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The Importance of the 1520 mm Gauge Rail Transport System for Trans-Eurasian International Trade in the Exchange of Goods

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Abstract

The article presents the importance of a specific rail transport system in the logistics service of cargo transported between two generators of international trade in goods – China and the European Union. Using selected operational data relating to the railway systems of several countries (including Belarus, Kazakhstan, Latvia, Russia, and Ukraine), it indicates the great economic importance of the *1520 Space* – an area dominated by broad-gauge infrastructure. Beyond the comparative aspect, and against the background of the influence and importance of railways for the economy, it presents the scope and costs of investments that are necessary and desirable to ensure the efficiency and optimization of goods flows. The study covers the growing share of Trans-Eurasian container transport in the volume of cargo handled using the *1520 Space* rail infrastructure, which is a key link in Trans-Eurasian supply chains and of which the Russian railway system is an essential component.

Keywords: Trans-Eurasian rail transport of goods, international railways exchange, *1520 Space*, transport infrastructure

JEL: N70, O57, R41

Introduction

The development and improvement of transport communications is one of the priority areas of a modern economy. Throughout the world, railways were a key innovation during the Industrial Revolution, fostering the integration of national and international markets (Keller and Shiue 2008, p. 38; Donaldson and Hornbeck 2013). In general, more railways and larger rail networks tended to point to greater economic growth as a result of increased trade and a greater degree of economic integration (Caruana-Galizia and Martí-Henneberg 2013, p. 169).

In the Western world, the construction of new railways was mainly for economic reasons, including the need to develop newly acquired areas. In Russia, the economic factor remained significant, but it was primarily the need to integrate new parts of the empire with the "continent", often perceived as including the region in the military control system, which contributed to the construction of new transport connections, especially railways. The Western world witnessed the biggest boom in history – the railroad boom, a genuinely revolutionary element of the Industrial Revolution (Drucker 1999, p. 50). Over the past two hundred years, the railroad has created change equivalent to that over the past several millennia. Up to now, the railroad has played an important role in developing modern civilization, and has contributed greatly to bettering humankind and making human existence easier (Matusitz 2009, p. 455).

Transport in any country serves as the material basis of the social division of labor, carrying diverse connections between production and consumption, industry and agriculture, mining and manufacturing industry, economic regions and population. It affects the whole process of expanded reproduction, the duration of the production cycle, and inventory (raw materials, fuel, warehouse capacity and the base), and it has an effect on the establishment and development of clusters. The quality of transport determines not only the economic situation of the transport, but also the efficient functioning and development of all other sectors of the economy (Gadelshina and Vakhitova 2015, p. 247).

The impact of railway construction is the location of the routes and corridors. However, decisions and reasons concerning where to build railways are not always determined purely by demand, as confirmed by numerous cases studies. For example, Duranton and Turner (2012) demonstrated that railways in the United States were built where land and labor were cheap, not where they were necessarily needed. Mojica and Martí-Henneberg (2011) found evidence that the construction of railways in Spain was rarely driven by demand but more by a perceived need to connect political and administrative capitals. For the countries included in the *1520 Space*, rail transport is a key component of the logistics system that supports economic processes. And in the case of Russia, rail transport is not only an integrator and a tool for internal economic activity. It is also an instrument of the implementation of economic policy by the state authorities in international terms, including competing with other economies. It often helps to create new solutions aimed at limiting the flow of goods when those flows are considered harmful from the point of view of the Russian raison d'état.

Comparative indicators of rail transport system in selected countries of the *1520 Space*

The railway transport system of the Commonwealth of Independence States, Ukraine, and the Baltic states operates on the basis of the 1520 mm track gauge infrastructure. The difference between this track gauge and that of neighboring countries is an obstacle to the efficient logistics handling of international exchange, but it is not a factor that only occurs in the post-Soviet space. Track gauge is the inner distance between the rail tracks and is normally measured in millimeters. A break-of-gauge happens along a route where there is a difference in track gauge between one network and the other, and as a result, the rolling stock of one gauge cannot ply over the other. The break-of-gauge usually happens at international borders when a train moves from one network to another, but it can also happen within a country if the rail network within that country has different track gauges. Around the globe, most of the railway network is built on the six gauges shown in Figure 1, from 1000 mm to 1676 mm.

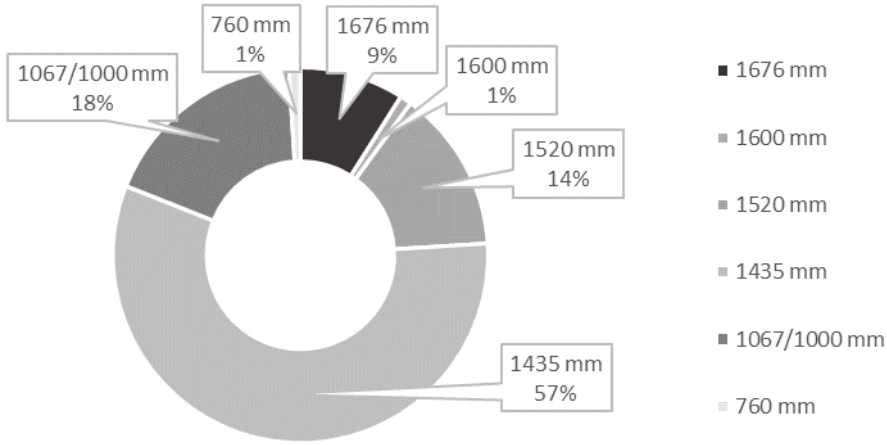

Figure 1. Share of the infrastructure of individual track gauges in the global rail network
Source: *Monograph Series*..., n.d., p. 10.

As Figure 1 shows, 57% of the global rail network is on standard gauge (1435 mm), e.g., Europe, the United States, China, and Iran, while 1520 mm infrastructure exists on 14% of the global rail network. It includes all fifteen former republics of the Soviet Union and Mongolia. Additionally, Finland's rail infrastructure is based on a track gauge of 1524 mm, which technically includes it in the broad-gauge *1520 Space*. However, as a member of the European Union, and therefore part of another economic market, it is not included as part of the 1520 system in economic analyses for this area.

For many countries of the *1520 Space*, rail transport is the backbone of the economy. Railways perform most of the work in a country's transport systems, ensuring the transportation of products from the place of extraction, and from the produc-

tion site to the place of sale in the domestic or foreign markets. They are also a connecting link in transit traffic. The importance of railway transport is confirmed by its high share in the structure of freight turnover: the share of railway transport in the freight turnover of the Russian Federation exceeds 46% (excluding pipeline transport – 87.1%), in Belarus – 37% (63%), and in Kazakhstan – 41% (49%).

Freight rail transport is significantly influenced by the global geopolitical and economic situation, as well as changes in the freight base and directions of transportation that take place in a number of major countries. In the *1520 Space* between 2010 and 2019, freight turnover, the key indicator that reflects the work of railway transport, increased by 22%, to 3152 billion tonne-kilometre [t-km] (Figure 2). Its dynamics in that period were multidirectional, but in general, there was an upward trend. In particular, between 2010 and 2012, for almost all countries, the *1520 Space* was characterized by an increase in cargo turnover, which is associated with the recovery of economies after the global economic crisis.

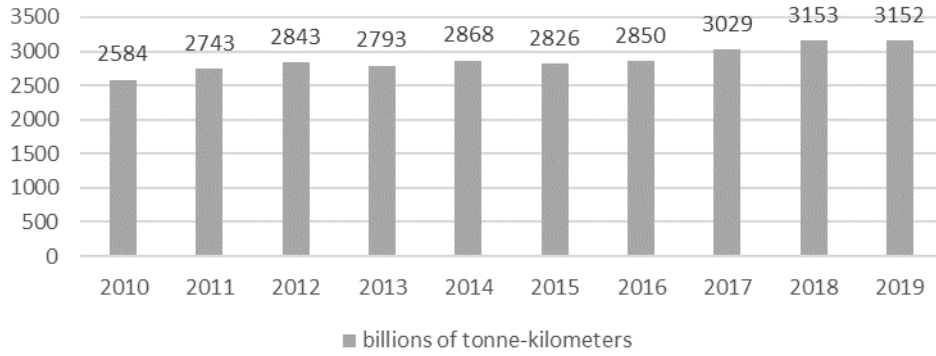

Figure 2. Freight turnover on the railway network of the *1520 Space* countries, 2010–2019
Source: Rynok gruzovyh zheleznodorozhnyh perevozok stran Prostranstva 1520, Moscow 2020, p. 7.

