (2.722)	4.447 (9.224)	0.367*** (0.105)	6.014*** (1.805)
lnX_2	β_2	0.075*** (0.020)	– 1.160* (0.653)	– 0.507** (0.227)	– 0.771** (0.279)	– 0.711*** (0.026)	0.247*** (0.023)	0.839*** (0.271)
lnX_3	β_3	– 0.016** (0.009)	– 0.067 (0.432)	0.212 (0.149)	– 0.229 (0.346)	0.296 (0.220)	– 0.052 (0.069)	– 0.456*** (0.104)
lnX_4	β_4	0.219*** (0.012)	– 5.541** (2.477)	– 1.927** (0.795)	– 2.972** (1.172)	– 2.726** (0.979)	0.468*** (0.084)	3.681*** (0.643)
R^2		69.863%	62.23%	83.18%	76.24%	80.22%	75.23%	78.63%

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

Table 2. Evaluation of long-term relationship parameters in models estimated with the FMOLS estimator for the group of countries classified as Strong Innovators (data from 2011–2019)

Variable	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
const	β_0	3.338*** (0.125)	33.381*** (6.050)	– 0.258 (1.712)	5.070*** (1.738)	– 2.837* (1.511)	6.050*** (1.542)	5.411*** (1.128)
lnX_1	β_1	0.050 (0.053)	6.125*** (1.631)	– 0.238*** (0.061)	– 0.373*** (0.071)	– 0.371*** (0.007)	– 0.576*** (0.048)	– 0.491*** (0.052)
lnX_2	β_2	– 0.260*** (0.020)	5.682*** (0.851)	0.828*** (0.268)	0.685** (0.274)	– 1.023*** (0.237)	0.725*** (0.169)	0.682 (0.548)
lnX_3	β_3	0.025** (0.011)	– 0.173 (0.511)	0.120** (0.033)	0.018 (0.238)	0.035 (0.127)	– 0.025*** (0.008)	– 0.065 (0.057)
lnX_4	β_4	– 0.036 (0.033)	– 8.263*** (1.622)	– 0.158 (0.358)	– 0.882*** (0.068)	– 0.332*** (0.004)	– 0.492*** (0.071)	– 0.547*** (0.068)

Variable	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
R^2		84.54%	66.28%	74.52%	71.46%	82.32%	85.27%	78.47%

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

The data in Table 2 show that among the Strong Innovator countries, in the long term, the increase in the X_1 variable (the percentage of the population aged *25–34 with tertiary education*) causes a significant (significance level – 0.01) increase in EU flows and a significant decrease in the EI, UE, IE, JJ_1 and JJ_2 variables. For example, a one-per-cent increase in the *percentage of the population aged 25–34 with tertiary education* increases the flow of EU workers by an average of approx. 6.125%, ceteris paribus. At the same time, it reduces EI flows by an average of approx. 0.238%, ceteris paribus. It can thus be concluded that an increase in the X_2 variable (*the percentage of the population aged 25–64 involved in lifelong learning*) causes a significant increase (significance level – 0.01) in EU, EI, EU, and JJ_1 flows, but a significant reduction in the EE and IE flows (ceteris paribus). A positive and significant impact (significance level – 0.05) of the X_3 variable (*enterprises that training to develop or upgrade their personnel's ICT skills*) is visible in the EE and IE variables, and a negative one (significance level – 0.01) in the JJ_1 turnover (in the other variables representing the flows/turnovers in the labour market, no significant impact of the X_3 variable was found). An increase in the value of the X_4 variable (*employment in knowledge-intensive activities (% of total employment)*) in the long term significantly (significance level – 0.01) reduces the EU, EU, IE flows of employees and the turnovers of JJ_1 and JJ_2, ceteris paribus.

Table 3. Evaluation of long-term relationship parameters in models estimated with the FMOLS estimator for the group of countries classified as Moderate Innovators (data from 2011–2019)

Variable	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
const	β_0	4.510*** (0.061)	1.152*** (0.090)	2.215*** (0.654)	–0.202 (0.622)	–2.025** (0.685)	5.261*** (0.057)	6.053*** (0.075)
lnX_1	β_1	0.012 (0.015)	–0.414*** (0.142)	–0.457*** (0.152)	0.291** (0.152)	0.201 (0.255)	0.214 (0.213)	0.305*** (0.018)
lnX_2	β_2	–0.032*** (0.004)	–0.926* (0.513)	0.522*** (0.086)	–0.904*** (0.136)	1.251*** (0.192)	0.052*** (0.006)	0.137 (0.115)
lnX_3	β_3	–0.022** (0.015)	0.562 (0.428)	0.125** (0.056)	–0.012* (0.006)	0.204** (0.141)	0.032*** (0.000)	–0.092 (0.087)

Variable	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
$\ln X_4$	β_4	0.025 (0.032)	−0.269 (0.552)	−0.251 (0.239)	0.241 (0.223)	−0.028 (0.245)	−0.029 (0.028)	−0.073 (0.140)
R^2		76.54%	88.79%	83.21%	77.45%	70.51%	82.74%	84.17%

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

The data in Table 3 show that among the countries classified as Moderate Innovators, in the long term, an increase in the X_1 variable (*percentage of the population aged 25–34 with tertiary education*) causes a significant (significance level – 0.01) increase in JJ_2 employee turnover and EU flows (significance level – 0.05) but a significant decrease in the EU and EI variables (significance level – 0.01), ceteris paribus.

Table 4. Evaluation of long-term relationship parameters in models estimated with the FMOLS estimator for the group of countries classified as Emerging Innovators (data from 2011–2019)

Vari-able	Parameter	Dependent variable						
		ln*EE*	ln*EU*	ln*EI*	ln*UE*	ln*IE*	ln*JJ_1*	ln*JJ_2*
const	β_0	5.593*** (0.131)	−7.935 (5.556)	−2.602 (2.159)	−5.907*** (1.967)	−10.595*** (2.199)	−7.132*** (1.257)	−3.643 (2.958)
$\ln X_1$	β_1	−0.057*** (0.016)	0.197*** (0.012)	1.579*** (0.299)	1.676*** (0.509)	2.757*** (0.596)	0.517*** (0.012)	1.498*** (0.178)
$\ln X_2$	β_2	−0.003 (0.002)	0.529*** (0.157)	0.053*** (0.017)	−0.303*** (0.053)	0.052*** (0.019)	0.641*** (0.117)	0.071*** (0.021)
$\ln X_3$	β_3	−0.016 (0.010)	0.263* (0.150)	0.550*** (0.165)	0.072 (0.152)	−0.290 (0.196)	0.973 (0.760)	0.499*** (0.110)
$\ln X_4$	β_4	−0.105*** (0.025)	−3.672*** (0.951)	−1.006** (0.515)	0.967*** (0.359)	0.696*** (0.120)	1.772*** (0.501)	−1.706** (0.234)
R^2		78.24%	77.32%	79.27%	87.92%	80.57%	86.55%	89.36%

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

It can thus be concluded that an increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning*) significantly increases (significance level – 0.01) EI and IE employee flows and JJ_1 turnover, while significantly reducing the EE and EU employee flows (ceteris paribus). A positive and significant impact (significance level – 0.05) of the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) is visible in the EI, IE flows (significance level – 0.05) and the JJ_1 turnover (significance level – 0.01), while a negative influence is visible in EE flows (significance level – 0.05). An increase in the X_4 variable (*employ-*

ment in knowledge-intensive activities (% of total employment)) in the long term does not significantly affect any type of employee flow.