The countries included in the *1520 Space* are economies in which the share of rail transport in the transport of goods is particularly important. Figure 3 presents the rail utilization rate in selected countries against the background of the importance of other modes of transport. These data show that the greatest importance of freight transport by rail is in Ukraine (53.6%), Russia (45.9%), Latvia (48.3%), and Kazakhstan (41%).

Nevertheless, Russia remains the main rail system in the *1520 Space* and holds a key share in the structure of its freight turnover. Russia's share from 2010 to 2019 increased by 4.7 p.p. and reached 82.5%. Against the background of the general growth in cargo turnover, there is a change in its structure and the contribution of countries (Table 1). Between 2010 and 2019 in Kazakhstan, cargo turnover increased by 5.1% to 224 billion t-km, and in Belarus – by 4.3% to 48.2 billion t-km, while their share in the structure of turnover in *1520 Space* decreased by 1.1 p.p. and 0.3 p.p., respectively. The growth in freight turnover in Kazakhstan and Belarus was largely facilitated by an increase in traffic in transit traffic, which influenced the geography and general structure of freight transportation.

During the period under review, in Kazakhstan, transportation in domestic traffic significantly increased, and in Belarus, it increased for export.

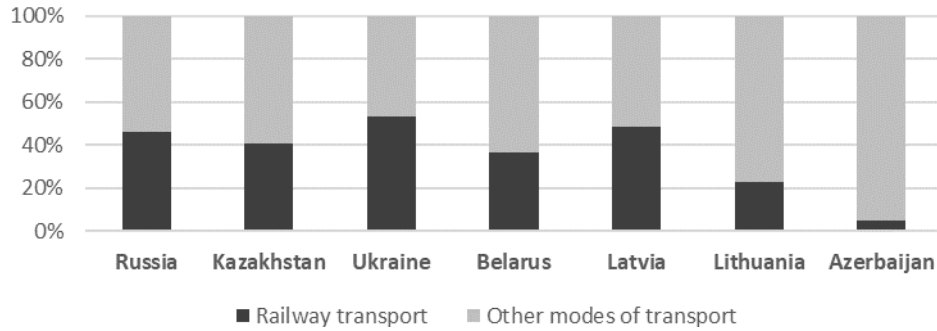

Figure 3. The share of rail transport in total freight turnover in 2019
Source: own compilation based on the statistical data of national offices that supervise transport activities, Federal State Statistics Service, Database VNPinfo.ru and ROSSTAT.

Table 1. Dynamics of freight turnover in countries of the *1520 Space*

Country	Freight turnover (billions of tonne-kilometers)	Country share (percent)	Percentage point	Billions of tonne-kilometers
	2019		Change compared to 2010	
Russian Federation	2602	82.5	+4.7	+590.6
Kazakhstan	224	7.1	–1.1	+10.8
Ukraine	182	5.8	–2.7	–36.3
Belarus	48	1.5	–0.3	+2
Other countries	96	3.1	–0.6	+0.1

Source: Rynok gruzovyh zheleznodorozhnyh perevozok stran Prostranstva 1520, Moscow 2020, p. 8.

In 2018, freight turnover set a new record in the entire history of railway transport in the Russian Federation, and again in 2019. The increase in cargo turnover is associated with a change in the structure of the cargo base and the geography of transportation due to the positive situation in foreign markets and the growth of export shipments from the central regions of the country. Between 2010 and 2019, the volume of transportation of goods for export increased by 24.4%, while the volume of traffic in domestic traffic decreased by 0.5%. As a result, the average transportation distance increased by 23.5% to 1852 km in 2019. The change in the geography of transportation was due to the reorientation of shipments of coal – the main export cargo transported by rail – from West to East. In 2019, a record of 96.3 million tonnes was set for the transportation of coal to the Far Eastne. This direction results from the importance of Russian coal exports to the countries of the Asia-Pacific region.[1]

1 According to a KPMG report, in 2018, the main recipients of Russian coal were South Korea (26% of exports), China (23%) and Japan (18%).

An important factor in improving transport efficiency is the increase in the mass of the freight trains that run on the railway network. This is important not only from the point of view of handling the growing demand for transport, but also minimizing the effects of bottlenecks. After all, with limited capacity, running heavier and/or longer trains makes it possible to handle a larger volume of goods. This directly results in growth performance indicators. In this area, Russia is second only to the United States.[2] In order to master the growing traffic volumes, Russian Railways works to optimize and develop new transportation technologies. In 2015 alone, over 1200 trains with a gross weight of 12,000 tonnes were operated on 1200 km lines of the Russian Far East. Currently, heavy traffic is carried out in all major export directions. In 2019, more than 162,000 trains weighing over 6000 tonnes were dispatched. The average gross weight of a freight train in 2019 was 4090 tonnes, the highest in the *1520 Space*. To master and develop the technology of heavy-haul traffic, JSC "Russian Railways" is actively purchasing modern traction rolling stock: 3E5K electric locomotives (Russian marking: 3*ЭС5К «Ермак»* or *«Атаман»*) and 3TE25K2M diesel locomotives (Russian marking: *3ТЭ25К «Пересвет»*).[3] Although cargo trains weighing 8000 tonnes run on the Russian rail network, they mainly transport coal to the Urals and to the Central Federal Region and are identified with the European part of the country. Figure 4 presents data on the average gross weight of a freight train among the *1520 Space* countries, achieving the highest indicators in terms of optimizing the gross of transports.

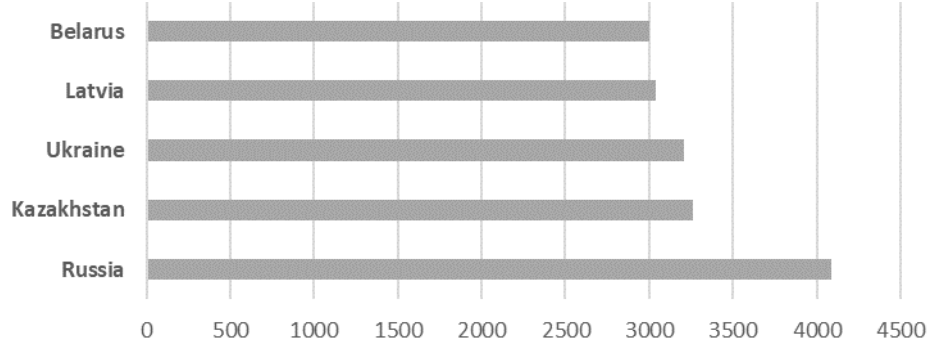

Figure 4. Average freight train weight in the top *1520 Space* countries (in tonnes)
Source: Rynok gruzovyh zheleznodorozhnyh perevozok stran Prostranstva 1520 Moscow 2020, p. 10.

2 According to data from 2014 published by the Institute for Natural Monopolies Research, the average gross weight of a freight train in the USA was 4375 tonnes, in Russia – 3929 tonnes, in China – 3550 tonnes, and in India – 3045 tonnes. These countries are the world leaders in terms of mass transport on its entire network.

3 These are now the most powerful locomotives on Russian railways: the electric 3E5K is rated at 9840 kW and the diesel 3TE25K2M is rated at 9300 kW.

The main trend in recent years in the *1520 Space* countries is the steady growth of container traffic. Special attention is paid to the development of transit container traffic. Russia, as well as Kazakhstan and Belarus, are the key connecting links between the EU and the Asia-Pacific region, and therefore, the transportation of goods in containers is one of the most dynamically developing directions. In the period from 2015 to 2019 alone, the volume of transit container traffic in Belarus increased 3.3 times, in Kazakhstan – 3.1 times. At the end of 2019, first place among the CIS countries in terms of the volume of transit container shipments went to Kazakhstan (664,600 TEU in 2019), ahead of Russia (618,000 TEU) and Belarus (504,100 TEU). Currently, on the territory of the *1520 Space* countries, transportation is carried out along a variety of transit routes and corridors.