The data in Table 4 show that among countries classified as Emerging Innovators, in the long term, an increase in the X_1 variable (*percentage of the population aged 25–34 with tertiary education*) causes a significant (significance level – 0.01) decrease in EE flows but a significant increase in all other flows, ceteris paribus. It can thus be concluded that the increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning*) causes a significant (significance level – 0.01) decrease in EU flows of labour but a significant increase in all the other flows and employee turnover (except for EE flows, in which it has no significant effect), ceteris paribus.

An increase of 1% in the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) causes, at the significance level of 0.05, an increase in EI employee flows by an average of approx. 0.55% and an increase in JJ_2 turnover by an average of approx. 0.499%, ceteris paribus. The impact of the X_3 variable on other types of employee flows is not statistically significant at the 0.05 significance level. An increase in the X_4 variable (*employment in knowledge-intensive activities (% of total employment)*) in the long term significantly (significance level – 0.01) reduces EE and EU flows, JJ_2 turnover and EI flows (significance level – 0.05) while significantly (significance level – 0.01) increasing UE and IE flows and JJ_1 turnover, ceteris paribus.

The short-term flexibility assessments for labour market flows in all four groups of countries with different levels of innovation, as obtained in the panel ECM models, are presented in Tables 5–8.

Table 5. Short-term flexibility assessments for labour market flows in panel ECM models for Innovation Leaders (data from 2011–2019)

Variable	Parameter	Dependent variable						
		$\Delta\ln EE_{it}$	$\Delta\ln EU_{it}$	$\Delta\ln EI_{it}$	$\Delta\ln UE_{it}$	$\Delta\ln IE_{it}$	$\Delta\ln JJ\_1_{it}$	$\Delta\ln JJ\_2_{it}$
$\Delta\ln X_{1,i,t-1}$	α_{21}	0.063* (0.034)	–1.309 (3.387)	–0.636* (0.340)	1.139 (0.834)	1.003 (3.717)	2.043 (2.268)	–4.188 (3.457)
$\Delta\ln X_{2,i,t-1}$	α_{22}	0.017** (0.008)	–0.347 (0.270)	–0.113* (0.061)	–0.173 (0.201)	–0.180*** (0.007)	0.170*** (0.038)	3.208*** (0.952)
$\Delta\ln X_{3,i,t-1}$	α_{23}	–0.007** (0.003)	–0.038 (0.133)	0.139*** (0.044)	–0.136*** (0.043)	0.133 (0.198)	0.138*** (0.017)	0.426*** (0.157)
$\Delta\ln X_{4,i,t-1}$	α_{24}	0.117** (0.037)	–3.030*** (0.817)	–0.710** (0.394)	–1.093** (0.486)	–1.036*** (0.336)	–0.028 (0.033)	–0.228*** (0.051)
$ECT_{i,t-1}$	γ	–0.006*** (0.001)	–0.027 (0.035)	–0.056*** (0.010)	–0.021** (0.008)	–0.032 (0.027)	–0.014*** (0.005)	–0.018*** (0.002)

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

For Innovation Leaders in the short-term perspective, a change in the X_1 variable (*percentage of the population aged 25–34 with tertiary education*) in the previous period significantly (significance level of 0.1) increases the EE flows of employees and reduces the EI flows for the current period, ceteris paribus. An increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning)* during the previous period causes a significant (significance level of 0.01) decrease in the IE and EI flows during the current period (significance level of 0.1). It also causes a significant increase (significance level of 0.01) during the current period of both JJ employee turnovers and EE employee flows (significance level of 0.01).

An increase of 1% in the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) during the previous period causes an increase in the EI employee flows during the current period by an average of approx. 0.138% and in the JJ_2 turnover by an average of approx. 0.426%, at the significance level of 0.01. It also causes an increase in the EI flows by an average of 0.139%, but a decrease in UE flows by 0.136%, ceteris paribus. An increase in this variable during the previous period also causes a decrease in the volume of EE flows during the current period at the significance level of 0.05, ceteris paribus. An increase in the X_4 variable (*employment in knowledge-intensive activities (% of total employment))* during the previous period causes in the current period a decrease in the EU and IE flows and the JJ_2 turnover at the significance level 0.01. It also causes a decrease in the EI and UE flows at the 0.05 significance level, ceteris paribus. An increase in this variable during the previous period also causes an increase in the volume of EE flows during the current period at the significance level of 0.05, ceteris paribus. Based on the analysis of the coefficients that modify the ECT, it can be concluded that the mechanism of achieving equilibrium is statistically significant (significance level of 0.01) for the EE and EI flows and both JJ employee turnovers. It is also statistically significant for UE flows, but at the significance level of 0.05. The error correction mechanism for the EI variable is the strongest: approximately 4.6% of the imbalance in relation to the long-term growth path is corrected through the short-term adjustment process.

Table 6. Short-term flexibility assessments for labour market flows in panel ECM models for Strong Innovators (data from 2011–2019)

Variable	Parameter	Dependent variable						
		$\Delta\ln EEit$	$\Delta\ln EUit$	$\Delta\ln Elit$	$\Delta\ln UEit$	$\Delta\ln IEit$	$\Delta\ln JJ\_1it$	$\Delta\ln JJ\_2it$
$\Delta\ln X_{1,i,t-1}$	α_{21}	0.014 (0.010)	0.573 (0.510)	−0.058*** (0.012)	−0.119*** (0.011)	−0.101 (0.111)	−0.069*** (0.016)	−0.161*** (0.035)
$\Delta\ln X_{2,i,t-1}$	α_{22}	−0.056*** (0.008)	1.145*** (0.377)	0.103 (0.107)	0.151 (0.109)	−0.111 (0.094)	0.181*** (0.019)	0.064 (0.054)

Variable	Parameter	Dependent variable						
		$\Delta\ln EEit$	$\Delta\ln EUit$	$\Delta\ln Elit$	$\Delta\ln UEit$	$\Delta\ln IEit$	$\Delta\ln JJ\_1it$	$\Delta\ln JJ\_2it$
$\Delta\ln X_{3,i,t-1}$	α_{23}	0.005 (0.003)	−0.038 (0.253)	0.015 (0.024)	0.004 (0.054)	0.010 (0.038)	−0.007 (0.006)	−0.022*** (0.002)
$\Delta\ln X_{4,i,t-1}$	α_{24}	−0.011 (0.053)	−1.554*** (0.235)	−0.049 (0.180)	−0.175*** (0.017)	−0.103*** (0.001)	−0.087*** (0.018)	−0.051*** (0.014)
$ECT_{i,t-1}$	γ	−0.015 (0.011)	−0.046*** (0.001)	−0.011 (0.085)	−0.009*** (0.01)	0.016 (0.022)	−0.02*** (0.002)	−0.036*** (0.01)

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

For the Strong Innovators group in the short-term perspective, a 1% increase in the X_1 variable (*percentage of the population aged 25–34 with tertiary education)* during the previous period causes a decrease in the current period (significance level of 0.01) in the following employee flows: EI by about 0.058% on average, UE by 0.119% on average, JJ_1 by 0.069% on average, and JJ_2 by 0.161% on average, ceteris paribus. In the same countries and also in the short term, a 1% increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning)* during the previous period causes a decline in the EE flows (significance level of 0.10) during the current period by an average of approx. 0.056%, ceteris paribus. It also caused a significant (by 1.145% on average) increase in the EU flows and an increase in employee turnover in the 15–24 age group by about 0.181%, on average, ceteris paribus A significant (significance level of 0.01) increase in the value of the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills)* during the previous period causes a significant (significance level of 0.01) reduction in the JJ_2 turnover during the current period and does not significantly affect the remaining flows.

The X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning*) in the short term did not have a significant impact on any employee flow, with a significance level of 0.05 within the Strong Innovators group. An increase in the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) during the previous period causes a reduction in the JJ_2 turnover during the current period at the significance level of 0.01, ceteris paribus. An increase in the X_4 variable (*employment in knowledge-intensive activities (% of total employment))* during the previous period causes a decrease (significance level 0.01) in the current period in the following flows: EU, UE, IE, JJ_1, and JJ_2, ceteris paribus. Negative values of the parameters that modify the *ECT* show that the EE, EU, UE, EI, JJ_1, and JJ_2 employee flows reached equilibrium as a result of the short-term adjustment mechanism, and that this mechanism is statistically significant at the 0.01 level only for the EU and UE flows and JJ_1 and JJ_2 turnovers. With the EU variable, the error correction mech-

anism is the strongest: about 4.6% of the imbalance of the long-term growth path is corrected with the short-term adjustment process.

Table 7. Short-term flexibility assessments for labour market flows in panel ECM models for Moderate Innovators (data from 2011–2019)

Variable	Parameter	Dependent variable						
		$\Delta\ln EEit$	$\Delta\ln EUit$	$\Delta\ln Elit$	$\Delta\ln UEit$	$\Delta\ln IEit$	$\Delta\ln JJ\_1it$	$\Delta\ln JJ\_2it$
$\Delta\ln X_{1,i,t-1}$	α_{21}	0.004 (0.006)	−0.121* (0.066)	−0.146** (0.065)	0.100 (0.061)	0.091 (0.066)	0.253*** (0.008)	1.079*** (0.084)
$\Delta\ln X_{2,i,t-1}$	α_{22}	−0.009*** (0.002)	−0.258 (0.322)	0.166*** (0.040)	−0.253*** (0.080)	0.266*** (0.048)	0.153 (0.172)	0.127*** (0.094)
$\Delta\ln X_{3,i,t-1}$	α_{23}	−0.009 (0.006)	0.156 (0.152)	0.026 (0.020)	−0.003 (0.005)	0.084* (0.050)	0.042*** (0.025)	0.099 (0.083)
$\Delta\ln X_{4,i,t-1}$	α_{24}	0.012 (0.009)	−0.126*** (0.006)	−0.119 (0.101)	0.109 (0.096)	−0.012 (0.104)	0.015*** (0.001)	0.043 (0.057)
$ECT_{i,t-1}$	γ	−0.022 (0.035)	−0.061*** (0.014)	−0.043*** (0.009)	−0.044*** (0.005)	−0.019 (0.011)	−0.063*** (0.021)	−0.057** (0.026)

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

In the Moderate Innovators group, a change in the X_1 variable (*percentage of the population aged 25–34 with tertiary education*) during the previous period causes during the current period an increase (significance level of 0.01) of employee turnovers JJ_1 and JJ_2 and a decrease at the significance level of 0.05 in the EI flows.

An increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning*) in the previous period causes an increase (significance level of 0.01) in the EI and IE flows and the JJ_2 turnover in the current period, and a decrease in the EE and UE flows at the same significance level (0.01) in this group, ceteris paribus. An increase in the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) during the previous period causes a significant increase in the JJ_1 turnover (at the significance level of 0.01) and an increase in the IE flows (at the significance level of 0.1), without significantly affecting other flows and turnovers. An increase in the X_4 variable (*employment in knowledge-intensive activities (% of total employment)*) during the previous period causes a decrease (significance level 0.01) in the UE flows in the current period, ceteris paribus. Negative assessments of the parameters at the ECT show that all flows and turnovers are equilibrated as a result of short-term adjustments, and this mechanism is statistically significant (at the 0.01 level) only for the EU, UE, and EI flows and both JJ_1 and JJ_2 turnovers. With the JJ_1 variable, the error correction mechanism is the strongest:

approximately 6.3% of the imbalance of the long-term growth path is corrected by short-term adjustments.

Table 8. Short-term flexibility assessments for labour market flows in panel ECM models for Emerging Innovators (data from 2011–2019)

Variable	Parameter	Dependent variable						
		$\Delta \ln EEit$	$\Delta \ln EUit$	$\Delta \ln Elit$	$\Delta \ln UEit$	$\Delta \ln lEit$	$\Delta \ln JJ\_1it$	$\Delta \ln JJ\_2it$
$\Delta \ln X_{1,i,t-1}$	α_{21}	−0.016*** (0.005)	0.066*** (0.004)	0.511*** (0.099)	0.591*** (0.063)	0.971*** (0.191)	0.205*** (0.009)	0.791*** (0.084)
$\Delta \ln X_{2,i,t-1}$	α_{22}	−0.003 (0.003)	0.161** (0.071)	0.010 (0.009)	−0.115*** (0.014)	0.020 (0.099)	0.321*** (0.054)	0.036*** (0.014)
$\Delta \ln X_{3,i,t-1}$	α_{23}	−0.005 (0.004)	0.094 (0.079)	0.140** (0.064)	0.013 (0.055)	−0.093 (0.064)	0.443 (0.331)	0.187*** (0.052)
$\Delta \ln X_{4,i,t-1}$	α_{24}	−0.030*** (0.007)	−1.055*** (0.111)	−0.199* (0.109)	0.179*** (0.053)	0.100*** (0.021)	0.852*** (0.318)	−0.876** (0.014)
$ECT_{i,t-1}$	γ	−0.006*** (0.001)	−0.086*** (0.024)	−0.054 (0.069)	−0.042*** (0.003)	0.040 (0.042)	−0.063*** (0.015)	−0.075*** (0.033)

The significance levels of 0.01; 0.05 and 0.1 are marked respectively with ***, ** and *
Source: own calculations based on Eurostat n.d.

In the Emerging Innovators group, a change in the X_1 variable (*percentage of the population aged 25–34 with tertiary education*) during the previous period causes a significant (significance level of 0.01) decrease in the EE flows during the current period and a significant (same level of significance) increase in all the other flows and turnovers, ceteris paribus. An increase in the X_2 variable (*percentage of the population aged 25–64 involved in lifelong learning*) during the previous period causes a significant (significance level of 0.01) decrease in UE flows during the current period and a significant (significance level of 0.05) increase in EU flows. It also causes a significant (significance level of 0.01) increase in both JJ turnovers. A one-per-cent increase in the X_3 variable (*enterprises that provide training to develop or upgrade their personnel's ICT skills*) during the previous period causes an increase in the JJ_2 turnover by about 0.187% and in the EI flows by approx. 0.14% on average during the current period, at the significance level of 0.01, ceteris paribus. The variable X_3 shows no statistically significant impact on the other types of flows. An increase in the value of the X_4 variable (*employment in knowledge-intensive activities (% of total employment)*) during the previous period causes a decrease in the current period in the EE and EU flows and the JJ_2 turnover, at the significance level 0.01, ceteris paribus. It also causes an increase in the EI and UE flows and the JJ_1 turnover at the same level of significance, ceteris paribus. Upon analysis of the parameters modifying the *ECT*, it can be concluded that equilibrium is achieved by all flows except for EI, and the mechanism of achieving equilibrium

is statistically significant (significance level of 0.01) only for the EE, EU, and UE flows. The error correction mechanism is the strongest for the EU variable: approximately 8.6% of the imbalance in the long-term growth path is corrected through short-term adjustments.