The concentration of freight traffic on the main lines of transport and economic relations is characterized by rail transport. In this case, the main burden falls on a relatively small length of the railway network. Half of the total turnover is done by 1/6 of the railways. On the average Russian railway network, congestion of 27 million t-km per 1 km operating length has traffic density two times higher. The most congested line include the Trans-Siberian Mainline, especially its Omsk to Novosibirsk section – the most congested part of the railway in the world.

The essence of the economic importance of *1520 Space* rail transport on the example of Russia

Russia's vast geographical terrain and extreme seasonal changes mean that having functional domestic transport networks has always been crucial both for connecting the country internally and for promoting trade with international partners. As a country reliant on the extraction and export of natural resources such as oil, gas, and coal, Russia must reliably convey these products across large swathes of territory to ensure GDP growth and economic security. This imperative presents both a problem and an opportunity for the Moscow-based political leadership (Ferris and Connolly 2020, p. 3).

At the end of 2019, 86,958 km of publicly accessible railway lines were in operation in the Russian Federation,[4] of which 44,067 km (50.7%) are electrified lines, and 44% are double- and more track. In addition, there are 32,000 km of industrial railways and sidings. In the transport of goods, rail transport is one of the two dominant modes of transport: in 2018, it handled 46.6% of the total load (48.1% was pipeline transport); excluding pipelines, the role of rail in freight turnover was 88.5%.

4 Including fragments of railway lines that cross neighboring countries but are managed by Russian infrastructure undertakings, e.g., the sections (Petuhovo) Gorbunovo – Yunino (Isilkul) and (Irtyshskoe) Urlyutyub – Nyzyltuz (Terengul) leading into Kazakhstan, which is key for freight transport on the Trans-Siberian corridor.

Rail transport in Russia is a branch of the economy that guarantees that all economic sectors function continually. From the very beginning, it was projected that the railroad would influence the social and economic development of the country, territorial development and planning, and national security. The railroad continues to play a decisive role. Together with its direct influence (the provision of jobs, JSC Russian Railways' tax payments to the budget, transit charges, etc.), the industry is characterized by the highest multiplicative effect compared with other branches of industry. There are several reasons for this. The railroad industry uses an effect system as a result of transportation redistribution among all means of transport and improving the efficient load on the transport network. The railroad industry's development is closely connected with allied industries: Russia's transit potential increases, and territory interconnection improves. All these factors contribute to reducing unemployment, increasing incomes, improving the investment climate, as well as raising standards of living. The importance of the railroad industry is enhanced by the vast territory of the country, which is connected with long transport times and changing time and climate zones. As a result, railways have advantages over other means of transport (Kirsanova and Lenkovets 2019, p. 421).

The share of transport in the structure of Russia's GDP is not indicated in official statistics. The adopted indicator "Transport and communications" does not make it possible to take into account either transport or communication. The indicator of 8% (the share of transport in Russia's GDP) is the aggregate indicator of two industries (Shcharbin 2020, p. 70).

Regarding the infrastructure of the Russian railway system, the theme of economic bottlenecks is particularly important. As federal transport law does not allow the railway carrier to refuse to perform the transport service (unlike the international rail transport law does)[5] the need for the actual availability of railway line capacity takes on a special meaning. From the macroeconomic point of view, an interesting source of information is a simulation of the impact of infrastructure constraints on the volume of goods transport and the amount of goods that would not be accepted for transport. Table 2 shows the projected decline in GDP and the Russian federal budget due to insufficient development of rail transport infrastructure for economic needs between 2012 and 2020.

5 *The Federal Law of 24.12.2002 on rail transport of the Russian Federation* (article 12) delegates to the departmental level the specification of technical and technological criteria, the lack of which is the basis for the carrier and infrastructure manager to refuse in transport service. They were introduced by the *Regulation of the Minister of Transport of 6.09.2010*. They define the necessary procedure for agreeing the transport, which is related to the need for the carrier to have appropriate rolling stock and to obtain arrangements with other managers of the infrastructure on which the transport will be performed. At the same time, article 14 of the *SMGS Agreement* provides inter alia that the transport is performed when the appropriate rolling stock is available, the transport is agreed with all infrastructure managers, and there are no objective obstacles that are beyond the company's control that would limit their ability to perform transport services.

Table 2. Summary assessment of the projected decline in GDP and the Russian Federal Budget as a result of insufficient development of rail transport infrastructure for economic needs, 2012–2020 (in trillions of RUB, 2010 price level)

	Base variant (elimination of narrow throats)	Variant A (transport on the existing one railway network)	Variant B (alternative routes of transport)
GDP	421.5	415.4	416.3
GDP losses compared with the base variant		6.4	5.5
Budget losses compared with the base variant		1.5	1.3

Source: Doński-Lesiuk 2020, p. 140.

The data presented in Table 2 shows that if the previous level of density and distribution of the railway network is maintained, i.e., current transport conditions, Russian GDP will lose 1.3–1.8% compared to the variant involving the expansion and modernization of infrastructure at the bottlenecks. It shows that economic efficiency investment in rail transport is vital for Russia. All the more so as, when the budget funds involved in modernizing the infrastructure to remove bottlenecks cover 50% of the total investment costs, using optimization indicators, it can be concluded that the real costs will be 3.5–4 times lower than the reduction in GDP that results from capacity constraints.

At the same time, after completing the necessary infrastructure improvement projects, budget revenues will double their costs, financed from public funds. Simulations carried out by the Strategic Analysis Center Foundation, which estimate the volumes of loads that would not be accepted for transport due to infrastructure limitations, indicate that by 2020, up to 13% of shippers' potential demand for transport cannot be satisfied.

At the same time, the problem of exhausted railway line capacity concerned as much as 19,500 km in 2020. Considering Russia's strategic position in international transport, of crucial importance are the railway lines that are part of the transport corridors, as well as other lines used for transport, which are essential from the point of view of international economic exchange (e.g., leading to seaports and deposits of export raw materials). The technical condition and the technology of transport in Russian ports organization used determine the effectiveness of internal and international economic exchange. For the Russian authorities, another important factor that determines the need to modernize and expand the rail transport infrastructure is that 70% of the volume of goods handled by rail is carried by 30% of the Russian rail network, and this is precisely the case with international corridors which give Russia a special place in the handling of international trade in goods (Doński-Lesiuk 2020, p. 143).

The strategic importance of the *1520 Space* rail transport system for international transit

Due to the rail transport system's specificity and strategic importance, it is generally shaped by the state. It is of particular interest to the authorities, not only because of its importance for the domestic economy and international exchange, but also because of the defense tasks of the transport infrastructure, which is part of the critical infrastructure. It consists of a set of systems and assets, physical or virtual, so essential to the nation that any disruption of their services could have a serious impact on national security, economic well-being, public health or safety, or any combination of these (Alcaraz and Zeadally 2015, p. 16).

The sharp disruption to the global economy in 2020 in connection with the Covid–19 epidemic did not change growth trends in rail forwards. Data from Chinese Railways shows 2920 trains on Asia-Europe routes between January and April 2020, carrying 262,000 TEU (up 24% year-on-year). In August 2020, the number of monthly trains hit a record of 1247 (up 62% compared to 2019). August was also the sixth consecutive month that China–Europe freight train traffic registered double-digit percentage growth year-on-year. How much traffic increased (despite the initial drop at the peak of the pandemic in China) can be seen in the statistics for the CR terminals. While in 2019, a maximum of ten trains were cleared and accepted daily in Alashan (the Xinjiang China–Kazakhstan border point), in February 2020, there were five trains, in March 2020, eleven trains, in April 2020, fourteen trains, and in June 2020, nineteen trains a day. In the first half of 2020, the Changan terminal in Xian (Shaanxi, Central China) cleared 1667 trains to Europe, meaning an almost twofold increase in traffic year on year. The weight of the shipped cargo increased similarly, reaching 1.3 billion tonnes (Czubiński 2020). Figure 5 shows the increase in the volume of rail container freight between China and the European Union (thousands of TEU).