Conclusions

The long-term development prospects of economies depend on their ability to innovate. Innovation is one of the significant factors that determine an economy's competitiveness. Although innovation is a key driver of the competitiveness of individual economies today, to the best of the authors' knowledge, there has been no empirical research on the impact of the economy's innovativeness on labour market flows. Our empirical results demonstrate significant and persistent differences in the scale and structure of labour market flows, which depend on the level of innovation in an economy. The economy's level of innovativeness determines specific flow patterns in the relevant labour market. The results are largely consistent with Elsby, Hobijn, and Sahin (2011), who stated that labour markets follow geographical patterns, i.e. relatively large groups of countries show similar dynamic labour market flows pattern.

The study involved an in-depth analysis of the impact of the level of economies' innovativeness on labour market flows. The results indicate that the level of an economy's innovativeness affects both the dynamics and the structure of flows in the labour market. The higher the innovativeness, the greater the dynamics of flows in the labour market, especially of the job-to-job type. In countries that are Innovation Leaders, participation in lifelong learning allows employees to maintain their employment status and, at the same time, upgrade to a better job. In countries that are Emerging Innovators, participation in lifelong learning and acquiring new digital skills increases the turnover of employees, mainly the young ones (15–24 y/o). However, it is accompanied by a change of status in the labour market. In economies where the level of innovation is high (Innovation Leaders), employees often change jobs but not their labour market status.

Innovative economies demonstrate stable employment statuses, i.e. a high rate of transitions from employment to employment (EE) and, at the same time, a high turnover of employees (job-to-job). Workforce flows between workplaces are a natural phenomenon. People keep looking for better-paid jobs and/or jobs that would allow them to develop new skills or acquire new qualifications. Employees move smoothly from one job to another, and the transition is accompanied by a flow of knowledge, further stimulating innovative activities. Employees most often change jobs having been offered a higher salary and professional development opportunities. Employee turnover leads to better allocation of labour resources and in-

creased productivity. It allows for a better person–job fit and stimulates innovation through the exchange of experience and knowledge between companies (Breschi and Lissoni 2009, pp. 439–468).

The analysis showed that in countries with a low level of innovativeness, i.e. Moderate Innovators or Emerging Innovators, employees change jobs much less frequently than in countries with a high level. Similar conclusions were reached by Pieroni and Pompei (2008), who showed that in the Italian economy (Moderate Innovators), companies more often use internal labour resources; hence, employee turnover is lower.

In more innovative countries, there are more opportunities to change jobs, but seeking such opportunities implies the need to continuously upgrade qualifications and update the knowledge acquired during formal education. An innovative (including digital) economy expects much more from its workforce. It requires life-long professional development, not only in youth, as employees must have up-to-date and useful knowledge at all times, even if their status changes very quickly. Our analysis shows that in countries classified as Innovation Leaders, the most important determiner of employee "job-to-job" turnover in the 15–24 age group (JJ_1) is the *percentage of the population aged 25–64 involved in lifelong learning* (X_2), while in Emerging Innovators, it is *enterprises that provide training to develop ICT skills* (X_3).

In countries with less innovativeness, it is the shortages of digital skills among (mainly young) employees that constitute a barrier to employee flows between companies. Haldane (2019) reached similar conclusions when analysing employment in the United Kingdom. Companies in EU countries increasingly highlight workers' skill shortages in many professions and industries. Technological progress, associated with widespread digitisation and innovation, increases the demand for new skills and new types of work. It requires employees to constantly develop, acquire new skills and look for new roles. Our research confirmed that an economy's innovation level determines relevant behaviours among employees. Keeping a position is increasingly associated with improving qualifications and acquiring new skills. The analysis presented in the article allows for a better understanding of labour market phenomena today.

The analysis has some shortcomings that determine possible directions for further research. The degree of heterogeneity of the labour market participants should be better considered, and not only between but also within the resource groups, i.e. the employed, the unemployed and the economically inactive. It should be expected that decomposing aggregate data on labour market resources, for instance, with the employed (by age, gender, education level or type of contract (temporary vs permanent)) might lead to conclusions that are both interesting and valuable from the point of view of an economy's level of innovation. Moreover, taking into account the digital skills of employees, especially those of Generations Y and Z, would make it possible to assess their situation in the era of the 4th Industrial Revolu-

tion. It is one of the most important challenges in the European Union (Morandini, Thum-Thyssen, and Vandeplas 2020). According to the results of the DESI (Digital Economy and Society Index) research, more than 40% of Europeans still do not have basic IT skills. These deficiencies create a barrier to development both at the individual level (e.g. they deepen the existing socio-economic inequalities) and at the aggregate level (e.g. they hinder the introduction of new technologies at enterprises). The aforementioned issues determine the further direction of our research to analyse the significance of flows between employee resources in the labour market in economies with different levels of innovation.

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Analiza wpływu innowacyjnych uwarunkowań gospodarki na przepływy pracowników na rynku pracy w państwach Unii Europejskiej

Głównym celem pracy jest przedstawienie wyników badań empirycznych dotyczących wpływu poziomu innowacyjności gospodarki na strukturę przepływów na rynku pracy.
Analiza kierunków i skali przepływów umożliwia poznanie ważnych własności rynku pracy, a tym samym pozwala lepiej konstruować i adresować polityki ukierunkowane na ograniczanie skali bezrobocia lub aktywizację osób biernych zawodowo. W opracowaniu wykorzystano dane z badania Labour Force Survey (LFS) oraz statystyk eksperymentalnych *job-to-job* dla państw Unii Europejskiej w latach 2011–2019. Badania przeprowadzono odrębnie dla wyróżnionych grup państw ze względu na poziom innowacyjności, tj. Liderzy innowacji (*Innovation leaders*), Silni innowatorzy (*Strong innovators*), Umiarkowani innowatorzy (*Moderate innovators*), Wschodzący innowatorzy (*Emerging innovators*). Wskazujemy, że skala i kierunek przepływów osób na rynku pracy zależą od poziomu innowacyjności gospodarki. Głównym wkładem opracowania jest zidentyfikowanie wzorców przepływów na rynku pracy w państwach Unii Europejskiej, warunkowanych poziomem innowacyjności gospodarki. W badaniu wykorzystano panelowe modele korekty błędem ECM oraz panelowy test przyczynowości. W krajach zaliczanych do Liderów innowacyjności kształcenie ustawiczne zwiększa przepływy pracowników (EE) oraz rotację (*job-to-job*) ogółem, natomiast w krajach słabych innowacyjnie wzrasta rotacja jedynie wśród osób młodych (15–24 lata).

Słowa kluczowe: przepływy na rynku pracy, zmiany statusu osób na rynku pracy, rotacja pracowników, innowacyjność gospodarki

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A Reassessment of Oil Market Volatility and Stock Market Volatility: Evidence from Selected SAARC Countries

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Abstract

Volatility spillover informs whether the information in one market impacts the information in another. This paper examines whether oil market volatility spills over to the equity markets of selected SAARC countries. The study uses data from February 2013 to September 2019 to obtain updated evidence about the transmission of global oil price volatility to the equity markets of the SAARC member countries. The bivariate EGARCH model is used to test for volatility transmission from the oil market to the stock market. It is found that oil price shocks do not significantly impact equity market volatility, except in Bangladesh. Policymakers can use these findings when making policy decisions.

Keywords: stock market, oil market, volatility spillovers, information transmission, EGARCH

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Introduction

Emerging countries' stock markets have grown rapidly over the last few decades. It has created many investment opportunities in those markets, increasing capital inflows from developed markets to emerging markets (Beckmann, Berger, and Czudaj 2015). Despite this, global news and events also affect emerging markets' stock returns, making them more volatile and creating an uncertain environment. Oil is one of the world's most widely used and traded products, and it remains the backbone of any economy. Because of recent major oil price fluctuations, research on oil markets received a boost as it has a wide impact on the business cycle of any economy. Studies have demonstrated that the relationship between stock returns and oil prices is still inconclusive, even though much research has been carried out on this topic. The stock market represents the economic condition of any country (Hamilton and Herrera 2004; Kilian 2008; Korhonen and Ledyaeva 2010). Therefore, oil market and stock market volatility spillover is crucial for decision-makers, such as energy policymakers and others who mitigate the risk generated through these fluctuations in oil price changes. This is one of the most debatable topics, as evidenced by increased research in this area (Filis, Degiannakis, and Floros 2011; Awartani and Maghyereh 2013; Ewing and Malik 2016; Kang, McIver, and Yoon 2017).

In the recent past, the analysis of stock market returns has revealed a high level of volatility. Different countries have different macroeconomic conditions and different types of investors with different perspectives on the stock market, which causes this high volatility. Because of the uncertainty in the stock market, risk-averse investors are always reluctant to invest in the stock market (Jones and Kaul 1996). The Financial Crisis of 2008 and the European sovereign debt crisis of 2011 adversely affected investor sentiment (Malmendier and Nagel 2011; Hoffmann, Post, and Pennings 2013). Many papers have investigated the correlation between stock and commodity prices because of their diversification advantage in the economy. Tiwari and Sahadudheen (2015) studied oil and gold as the most highly liquid commodities and found movement in stock market returns when oil and gold are included in the portfolio. That is why investors are motivated to add commodities (gold and oil) to their portfolios. During economic downturns, which negatively impact investors' returns, e.g., the economic crisis of 1970, the Russian crisis in 1997, the Asian financial crisis in 1998, and the global financial crisis of 2007–2009, investors are encouraged to look for alternative investments to diversify their assets and avoid return losses. To hedge the risk, a portfolio construction strategy remains the focus for all individual investors suggested by researchers and investment managers. It will bring back investors' confidence in the financial markets and help them prevent sudden losses because of market turmoil.

Much research has been conducted on oil as an asset in portfolio optimization in connection with stock returns. Researchers have found a significant association of this asset class

in portfolio optimization (Park and Ratti 2008; Degiannakis, Filis, and Kizys 2014; Lin and Appiah 2014; Khalfaoui, Boutahar, and Boubaker 2015; Wang and Liu 2016).

According to a 2015 report by Jadwa Investment, investor sentiment is affected by oil price fluctuations in the international market because 90% of trading volumes are generated by individual investors, and these sentiments drive investors to take investment decisions. In Saudi Arabia (a major oil exporting country), 86% of government revenue comes from oil and oil-related products. Whenever the price of oil fluctuates in the international market, Saudi Arabia's government expenditures and stock market returns are affected. In addition, according to Raza et al. (2016), all emerging markets are less impacted by oil price changes. Thus, emerging markets have negative relationship with oil price. Global oil prices showed a rapid decline from January 2013 to mid-2015, and then they increased steadily. Noor and Dutta (2017) noted that volatility spillover exists between the oil market and the stock market for selected countries (i.e., Sri Lanka, India, and Pakistan). Fowowe (2017) investigated Nigeria and South Africa for volatility spillover between oil prices and the stock market. They note that in Nigeria, volatility spillover is not significant. The mixed results could be attributed to the use of different data frequencies, different econometric models, or different variable measurements. Regarding the mixed results and changing patterns of global oil prices, this study aims to provide updated evidence of volatility spillover from global oil prices to the stock markets of the South Asian Association for Regional Cooperation(SAARC) member countries.

The study contributes to the literature in multiple ways. First, it examines the volatility spillover between the oil market and the stock market for selected SAARC member countries. Second, the study uses the prices of two different oil standards, including Brent oil and WTI, which ensures consistent and reliable results. Third, the study employs the EGARCH model, which allows for the leverage effect and is more efficient than the simple GARCH model and other linear regression models. Because the rise and fall in oil prices do not cause uniform shocks to stock returns; thus, that behavior can be captured efficiently using the EGARCH model. Fourth, oil prices and stock prices are time-varying variables; hence continuous screening and investigation are needed. Therefore, the current study provides up-to-date evidence about the link between oil prices and stock returns.

The rest of the paper is organized as follows. The second part provides a literature review, while the third part provides the research methodology. The fourth part contains the results and discussion, while the fifth part provides conclusions.

Literature review

Numerous researchers have examined global economies and found that fluctuations in oil prices have significant and insignificant impacts. Whenever there is a new oil price shock in the international market, the movement of oil prices gains significance in the literature, emphasizing a new research horizon. Earlier research (Hamilton 1983; Mork 1989; Kilian 2009) found significant evidence that oil prices negatively correlate with GDP, which means that oil price shocks will not be affected much and economic recessions are under control. In four developed markets, including the USA, Japan, Canada and the UK, Jones and Kaul (1996) found that oil prices pose a significant risk factor for the stock market because they negatively impacted stock market returns.

In contrast, Sadorsky (2001) found that oil prices and stock market returns are positively correlated. He found that key factors that affect the stock market are interest rates, risk premiums, and exchange rates. It may also be possible that both equity returns and oil prices have no relationship. In this regard, Wei (2003) found no relationship between stock market returns and oil prices because their correlation was insignificant, which shows that oil prices cannot determine movements in stock prices. Fayyad and Daly (2011) used (VAR) and used data from seven counties (the UAE, the UK, the USA, Oman, Kuwait, Bahrain, and Qatar) to investigate the relationship between stock market returns and oil prices. Empirical findings suggested that there is a significant relationship between fluctuations in oil prices and Gulf Coordination council (GCC) countries' stock market returns. They also found that developed countries' (UK and USA) equity market returns are also affected by oil prices.

Further, Arouri and Nguyen (2010) showed that macroeconomic variables are affected by oil price fluctuations, including inflation, income level, interest rate, investor confidence, and production costs. The study conducted by Arouri, Lahiani, and Nguyen (2011) investigated the spillover effects between oil and stock market returns by utilizing data from the US and European stock markets. To examine the role of oil as an asset in hedging portfolio risk, they employed the VAR-GARCH model. Their analysis revealed that oil plays a vital and noteworthy role in both hedging portfolio risk and optimizing portfolios. Further, Arouri, Jouini, and Nguyen (2012) studied stock index returns and oil prices in European countries in terms of volatility spillovers. They found that price fluctuations of oil and equity market returns have significant volatility transmission. This means that we must understand this correlation first to make an optimal portfolio, which should include oil prices. Raza et al. (2016) examined developed countries and examined the relationship by using asymmetric effects between oil and stock market returns. They found a significant negative relationship between them.

Emerging economies are negatively influenced by oil price volatilities. Lin and Appiah (2014) studied oil prices and stock market returns in Ghana and Nigeria in terms of volatility spillover. They found when hedging stock market risk, oil is the better alternative asset for investment. They also found that the Nigerian stock market was affected by oil price fluctuations; it means volatility spillover was higher in that market. Meanwhile, the Ghanaian stock market was more affected when hedging the portfolio risk.