The growing importance of container transport by rail on the Asia–Europe–Asia routes is also confirmed by data from Russian Railways (RZD). Between 2016 and 2019, the trend towards the containerization of goods steadily grew, leading to an increase in container cargo flows in export and transit directions. Thus, in 2018, Russian rail export shipments of containers amounted to 900,000 TEU, and transit container traffic reached 377,000 TEU. The container market in Russia grew by 9% at the end of 2019. High rates of market growth were supported by two segments transit (+22%) due to routes between China and Europe and exports (+14%). RZD forecasts for 2020 show a growth rate of 7%.

On the one hand, forecasts of key macro parameters of the Russian economy in 2020 are more optimistic than in 2019, which implies an increase in entrepreneurial and consumer confidence and, consequently, an increase in the import direction. An increase in freight traffic in transit from Japan and Korea to Europe is also expected. According to Russian analyses of the logistics sector, the boom in transit through Russia on the China-Europe route took place in 2018–2019 (Doński-Lesiuk and Skurpel 2020, pp. 75–76).

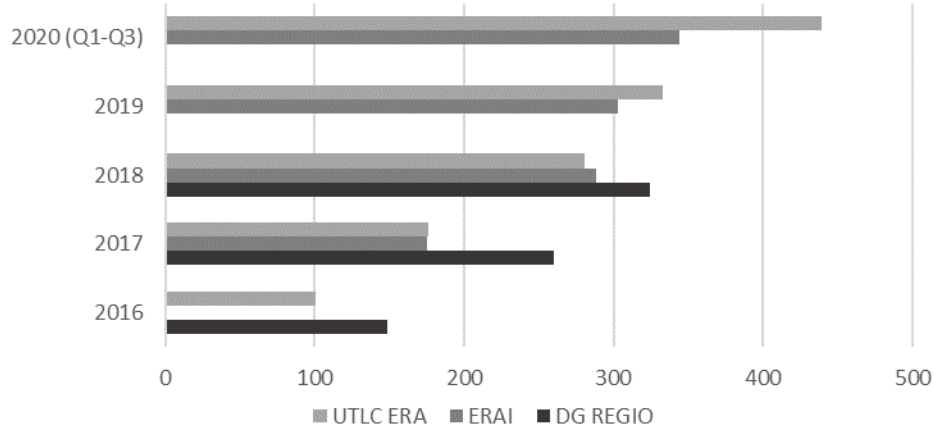

Figure 5. The volume of container transport by rail in the China-Europe exchange[6]
Source: own compilation based on the Directorate General for Regional and Urban Policy (DG REGIO), Eurasian Rail Alliance Index (ERAI), and the United Transport and Logistics Company (UTLC ERA) transport volume data.

In Russia, the basic document that defines actions to improve the conditions for rail transport is the *Strategy for the development of rail transport in the Russian Federation until 2030*, introduced on June 17, 2008, by order of the President of the Russian Federation No. 877-r. This document includes a forecast of the growth in demand for transport in 2030, specifying:

- in the minimum variant – loading 1970 million tonnes (147% compared to 2007) and transport of 3050 billion t-km (146% of the volume in 2007),
- in the maximum variant – loading 2150 million tonnes (160% compared to 2007) and transporting 3300 billion t-km (158% of the volume in 2007).

The *Strategy*'s forecasts envisage that in 2030, the lines leading to the Saint-Petersburg Railway Junction, towards the North Caucasus and the ports of the Primorsky Krai, as well as lines serving the exit routes from Western Siberia and the Urals to the Far East, will be the most loaded. The same as and the Moscow Railway Junction. The assessment of the demand for rail transport included in the document, resulting from parallel investments in the infrastructure of seaports, indicates that cargo volumes to/from Russian ports will increase 1.5–2 times and as much as 2–2.5 times in the Azov-Black Sea direction. The increased demand for transport from the Urals is estimated at 1.8–2 times compared to the present state, and 1.5–1.8 times in the direction of the Urals. This is due to the expansion of the resource base Yamalo-Nenets Autonomous Okrug.

The greatest increase in the demand for transport (even 7–10 times) is expected on the Baikal-Amur Mainline (BAM), which leads to the ports of Vanino and Sovetskaya Gavan, due to the ongoing significant intensification of the use of raw materi-

6 Data on the number of containers differ due to the different scale of statistical data from individual sources (only selected railway lines or corridors, etc. are analyzed).

als from the Republic of Sakha (Yakutia). For them, BAM remains the only overland export channel.[7] Additionally, of particular importance are the investments to specialize the Trans-Siberian Mainline for passenger and container transport. According to the *Strategy*, until 2030, investments in rail transport infrastructure include:

- the construction of a second plain line on sections with a length of 1767 km (minimum variant) to 3055 km (maximum variant),
- the construction of new lines enabling transit transport to bypass the Irkutsk, Perm, and Novosibirsk junctions and the northern bypass of the Yekaterinburg junction,
- the construction of the third perimeter line around the Moscow Railway Junction,
- the electrification of sections with a total length from 3132 km (minimum variant) to 3580 km (maximum variant), including the prior preparation of a number of detour lines,
- equipping from 1085 km (minimum variant) to 3128 km (variant maximum) of sections with an automatic line block,
- reconstructing and modernizing the traction network on a total length of 50,900 km, including the reconstruction of 763 substations (especially on Trans-Siberian Mainline and its branches),
- modernizing line blockades on sections with a total length of 1171 km and equipment of 11,515 km of routes with devices that allow the operation of two-way on the track intended for opposite-direction tracks to be used,
- modernizing the Ulan-Ude–Naushki line, connecting the Trans-Siberian Mainline with the Russian-Mongolian border crossing on the Trans-Mongolian route to China.

For the increased importance of Russia's transit rail transport system, by 2030, 16,017 km (minimum variant) / 20,730 km (maximum variant) of new lines are planned to be built. Depending on the variant, 4,573 km / 4,660 km of lines have been identified in *Strategy* as 'necessary due to the needs of the new freight corridors'.

As part of the comprehensive plan to modernize and expand the main infrastructure by 2024, it is planned to increase the carrying capacity of the Baikal-Amur and Trans-Siberian Mainlines to 180 million tons, as well as the railway infrastructure on the approaches to the ports of the Azov-Black Sea (to Novorossiysk[8] and other important seaports from the perspective of international trade). It is also envisaged to increase the throughput to ensure the four-fold growth of the volume of transit con-

7 Sakha-Yakutia exploits resources of crude oil, gas, hard coal, metal ores, rare metals, and various aggregates. Currently, there are 1500 known deposits of mineral resources. Its raw material potential, the richest entity of the Russian Federation, is estimated at RUB 78.4 billion. According to data from the Ministry of Natural Resources and Ecology, 47% of the total developed coal resources and 35% of the developed oil and gas resources of the East Siberian-Far East area are concentrated in Yakutia.

8 Novorossiysk is the largest port of the Russian Federation, in 2019 handled 156.8 million tons of cargo, which is 18.7% of the total transshipments in Russian seaports.

tainer traffic. It includes reducing container transportation times by rail, in particular, from the Far East to the western border of Russia (i.e., the border crossing with Belarus on the Moscow – Minsk – Western Europe and Baltic States corridors) to seven days. It is also planned to increase Russia's economic connectivity with major neighboring markets and a corresponding increase in the contribution of Russian Railways to the country's GDP growth. That one state-owned enterprise (RZD) alone will increase its share of contributions to the Russian Federation's GDP from 5.1% in 2018 to 5.4–5.6% in 2025, according to *The Long-term Development Program of Russian Railways until 2025*.

Conclusion

Much attention has focused on Russia's so-called 'pivot to the East' – its military and political alliances with rising powers such as China, and its attempts more broadly to recruit Central and Southern Asian countries into coalitions against the West. Russia's cultivation of political and economic ties with countries such as India, Vietnam, and Japan is long-standing. However, it has been given fresh impetus by the deterioration in diplomatic relations between Russia and the West. The introduction of Western sanctions, following Russia's annexation of Crimea in 2014 and military intervention in eastern Ukraine, has obliged the Kremlin to seek alternative trade partners and to redirect its trade links from West to East (Ferris and Connolly 2020, p. 3). This shift has added urgency to Moscow's desire to promote the economic development of the Russian Far East to potential partners – Japan, India, or South Korea.

The development of modern and competitive transport and communications infrastructure is one of the key conditions of high and sustainable economic growth that will achieve and ensure the country's economic security. Since rail transport is a strategic resource in increasing the competitiveness of the economy, successfully solving the many interrelated tasks of its operation is possible only by studying domestic and foreign experience, and testing fundamental hypotheses and proposals which are made in a wide range of opposing directions of economic thought (Gadelshina and Vakhitova 2015, p. 248).

The existing infrastructure of Euro-Asian inland routes and ports facilities provide good potential opportunities to further develop the inland transport of goods between Europe and Asia. However, competition of transport routes on the Euro-Asian continent was not about the simple choice between transport routes and/or transport modes. It is the competition of logistic decisions based on intermodal services and value-added services, and it focuses on the needs of particular supply chains. Those require regular services, high punctuality, flexible costs, value-added services availability, and delivery speeds that are appropriate for certain types of cargo.

Taking into account the observed and planned investments aimed at improving the efficiency and effectiveness of rail transport of the Russian Federation, its rail

transport system can attract traffic as long as it remains competitive in the context of supply chains. And without a doubt, it will remain the most heavily loaded with transport services in the *1520 Space*. The quality of infrastructure, of course, remains only one of several factors to optimize freight flows. Nevertheless, the modernization of the Trans-Eurasian transport corridors, including the construction and expansion of border terminals at the junction of railway lines with different track gauges, directly affects the competitiveness of supplies. This is happening not only due to the increase in capacity and transport capacity, but also the implementation of favorable legal solutions. Russia is participating in several projects to harmonize system solutions that support the international trade in goods and forwarding. This seems to be done based on its own interests and the particular needs of using *soft power* in relation to some neighboring countries. However, the economic benefits of participating in the transit of international supply chains are and will remain important for Russia. It is part of the economic benefits that result from its geostrategic location and the possibility of creating logistic channels of transcontinental importance.

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Znaczenie systemu transportu kolejowego o rozstawie 1520 mm dla międzynarodowej wymiany towarowej pomiędzy Europą a Azją

W artykule przedstawiono znaczenie specyficznego systemu transportu kolejowego w obsłudze logistycznej towarów przewożonych pomiędzy dwoma generatorami międzynarodowego handlu towarami – Chinami i Unią Europejską. Posługując się wybranymi danymi operacyjnymi, odnoszącymi się do systemów kolejowych kilku krajów (m.in. Białorusi, Kazachstanu, Łotwy, Rosji, Ukrainy), artykuł wskazuje na duże znaczenie gospodarcze systemu 1520 mm – tzw. infrastruktury szerokotorowej. Poza aspektem porównawczym, na tle wpływu i znaczenia transportu kolejowego dla gospodarki, przedstawiono w nim zakres i koszty inwestycji, które są niezbędne i pożądane dla zapewnienia efektywności i optymalizacji przepływów towarów. W badaniu uwzględniono rosnący znaczenie transeurazjatyckich przewozów kontenerowych w wolumenie ładunków obsługiwanych z wykorzystaniem infrastruktury kolejowej 1520 mm, która jest kluczowym ogniwem w transeurazjatyckich łańcuchach dostaw, a której kluczowym elementem pozostaje rosyjski system kolejowy.

Słowa kluczowe: transeurazjatyckie przewozy towarów koleją, międzynarodowe przewozy kolejowe, system 1520 mm, infrastruktura transportu

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Human Capital Development, Remittances, and Poverty in Central and Eastern European Countries: What Do the Data Tell Us?

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Abstract

The study investigates the impact of human capital development on poverty in Central and Eastern European Countries (CEECs) using dynamic generalized methods of moments (GMM), fixed effects, random effects, and pooled ordinary least squares (OLS) with panel data ranging from 2008 to 2019. Using the same panel data analysis methods and data set, the study also explored the influence of the complementarity between human capital development and personal remittances on poverty in CEECs. What triggered the investigation into this topic is that the available literature on the subject matter is mixed, divergent, and very much conflicting. The lag of poverty, remittances, the interaction between human capital development and remittances, trade openness, unemployment, and partly financial development significantly increased infant mortality rates in CEECs. On the other hand, human capital development, infrastructural development, and partly financial development were found to have reduced infant mortality rates. These results mean that human capital development, financial development, and infrastructural development reduced poverty in CEECs during the period under study. Central and Eastern European Countries are therefore urged to craft and implement financial development, infrastructural development, and human capital development enhancement policies to combat poverty. Future empirical research could also investigate at what threshold the level of human capital development, financial and infrastructural development would poverty be significantly reduced in CEECs.

Keywords: human capital development, remittances, poverty, panel data analysis

JEL: J24, F24, I3

Introduction

This section consists of three segments, namely the background of the study, the contribution of the paper, and the organization of the study.

Background of the study and research gaps

Poverty eradication is one of the key United Nations Millennium Development Goals, alongside human capital development and unemployment and income inequality reduction, in line with empirical research on the subject matter. The Millennium Development Goals were crafted in such a way that recognizes that human capital development is central to alleviating unemployment, poverty, and income inequality. There have been several empirical studies that investigated the impact of human capital development on poverty, including Awan, Iqbal, and Waqas (2011), Chukwubudom (2016), Adekoya (2018), Bidemi et al. (2018), Olopade et al. (2019), Sajjad et al. (2019), and Wang et al. (2021). These empirical studies produced mixed results and were inconclusive, paving the way for further empirical tests on the subject matter.

The results of this prior empirical research on the influence of human capital development on poverty have several methodological deficiencies. Firstly, they ignored the endogeneity problem normally associated with poverty and its determinants. Secondly, the dynamic nature of the poverty data was largely ignored. Thirdly, they never studied the subject matter using CEECs as a unit of analysis, meaning they are narrow. Fourthly, they wrongly assumed that the relationship between poverty and human capital development is linear. Finally, the majority used an outdated dataset. The current study fills these gaps.

Contribution of the paper

This study contributes to the literature in six different ways. 1) Using the dynamic GMM, the study considered the endogeneity of the poverty function. 2) The dynamic characteristics of poverty data were captured by the dynamic GMM. 3) To the best of the author's knowledge, this is the first study to investigate how the complementarity between human capital development and personal remittances influences poverty. 4) Earlier empirical research on the human capital development-poverty nexus and personal remittances-poverty causality ignored Central and Eastern European Countries (CEECs) as a unit of analysis. In other words, there is an untold story on the human capital development-remittances-poverty nexus in the CEECs. This study fills that gap. 5) Unlike the majority of the empirical literature on the subject matter, this study assumes that there is a non-linear relationship between human capital development and poverty. 6) Unlike prior empirical research work on the subject matter, this study made use of the most recent dataset (2008–2019).

Organization of the paper

The rest of the study is divided into seven sections. Section 2 discusses the impact of human capital development on poverty in the theoretical literature, while Section 3 focuses on the influence of human capital development on poverty found in the empirical literature. Section 4 presents the theoretical literature that explains how remittances affect poverty. Section 5 provides a comprehensive theoretical literature review on how each control variable (financial development, unemployment, savings, infrastructural development, trade openness) influences poverty. Section 6 details the methodological framework used in the research. Items covered include data description, general model specification, econometric model specification, correlation analysis, descriptive statistics, panel unit root tests, and panel co-integration tests. Section 7 discusses and interprets the main results. Section 8 concludes.

The impact of human capital development on poverty – the theoretical literature

According to Chaudhry and Rehman (2009), enhanced human capital development gives people good health, education, and the skills for their businesses to survive and prosper, even in challenging circumstances. The skills and education also easily allow them to get well-paying jobs, reducing not only unemployment but also poverty and income inequality (Afzal et al. 2010).

According to Oshio (2019), poverty is perpetuated and contributes to poor health behaviors, while human capital development is also enhanced by good health status. The same study argued that poor education and health trigger many constraints, which constrains labor participation and reduces the quality of life. Daepp and Arcaya (2017) also noted that the individual's ability to work and access meaningful economic opportunities is curtailed by one's state of health. The same study also revealed that the rate at which one is willing and able to use new technologies depends on an individual's education and health status.