Singhal and Ghosh (2016) studied the link between the oil market and the stock market in India. They utilized the VAR_DCC_GARCH model to study the link between two variables from January 1, 2006, to February 28, 2015. They did not find significant volatility spillover between the oil market and the stock market. Dedi and Yavas (2016) examined five countries for volatility spillover between oil prices and the stock market. They employed various GARCH techniques to study this link for Germany, Turkey, Russia, the United Kingdom, and China. They noted that volatility spillover existed between all the countries between March 31, 2011, and March 11, 2016.

Many researchers have also found that news regarding oil price fluctuations specifically affects emerging economies and creates a more sensitive, ambiguous economic environment. Using data from eleven countries from 2008 to 2015, Maghyereh, Awartani, and Bouri (2016) found that both oil and stock market returns are affected by news spillovers. Guesmi (2014) used a multivariate GJRDCC-GARCH model in countries that export oil (i.e., Venezuela, the Kingdom of Saudi Arabia (KSA), Kuwait, and the UAE) and those countries that import oil (the USA, France, Italy, Germany, and the Netherlands) to analyze the impact of oil prices fluctuations on stock markets in terms of volatility spillover. They found that in periods of global turmoil, oil prices significantly impacted the stock market returns of these exports and import-oriented countries. Bouri (2015) studied the shock effects of the 2008 global financial crisis on Jordan and Lebanon, which are small oil importers, by focusing on volatility spillover to see whether the financial crisis shocks had any impact on their price of oil and stock market returns. He found that price of oil and returns of stock market both were significantly affected in Jordan but not in Lebanon.

Gbatu et al. (2017) applied the ADL bounds test approach of Pesaran, Shin, and Smith (2001) to investigate the impact of oil price fluctuations on the Liberian economy. They showed that oil prices have a significant impact in the short run, and Real GDP has a nexus with these oil price fluctuations. Using data from February 2007 to July 2016, Trabelsi (2017) examined three major oil-exporting economies (the UAE, Saudi Arabia, and Russia). He used the stock market indices of these countries to see the impact of oil price spillovers. He adopted the DCC-GARCH and Co Var measure. For Saudi Arabia, he used the Saudi Arabia (TASI) Index, for the UAE, he used the DFM index,

and for Russia, he used the RSI index. He noted a significant negative relationship between stock market indices and oil prices.

Bouri et al. (2018) used quantile response methods and a multivariate regression quantile technique to see the relationship between countries that export oil (i.e., Brazil and Russia) and those that import oil (i.e., India and China) by applying a shock transmission mechanism. He also used oil prices to examine the dependence of the oil shocks and BRICS sovereign risk on stock volatility. The empirical results showed that there is an asymmetric effect. In addition, a negative shock in oil volatility impacts oil-importing economies more, whereas a positive shock in oil volatility impacts oil-exporting economies more. Ping et al. (2018) examined the energy stock market in connection with fuel oil spots and fuel oil futures by focusing on volatility spillover using DCC-GARCH and VAR-BEKK-GARCH frameworks. They found these markets have bidirectional effects in connection with volatility spillovers.

Methodology

Data and variables

The paper uses monthly time series data from February 2013 to September 2019 to study the volatility spillover between stock market returns and oil prices. For a fair examination, the study used the two most traded and popular benchmark oil commodities, i.e., West Texas Intermediate (WTI) and Brent North Sea Crude (Brent). The data of both benchmarks were obtained from Investing.com. The target sample of the study is SAARC member countries, although another four countries are included in the sample, i.e., Pakistan, Sri Lanka, India, and Bangladesh. These countries account for more than 90% market capitalization of the SAARC region. The market data of the countries are taken from the global market data forum, Investing.com.

The prices are used at the percentage difference level calculated by using the following equations:

$$Ret_{(equity,WTI,Brent)} = \left[\frac{price_t - price_{t-1}}{price_{t-1}}\right] \cdot 100, \tag{1}$$

where $R_{(equity,\ WTI,\ Brent)}$ shows the returns/percentage change in oil prices and equity prices.

$Price_t$ shows the prices of the current month, while $Price_{t-1}$ represents the prices of the previous month.

Unit root test

As stationarity influences the behavior of variables, the stationary and non-stationary variables are treated differently (Brooks 2019). Therefore, before selecting the econometric model, the level of stationarity for each variable is important. The study uses the Augmented Dickey-Fuller test (ADF) and the Phillip-Perron unit root test (PP) to test the stationarity of the variables.

Econometric model

To examine the volatility spillover effect between stock market returns and oil prices, Generalized Autoregressive Conditional Heteroscedastic (GARCH) and Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) models are employed. The EGARCH model is an extended version of the GARCH model to investigate the leverage effect.

The GARCH model is a widely used model to study volatility that makes it possible to predict the conditional variance on its own lag terms (Brooks 2019). The general equations of the GARCH model are given below:

$$y_t = \mu + \alpha y_{t-1} + u_t, \dot{o}_t \sim N\left(0, \delta_t^2\right), \tag{2}$$

$$\delta_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \gamma \delta_{t-1}^2. \tag{3}$$

This is a univariate standard GARCH (1,1) model, where equation (2) shows the conditional mean and equation (3) represent the conditional variance. The model can convert to order (p, q) by extending previous lags of ut to the qth order, and the lag terms of δ_t^2

to the pth order, as given below:

$$\delta_t^2 = \beta_0 + \sum_{i=1}^{q} \beta_1 u_{t-1}^2 + \sum_{j=1}^{p} \gamma_j \delta_{t-j}^2, \tag{4}$$

where equation (4) shows the conditional variance; β_0, β_i, and γ_j are the coefficient of the model; u_{t-1}^2 is the previous lags of the error term, and δ_{t-1}^2 is the lag terms of the variance. The study employed a bivariate GARCH (1,1) model to check the volatility persistence. The specification of the models is shown below:

$$\delta_{t(Ret)}^2 = \alpha_1 + \beta_1 u_{t-1}^2 + \gamma_1 \delta_{t-1(Ret)}^2 + \omega_1 WTI_{t-1}, \tag{5}$$

$$\delta^2_{t(Ret)} = \alpha_2 + \beta_2 u^2_{t-1} + \gamma_2 \delta^2_{t-1(Ret)} + \omega_2 Brent_{t-1}, \tag{6}$$

where $\delta^2_{t(Ret)}$, $\delta^2_{t(WTI)}$ and $\delta^2_{t(Brent)}$ are the conditional variance of stock market returns, WTI, and Brent, respectively. α_1–α_4 are intercepts of the models. β_1–β_4 are the coefficients of moving average terms (MA), which show the impact of the error term on the conditional variance. Similarly, $\gamma_1\gamma_4$ measures the impact of own lags of the variance on the variance of the current month. $\omega_1 - \omega_4$ shows the impact of the lag term of the independent variable in the model on the conditional variance of the dependent variable.

To investigate the leverage effect, the EGARCH model is a better tool that also does not necessitate the condition of positive variances (Brooks 2019). The conditional variance of the EGARCH model is given below:

$$\ln(\delta_t^2) = \alpha_0 + \beta \ln\left(\delta^2_{t-1}\right) + \gamma \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \varphi\left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}}\right]. \tag{7}$$

In the equation, $\ln(\delta t^2)$ shows the natural log of conditional variance; β measures the persistence of volatility; γ gives the existence of an asymmetric or leverage effect in the model; φ provides the symmetric effect.

The specific equations for the conditional mean and the conditional variance of the bivariate EGARCH model are developed, following Kanas (2000) and Jebran and Iqbal (2016).

Volatility transmission from WTI oil prices to stock market

To examine the volatility spillover or volatility transmission from WTI crude oil market returns to stock market returns, the algebraic equations of the bivariate EGARCH model are given below:

$$Ret_t = \alpha_0 + \alpha_1 Ret_{t-1} + \alpha_2 WTI_{t-1} + u_t, \tag{8}$$

$$\ln\left(\delta^2_{t(Ret)}\right) = \beta_0 + \beta_1 \ln\left(\delta^2_{t-1(Ret)}\right) + \beta_2 \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \varphi\left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}}\right] + \rho V_{(WTI)}, \tag{9}$$

where Ret shows the stock market returns, and V represents the volatility of WTI and ρ provides the spillover effects.

Volatility transmission from Brent oil prices to the stock market

The bivariate EGARCH (1,1) model checks the volatility spillover from the Brent oil market returns to the stock market returns. The conditional mean and variance of the model are:

$$Ret_t = \alpha_0 + \alpha_1 Ret^t_{-1} + \alpha_2 Brent_{t-1} + u, \tag{10}$$

$$\ln\left(\delta^2_{t(Ret)}\right) = \beta_0 + \beta_1 \ln\left(\delta^2_{t-1(Ret)}\right) + \beta_2 \frac{u_{-1}}{\sqrt{\delta^2_{t-1}}} + \varphi\left[\frac{|u_{-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}}\right] + \rho V_{(Brent)}, \tag{11}$$

where the coefficients and symbols have the same interpretations as provided in the later section.

The models are used separately for each country for the bidirectional volatility spillover or volatility transmission between stock market return and WTI oil prices, and stock market return and Brent oil prices.

Results and discussion

Before the empirical analysis, the behavior of oil prices and returns of the stock market is visualized through univariate analysis, including univariate graphs and descriptive statistics. The trends of oil prices and stock market prices are shown in Figure 1. The oil prices of both benchmarks are at peak in 2012–2013, showing a downward trend in the beginning months of 2014, and reaching the lowest level in 2015–2016. After mid-2015, oil prices show an upward trend with minor shocks till the last month of the sample. The same figure shows the equity market trends of all four countries, including the KSE–100 index (Pakistan), the BSE SENSEX index (India), the CSE all-share index (Sri Lanka), and the DSEX index (Bangladesh).

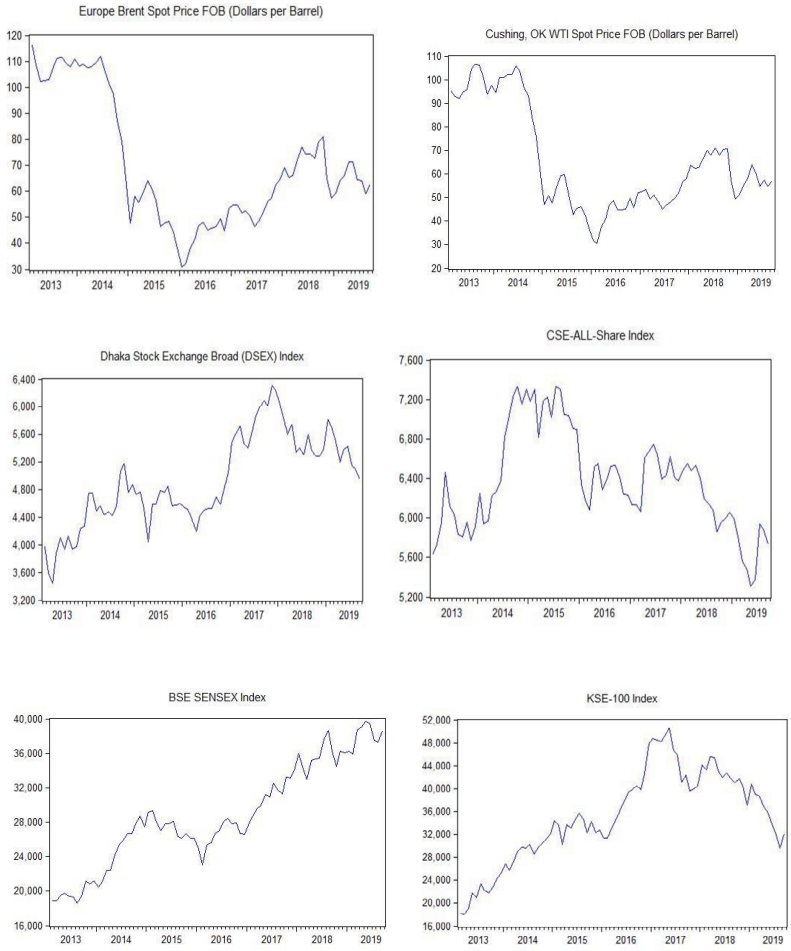

Figure 1. Plots the market indices and oil prices

Sources: http://www.investing.com by Fusion Media Limited.

The descriptive statistics are shown in Table 1. The average value of WTI is –0.65, and fluctuated between 21.38 and –24.55 with a standard deviation of 8.58. The maximum value of Brent oil prices is 19.59, the minimum is –26.64, and the standard deviation is 8.82. The mean values of stock returns of all the countries are positive over the sample period. India (the Bombay stock exchange) shows the highest average returns, whereas Sri Lanka (the Colombo stock exchange) has the lowest. However, the Colombo stock exchange is more stable as it has the lowest standard deviation. In contrast, the equity market of Pakistan (KSE–100 index) is highly volatile compared to the other SAARC member countries. The data of stock returns of all countries are normally distributed at the 5% level of significance as the p-value of the Jarque-Bera statistics is greater than 0.05 for all countries. The WTI series is normally distributed, although the normality hypothesis of Brent is not supported at the 5% level of significance.

Table 1. Descriptive statistics

	Pakistan	India	Sri Lanka	Bangladesh	WTI	BRENT
Mean	0.71	0.90	0.02	0.27	– 0.65	– 0.77
Median	1.14	0.92	– 0.20	0.36	1.01	0.52
Maximum	13.94	9.68	9.96	12.5	21.38	19.59
Minimum	– 11.02	– 7.81	– 8.38	– 11.27	– 24.55	– 26.64
Std. Dev	5.32	3.77	3.38	4.71	8.58	8.82
Skewness	0.01	– 0.07	0.53	0.29	– 0.56	– 0.65
Kurtosis	2.63	2.63	3.75	3.33	3.54	4.00
Jarque-Bera	0.44	0.52	5.59	1.49	5.12	9.01
Probability	(0.80)	(0.76)	(0.06)	(0.47)	0.07	0.01

Source: data from http://www.investing.com by Fusion Media Limited.

After examining the descriptive statistics, the unit root test was conducted to determine whether the variables are stationary or not. Table 2 summarizes the results of AD and PP, with both tests showing that the variables are stationary at first difference.

Table 2. Unit root test – stock returns of selected countries

Market	ADF		PP	
	Level	1st Difference	Level	1st Difference
Pakistan	– 2.12	– 9.11*	– 2.12	– 9.12*
India	– 0.85	– 9.03*	– 0.75	– 9.11*
Srilanka	– 1.98	– 8.83*	– 1.99	– 8.83*
Bangladesh	– 1.86	– 8.96*	– 1.79	– 9.02*

*, **, *** is 1, 5, 10 % level respectively.
Source: own calculation using EViews software.