The impact of human capital development on poverty – the empirical literature

Table 1. A summary of empirical studies on human capital development on poverty

Author	Focus of analysis	Methodology	Research findings
Chukwubudom (2016)	Nigeria	Ordinary Least Squares (OLS)	Human capital development's impact on poverty alleviation was found to be positive and significant.
Adekoya (2018)	Nigeria	Vector Error Correction Model (VECM)	Health and education elements of human capital development was found to have reduced poverty in Nigeria.
Bidemi et al. (2018)	Nigeria	Generalized Methods of Moments	Expenditure on health and education was found to have had a significant negative effect on poverty in Nigeria. In other words, human capital development reduced poverty in the case of Nigeria.
Olopade et al. (2019)	OPEC member countries	Panel fully modified least squares of 12 countries	High-quality education and healthcare were found to have reduced poverty in the OPEC group of countries.
Sajjad et al. (2019)	Pakistan	Multiple regression model	A significant positive relationship running from education and health towards poverty alleviation in the Swabi district, Pakistan
Awan, Iqbal, and Waqas (2011)	Pakistan	Multinomial regression analysis	Education of the poor people was found to have had a higher poverty reduction effect in both genders.
Wang et al. (2021)	Sub-Saharan Africa	Autoregressive Distributive Lag (ARDL)	No evidence that human capital development reduces poverty in the long run in Sub-Saharan Africa was found. Short run period revealed that human capital development reduced poverty.
Babasanya, Oseni, and Subair (2018)	Nigeria	Multiregression analysis	Human capital development enhanced Nigeria's ability to achieve millennium development goals during the period under review.
Ewubare and Mark (2018)	Nigeria	Vector Autoregressive (VAR) model	Primary and secondary school enrolments and public health expenditure were all found to have significantly reduced poverty in Nigeria
Ahmad, Bashir, and Hussain (2018)	Developing countries	Generalized Methods of Moments (GMM)	Technology and human capital development had a significant deleterious impact on poverty in developing countries.
Winters and Chiodi (2008)	Mexico	Descriptive statistics	Investment in education improved employment in the agricultural sector, reducing poverty and income inequality overall in Mexico.
David, Awe, and Sesan (2018)	Nigeria	Linear probability model approach	Poverty in Nigeria was further reduced by increased investment in health and education.

Author	Focus of analysis	Methodology	Research findings
Tsaurai (2021)	Emerging markets	Panel data analysis	The complementarity between economic growth and human capital development was observed to have had a significant poverty reduction effect in emerging markets.

Source: author's compilation.

Impact of remittances on poverty alleviation – literature review

According to Anyanwu and Erhijakpor (2010), over-relying on remittance inflows, in the long run, could cause laziness, have a deleterious on economic growth, and increase poverty levels in the long run. However, the optimistic hypothesis authored and expanded by Cattaneo (2005) noted that remittance inflow promotes entrepreneurship, creates self-help projects, boosts self-employment levels and economic growth, and, overall, enhances poverty reduction in the labor-sending country in the long run.

Impact of control variables on poverty

Table 2. Theoretical literature on the impact of control variables on poverty

Variable	Proxy used	Theory intuition	Expected sign
SAV	Gross domestic savings (% of GDP)	According to Azher (1995), a meaningful amount of savings enhances an individual's ability to begin entrepreneurial projects and self-help projects.	-
UNEMP	Unemployment, total (% of total labor force)	According to the majority of the existing literature, unemployed people are more exposed to poverty in comparison to employed people. The income that employed people receive enhances their purchasing power, reducing poverty levels (Azher 1995).	-
OPEN	Total trade (% of GDP)	According to Pradhan and Mahesh (2014), high trade openness leads to increased competition, negatively affecting domestic firms' ability to expand; it creates employment and stems from poverty. The same study believed that increased trade openness enables domestic firms to be international players in sourcing raw materials, funding, and information technology, enhancing their local, regional, and global competitiveness. This enables them to expand, create more jobs, and reduce poverty levels.	+/-

Variable	Proxy used	Theory intuition	Expected sign
FIN	Domestic credit to private sector (% of GDP)	According to Boukhatem (2016), a developed financial sector demands high-value collateral security during the money process. Poor people do not have the required collateral security, further trapping them in the vicious poverty cycle. On the other hand, according to Rajan and Zingales (1998), financial development allows poor people to access small loans, which they can use to finance small self-help projects and entrepreneurial projects, creating self-employment.	+/-
INFR	Individuals using the Internet (% of population)	According to Jahan and McCleery (2005), enhanced infrastructural development enables people to have good roads, access clean water, better health care, all of which reduces poverty levels. Pradhan and Mahesh's (2014) results show that infrastructural development increased poverty levels in developing countries.	+/-

Source: author's compilation.

Research methodology

Data character and description

The study used panel data ranging from 2008 to 2019 to investigate the relationship between human capital development, remittances, and poverty in CEECs. They include Bulgaria, Albania, Croatia, Poland, Romania, Hungary, Slovenia, the Czech Republic, Lithuania, Latvia, Estonia, and Slovakia. The United Nations Development Programme, World Development Indicators, International Financial Statistics, and the International Monetary Fund are the prominent international databases from which the datasets were extracted.

General model specification

Equation 1 represents a general model specification of the poverty function.

$$POVERTY = f(HCD, REMIT, INFR, OPEN, SAV, UNEMP, FIN) \quad (1)$$

The choice of explanatory variables in the poverty function was largely influenced by earlier empirical research on human capital development's impact on poverty (see Winters and Chiodi 2008; Awan, Iqbal, and Waqas 2011; Ahmad, Bashir, and Hussain

2018; Babasanya, Oseni, and Subair 2018; David, Awe, and Sesan 2018; Ewubare and Mark 2018; Wang et al. 2021). The proxies of these variables (poverty, human capital development, remittances, savings, infrastructural development, unemployment, trade openness, and financial development, were also largely selected based on similar empirical research by Awan, Iqbal, and Waqas (2011), Chukwubudom (2016), Adekoya (2018), Bidemi et al. (2018), Olopade et al. (2019), Sajjad et al. (2019), and Tsaurai (2021).

Econometric model specification

Equation 2 is the econometric model version of the econometric model specification.

$$\begin{aligned} POVERTY_{it} = \beta_0 + \beta_1 HCD_{it-1} + \beta_2 REMIT_{it} + \beta_3 INFR_{it} + \beta_4 OPEN + \beta_5 SAV_{it} + \\ + \beta_6 UNEMP_{it} + \beta_7 FIN_{it} + \varepsilon \end{aligned} \quad (2)$$

The intercept is represented by β_0, β_1 to β_7 represents the coefficients for the respective independent variables of the poverty function. ε stands for the error term.

$$\begin{aligned} POVERTY_{it} = \beta_0 + \beta_1 HCD_{it} + \beta_2 REMIT_{it} + \beta_3 (HCD_{it} \cdot REMIT_{it}) + \beta_4 INFR + \\ + \beta_5 OPEN_{it} + \beta_6 SAV_{it} + \beta_7 UNEMP_{it} + \beta_8 FIN_{it} + \varepsilon \end{aligned} \quad (3)$$

A complementary variable (between human capital development and remittances) was introduced into the poverty econometric equation 3, in line with Anyanwu and Erhijakpor (2010). Their study noted that human capital development increases remittance inflows into the labor-sending country, enhancing its ability to promote self-employment, entrepreneurship, economic growth, and poverty reduction efforts. If the co-efficient β_4 is negative and significant, the complementarity between human capital development and personal remittances would have reduced poverty in the Central and Eastern European Countries. The random effects, pooled OLS, and fixed effects are the three panel econometric estimation approaches that were used to estimate equation 3.

$$\begin{aligned} POVERTY_{it} = \beta_0 + \beta_1 POVERTY_{it-1} + \beta_1 HCD_{it} + \beta_3 REMIT_{it} + \\ + \beta_4 (HCD_{it} \cdot REMIT_{it}) + \beta_5 INFR + \beta_6 OPEN_{it} + \beta_7 SAV_{it} + \\ + \beta_8 UNEMP_{it} + \beta_9 FINi_{it} + \varepsilon \end{aligned} \quad (4)$$

Equation 4 introduced the lag of poverty as one of the factors that influence poverty, in line with Azher's (1995) argument supporting the existence of a vicious cycle of poverty. Equation 4 was estimated using the dynamic GMM approach, whose advantages

include (1) that it captures the dynamic nature of poverty data and (2) it considers the endogeneity characteristics of poverty and its determinants.