Table 3 shows the results of the EGARCH model, which investigated the volatility transmission from the oil market to the equity market. Panel A of the table summarizes the results for WTI oil prices, and Panel B provides the results for Brent prices. The results show that the value of ρ is insignificant at the 5% significance level for both panels for all the countries except Bangladesh, which is significant for WTI. This finding indicates that the volatility of global oil prices does not affect the equity markets of SAARC member countries. Only the volatility of WTI oil prices positively influences the volatility of Bangladesh stock market returns. In other words, the stock market returns of the selected SAARC member countries do not significantly react to the shocks in global oil prices.

The coefficient of ARCH and GARCH (β_1 and φ) are insignificant in all the countries except Pakistan. The results show that volatility persistence and shock dependency of the conditional variance model exist only in Pakistan, which means the previous shocks influence the conditional volatility of the stock prices. The coefficient of leverage effect (β_2) is negative in most of the countries but not significant in any of them, meaning that negative shocks have no significantly higher influence than positive shocks. Therefore, positive shocks and negative shocks have the same effect on the volatility of the stock market returns.

The coefficient of the mean equation (α_1) is negative for both the benchmarks of crude oil markets for India and Pakistan, meaning that the previous month's stock prices negatively influence the average prices of the current month. In contrast, the coefficient is positive for Bangladesh in the models for both crude oil benchmarks. However, the relationships are not statistically significant. The coefficient (α_2) is positive for Pakistan and India in the models for both WTI and Brent. The signs are mixed for Bangladesh and Sri Lanka, but not significant at the 5% level of significance. These findings mean that fluctuations in the equity market and global crude oil markets of the previous month cannot predict the average stock market returns of the SAARC member countries.

The same relationships were investigated by Noor and Dutta (2017) using data from January 2001 to December 2014 for three South Asian countries, i.e., Sri Lanka, India, and Pakistan. Using the VAR-GARCH model, they found unidirectional volatility spillover from global oil prices to equity markets.

This study provides an up-to-date version of the volatility spillover and includes another major SAARC member, i.e., Bangladesh. Our findings are in contrast to the literature. A possible reason could be government subsidies and internal energy sources, which may help in reducing the effect of shock on global oil prices. Further, it may be quite possible that the companies have defensive plans to overcome the instability of their stock prices. The methodology also plays a key role in the mixed results in the literature. As the findings of Chittedi (2012) show, there is a volatility spillover from oil prices to stock market returns in the Indian equity markets. He used oil prices relative to stock market indices and investigated the impacts through the auto regressive distributed lag ARDL model.

Table 3. Volatility spillover

Country	India	Sri Lanka	Pakistan	Bangladesh
Panel A: Volatility spillover from West Texas Intermediate (WTI) to the stock market				
α_0	0.98** (0.02)	0.11 (0.78)	1.12** (0.07)	0.73 (0.21)
α_1	−0.01 (0.90)	0.02 (0.76)	−0.14 (0.23)	0.05 (0.47)
α_2	0.08 (0.13)	0.02 (0.58)	0.04 (0.43)	−0.06 (0.31)
β_0	1.76 (0.16)	2.86** (0.01)	6.36*** (0.00)	4.38 (0.00)
β_1	−0.37 (0.35)	−0.47 (0.12)	0.33 (0.31)	−0.64 (0.02)
β_2	−0.33 (0.16)	0.24 (0.16)	0.04 (0.68)	−0.21 (0.24)
φ	0.42 (0.31)	−0.04 (0.93)	−0.98*** (0.00)	−0.32 (0.17)
ρ	−0.01 (0.49)	0.02 (0.28)	0.03 (0.20)	0.08** (0.01)
LL	−209.69	−203.41	−233.12	−223.62
SCI	5.82	5.66	6.42	6.18
Panel B: Volatility spillover from Europe Brent oil prices to the stock market				
α_0	1.01** (0.02)	0.02 (0.95)	0.88** (0.02)	0.52 (0.33)
α_1	−0.05 (0.60)	−0.02 (0.81)	−0.08 (0.27)	0.05 (0.51)
α_2	0.05 (0.21)	0.00 (0.94)	0.08 (0.14)	0.00 (0.87)
β_0	2.49* (0.05)	3.44** (0.01)	0.81*** (0.00)	4.04*** (0.00)
β_1	−0.06 (0.89)	−0.31 (0.25)	−0.48*** (0.00)	−0.29 (0.33)
β_2	−0.36 (0.10)	0.24 (0.22)	−0.02 (0.48)	−0.28 (0.16)
φ	0.04 (0.93)	−0.33 (0.56)	0.87*** (0.00)	−0.28 (0.28)
ρ	0 (0.80)	0.00 (0.97)	−0.01 (0.16)	0.04 (0.14)
LL	−210.71	−204.09	−233.06	−225.62
SCI	5.84	5.68	6.42	6.23

*, **, *** is 1, 5, 10 % level respectively.
Source: own calculation using EViews software.

Conclusion

The paper studied the volatility spillover from global oil prices to the stock market returns of four SAARC member countries, namely Pakistan, India, Sri Lanka, and Bangladesh. For the empirical analysis, monthly data was used. The literature mainly focused on developed economies or investigated the simple cause-and-effect relationship between the monetary values of oil prices and stock prices using correlation-based statistical techniques. Therefore, the study makes important contributions by examining the volatility spillover of oil prices on stock returns in developing countries and using the EGARCH model, which allows for the asymmetric/leverage effect of positive and negative shocks. Two different popular oil benchmarks (WTI and Brent) were taken into consideration to obtain more consistent results. The results of the EGARCH model show that volatility does not transmit from global oil prices to the equity markets of the selected SAARC countries.

Implications & limitations

The findings are important for investors in making portfolio decisions. Investors must consider oil price shocks in their stock market returns and create a diversified portfolio. Although the literature argues there is a significant impact of oil prices on stock returns, the current study argues that the shocks in oil prices do not propagate into the stock markets of SAARC member countries. Therefore, investors should consider other macro and microeconomic factors. Further, the findings are important for policymakers to formulate effective and efficient market strategies and policies. The current investigation is limited to oil.The results can be improved by using additional commodities and a longer time frame in the analysis.

Future recommendations

There are a few recommendations for future research. First, the study could extend by including other macroeconomic factors like energy consumption, renewable energy, economic growth, and trade deficit. Second, the results can be made more robust by considering structural breaks and extreme quantile effects.

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Ponowna ocena zmienności na rynku ropy naftowej i zmienności na rynku akcji na przykładzie wybranych krajów SAARC

Przenoszenie zmienności dostarcza informacji, czy informacje na jednym rynku wpływają na informacje na innym rynku. W niniejszym artykule zbadano, czy zmienność rynku ropy naftowej przenosi się na rynki akcji wybranych krajów SAARC. W badaniu wykorzystano dane z okresu od lutego 2013 r. do września 2019 r. w celu uzyskania zaktualizowanych danych na temat przenoszenia zmienności globalnych cen ropy naftowej na rynki akcji państw członkowskich SAARC. Wykorzystano dwuwymiarowy model EGARCH do testowania przenoszenia zmienności z rynku ropy naftowej na rynek akcji. Należy zauważyć, że szoki cenowe na rynku ropy naftowej nie mają znaczącego wpływu na zmienność na rynkach akcji, z wyjątkiem rynku akcji w Bangladeszu. Decydenci mogą wykorzystać te ustalenia przy podejmowaniu decyzji w obszarze polityki.

Słowa kluczowe: giełda, rynek ropy naftowej, przenoszenie zmienności, transmisja informacji, EGARCH