Correlation analysis results

Table 3. Correlation analysis results

	POV	HCD	REMIT	INFR	OPEN	SAV	UNEMP	FIN
POV	1.00							
HCD	−0.84***	1.00						
REMIT	0.58***	−0.54***	1.00					
INFR	−0.82***	0.80***	−0.32***	1.00				
OPEN	−0.54***	0.50***	−0.23***	0.74***	1.00			
SAV	−0.70***	0.63***	−0.75***	0.58***	0.58***	1.00		
UNEMP	0.34***	−0.35***	0.52***	−0.25***	−0.18**	−0.58***	1.00	
FIN	−0.25***	0.04	−0.20**	0.10	−0.06	0.17**	0.25***	1.00

Source: author's compilation from E-Views.

Where POV is the infant mortality rate (per 1000 live births).

Table 3 shows that there is a significant negative relationship between (1) poverty and human capital development, (2) poverty and infrastructural development, (3) poverty and trade openness, (4) savings and poverty, and (5) poverty and financial development. A significant positive relationship between (a) remittances and poverty and (b) poverty and unemployment was also observed, according to Table 3. The results could imply that human capital development, infrastructural development, trade openness, savings, and financial development are in line with the existing literature. The highest correlation was found between human capital development and poverty (0.84), which is more than 0.80. This means that there is a multicollinearity problem, or the multicollinearity problem exists, consistent with Wisniewski and Stead (1996).

Descriptive statistics results

Table 4. Descriptive statistics results

	POV	HCD	REMIT	INFR	OPEN	SAV	UNEMP	FIN
Mean	5.15	0.83	3.24	67.46	113.55	23.00	9.22	52.85
Median	4.55	0.84	2.44	69.8	122.7	22.78	8.48	50.35
Maximum	14.1	0.92	14.48	90.23	190.86	33.93	19.48	100.82
Minimum	1.70	0.67	0.37	23.86	26.93	6.53	2.01	24.75
Standard deviation	2.56	0.05	2.90	12.67	43.78	6.13	3.94	15.52
Skewness	1.09	−0.95	2.07	−0.79	−0.23	−0.62	0.51	0.81

	POV	HCD	REMIT	INFR	OPEN	SAV	UNEMP	FIN
Kurtosis	3.87	3.94	7.17	3.43	1.91	3.44	2.45	3.50
Jarque-Bera	33.22	26.83	207.7	16.26	8.44	10.47	7.98	17.16
Probability	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Observations	144	144	144	144	144	144	144	144

Source: author's compilation from E-Views.

Where POV is represented by infant mortality rate (per 1000 live births). The standard deviation for variables such as poverty, remittances, infrastructural development, trade openness, savings, unemployment, and financial development is greater than 1. This means that extreme values exist among these variables.

Human capital development, infrastructural development, trade openness, and savings are skewed to the left, while variables skewed to the right include poverty, remittances, financial development, and unemployment, a sign that the data may not be normally distributed. The probability of the Jarque-Bera criteria for all the variables studied is almost zero, an indication that these variables are not normally distributed. In line with Aye and Edoja (2017), if the data shows the character of multi-collinearity, extreme values, and abnormal distribution, the data must be transformed into natural logarithms before the final data analysis. This is done to avoid getting spurious results. This study followed Aye and Edoja's (2017) recommendations.

Panel unit root tests

Table 5 presents the results for panel unit root tests.

Table 5. Panel root tests –Individual intercept

Level				
	LLC	IPS	ADF	PP
LPOV1	–3.42***	–0.31	–2.36**	–6.81***
LPOV2	–6.95***	–2.11**	41.72**	67.56***
LHCD	–34.90***	–21.28***	183.93***	102.90***
LREMIT	–0.20	1.66	14.11	17.89
LINFR	0.77	0.90	20.62	61.44***
LOPEN	–13.85***	–8.37***	103.42***	16.43
LSAV	–7.96***	–3.18***	52.70***	23.73
LUNEMP	1.78	1.36	13.42	8.70
LFIN	–2.65***	0.29	21.31	27.54
First difference				
LPOV1	–7.04**	–2.83*	–5.83***	–12.94***
LPOV2	–2.22**	–2.39***	42.89**	140.80***
LHCD	–26.72***	–15.79***	172.75***	75.39***
LREMIT	–3.32***	–1.57**	35.46**	65.19***

Level				
	LLC	IPS	ADF	PP
LINFR	–2.73**	–6.49***	88.48***	142.49***
LOPEN	–5.21***	–3.63***	56.29***	100.53***
LSAV	–6.73***	–4.75***	65.57***	116.80***
LUNEMP	–4.40***	–3.01***	53.09***	92.64***
LFIN	–5.01***	–2.28**	42.59**	50.44***

Note: LLC, IPS, ADF, and PP stands for Levin, Lin, and Chu (2002); Im, Pesaran, and Shin (2003); ADF Fisher Chi Square, and PP Fisher Chi Square tests, respectively. *, ** and *** denote 10%, 5% and 1% levels of significance, respectively.
Source: author's compilation from E-Views.

Where POV1 is the infant mortality rate (per 1000 live births), and POV2 is the life expectancy at birth, total (years).

It is clear from Table 5 that all the variables were integrated of order 1. In other words, the study observed that all the variables studied were stationary at first difference, consistent with Aye and Edoja (2017). The results paved the way for panel co-integration tests.

Panel co-integration tests

The Kao (1999) panel co-integration methodology produced results that are summarized in Table 6.

Table 6. Results of Kao co-integration tests

Series	ADF t-statistic
POV1 HCD REMIT INFR OPEN SAV UNEMP FIN	–1.3497*
POV2 HCD REMIT INFR OPEN SAV UNEMP FIN	–1.0036

Source: author's compilation.

Using infant mortality rate as a measure of poverty, a long-run relationship between and among the variables used in the study was detected. Consistent with Tembo (2018), an alternative hypothesis that says there is no long-run relationship between and among the variables studied is rejected. This means the null hypothesis, which says that there is a long-run relationship, is not rejected. Using life expectancy as a proxy of poverty, the study noted that the variables under study are not co-integrated. Such results cause the author to drop life expectancy (as a measure of poverty) from the study.

Main data analysis, results discussion, and interpretation

Table 7. Panel data analysis results

	Dynamic GMM	Fixed effects	Random effects	Pooled OLS
POVERTY Lag	1.01***	–	–	–
HCD	–0.17	–0.43	–1.74***	–4.23***
REMIT	–0.002	0.11***	0.14***	0.43***
INTERACTION TERM	–0.005	0.24	0.36**	1.56***
INFR	0.02	–0.30***	–0.52***	–0.91***
OPEN	–0.01	0.06*	0.004	0.03
SAV	–0.02	0.08	0.03	–0.11
UNEMP	–0.01	–0.004	0.09***	0.13**
FIN	0.01	0.37***	0.36***	–0.26***
Adjusted R-squared	0.79	0.73	0.68	0.61
J/F-statistic	134	290	96	73
Prob (J/F-statistic)	0.00	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.
Source: author's compilation from E-Views.

Consistent with Azher (1995), whose study supported the vicious cycle of poverty, the dynamic GMM shows that poverty was positively and significantly affected by its own lag. Fixed effects and the dynamic GMM produced results that show that human capital development had a non-significant negative impact on infant mortality rates, while the random effects and pooled OLS results indicate a significant negative relationship running from human capital development towards infant mortality rate. These results show that human capital development reduced poverty levels in CEECs, in line with Afzal et al. (2010), whose study argued that skills and education also allow people to easily get a well-paying job, reducing not only unemployment but poverty and income inequality as well.

The dynamic GMM shows that remittances had a non-significant negative effect on infant mortality rates, consistent with Cattaneo's (2005) optimistic hypothesis that remittance inflows promote entrepreneurship, create self-help projects, and boost self-employment levels and economic growth. Fixed effects, random effects, and pooled OLS show a significant positive relationship running from remittances on infant mortality, consistent with Anyanwu and Erhijakpor (2010), whose study argued that over-relying on remittances inflows, in the long run, could cause laziness, have a deleterious on economic growth, and increase poverty levels.

The interaction between human capital development and remittances was found to have had a non-significant negative effect on infant mortality rates under the dynamic GMM, contrary to the existing literature. Random effects and pooled OLS showed that the complementarity between human capital development and remittances had a significant positive influence on infant mortality rates. However, fixed effects

produced results that show that infant mortality rates were positively and significantly affected by the interaction term. These results are in line with Anyanwu and Erhijakpor (2010). Their study noted that human capital development increases remittance inflows into the labor-sending country, enhancing its ability to promote self-employment, entrepreneurship, economic growth, and poverty reduction efforts.

A non-significant positive relationship running from infrastructural development towards infant mortality rate under the dynamic GMM means that infrastructural development non-significantly increased poverty, in line with Pradhan and Mahesh (2014). However, infrastructural development had a significant negative effect on infant mortality rates under fixed effects, random effects, and the pooled OLS. This means that random effects, fixed effects, and pooled OLS produced results that show that infrastructural development reduced poverty in CEECs, in line with Jahan and McCleery (2005), whose study noted that enhanced infrastructural development enables people to have good roads, access to clean water, and better health care, all of which reduces poverty levels.

The impact of trade openness on infant mortality was observed to be negative but non-significant under the dynamic GMM, in support of a study by Pradhan and Mahesh (2014). They are of the view that increased trade openness enables domestic firms to be international players in sourcing raw materials, funding, and information technology, enhancing their local, regional, and global competitiveness. Fixed effects showed that trade openness's positive effect on infant mortality is significant, although random effects and the pooled OLS showed a positive but non-significant relationship. These results are in line with Pradhan and Mahesh (2014), who noted that high trade openness increases competition, negatively affecting domestic firms' ability to expand, create employment, or stem poverty.

The impact of savings and unemployment on infant mortality rates produced mixed results across all four econometric estimation methods. On the other hand, fixed and random effects showed that financial development's impact on infant mortality was positive and significant. This was in line with Boukhatem (2016), who argued that a developed financial sector demands high-value collateral security during the money process. By contrast, the pooled OLS noted a significant negative relationship running from financial development towards infant mortality rate. This means that financial development reduced poverty levels under the pooled OLS, in line with Rajan and Zingales (1998). They argued that financial development allows poor people to access small loans, which they can use to finance small self-help projects and entrepreneurial projects, creating self-employment.

Conclusion

The study investigated the impact of human capital development on poverty in Central and Eastern European Countries using dynamic GMM, fixed effects, random effects, and pooled OLS, with panel data ranging from 2008 to 2019. Using the same panel data analysis methods and data set, the study also explored the influence of the complementarity between human capital development and personal remittances on poverty in CEECs. What triggered the investigation into this topic is that the available literature on the subject matter is mixed, divergent, and conflicting.

The lag of poverty, remittances, the interaction between human capital development and remittances, trade openness, unemployment, and partly financial development had a significant effect on increasing infant mortality rates in CEECs. On the other hand, human capital development, infrastructural development, and partly financial development were found to have reduced infant mortality. These results mean that human capital development, financial development, and infrastructural development reduced poverty in CEECs during the period under study. Central and Eastern European Countries are therefore urged to craft and implement financial development, infrastructural development, and human capital development enhancement policies to combat poverty. Future empirical research could also investigate the level of human capital development and financial and infrastructural development that would significantly reduce poverty in CEECs.

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Rozwój kapitału ludzkiego, przekazy pieniężne i ubóstwo w krajach Europy Środkowo-Wschodniej: co mówią nam dane?

Opracowanie przedstawia analizę wpływu rozwoju kapitału ludzkiego na poziom ubóstwa w krajach Europy Środkowej i Wschodniej (CEEC) przy użyciu dynamicznych uogólnionych metod momentów (GMM), metody efektów stałych, efektów losowych i metody pooled OLS na podstawie danych panelowych z okresu 2008–2019. Wykorzystując te same metody analizy danych panelowych i zestaw danych, zbadano również wpływ komplementarności między rozwojem kapitału ludzkiego a osobistymi przekazami pieniężnymi na ubóstwo w krajach Europy Środkowej i Wschodniej. Powodem podjęcia tego tematu był fakt, że dostępna na ten temat literatura jest niepełna, rozbieżna i bardzo sprzeczna. Poziom ubóstwa z roku poprzedniego, przekazy pieniężne, interakcje między rozwojem kapitału ludzkiego a przekazami pieniężnymi, otwartość na handel, bezrobocie i częściowo rozwój finansowy znacznie zwiększyły wskaźniki śmiertelności niemowląt w krajach Europy Środkowo-Wschodniej. Z drugiej strony stwierdzono, że rozwój kapitału ludzkiego, rozwój infrastruktury i częściowo rozwój finansowy zmniejszyły wskaźniki śmiertelności niemowląt. Wyniki te oznaczają, że rozwój kapitału ludzkiego, rozwój finansowy i rozwój infrastruktury ograniczyły ubóstwo w krajach Europy Środkowo-Wschodniej w badanym okresie. W związku z tym wzywa się kraje Europy Środkowej i Wschodniej do opracowania i wdrożenia

polityki rozwoju finansowego, rozwoju infrastruktury i rozwoju kapitału ludzkiego w celu zwalczania ubóstwa. Przyszłe badania empiryczne mogłyby również wykazać, przy jakim poziomie rozwoju kapitału ludzkiego, rozwoju finansowego i infrastrukturalnego możliwa byłaby znacząca redukcja ubóstwa w krajach Europy Środkowo-Wschodniej.

Słowa kluczowe: rozwój kapitału ludzkiego, przekazy pieniężne, ubóstwo, analiza danych panelowych

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The Inefficiency of the Adjustment Mechanism in the Contemporary Global Economy the Case of the United States and China

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Abstract

In the current international monetary system, the adjustment mechanism does not work properly to eliminate the excessive surpluses/deficits on the current accounts of the major countries that participate in international trade. Consequently, the adjustment changes do not take place in an evolutionary way, through market changes or decisions taken by the national authorities. They are the result of crises that reflect the unfavourable macroeconomic situation in different countries. The article explains the functioning of the adjustment mechanism in the contemporary international monetary system and the circumstances in which significant imbalances emerge at the global (US–China) level. Increasing external imbalances are an immanent systemic feature of the contemporary international monetary system. The lack of an adjustment mechanism in this system leads to the potentially cyclical emergence of such imbalances and their correction by crises. Thus, the current post-crisis period may only be a stage before the next period of growing imbalances. The remedy for this threat lies in correcting the existing principles of the system.

Keywords: international capital flows, global imbalance, current account, adjustment mechanism, United States, China

JEL: F21, F3, F65

Introduction

External imbalances that have been growing for some years in the global economy are sometimes seen as one of the main causes of the 2008+ global financial crisis (see, e.g., Borio and Disyatat 2010; Nier and Merrouche 2010; Obstfeld and Rogoff 2010; Obstfeld 2012a). In contrast to the intertemporal approach (see Obstfeld and Rogoff 1994), which explains why countries maintain significant current account deficits, the economic and financial stability of countries is significantly dependent on maintaining the external balance. In a simplified way, this balance is defined as a current account of the balance of payments deficit/surplus not in excess of 4% of GDP. If the latter value is exceeded, it means not only that the adjustment mechanisms that help absorb external imbalances or prevent their occurrence have failed, but also that a country is becoming susceptible to a financial crisis (see Janicka 2018). A significant reduction in current account deficits/surpluses of the main actors of the global economy – the US and China – took place after the outbreak of the 2008+ financial crisis, which, by the same token, acted as a highly imperfect imbalance adjustment mechanism. That may suggest that if the adjustment mechanism within the international monetary system in its current framework is ineffective, the next wave of external imbalances may trigger the next wave of crises which will take over the role of the mechanism in the global economy. The article explains the functioning of the adjustment mechanism in the contemporary international monetary system and the emergence of the significant imbalances at the global (US–China) level. The current pandemic crisis, as a phenomenon of a completely exogenous nature, and its impact on the global economy do not fit into the scope of the analysis carried out in the article.

The adjustment mechanism in the international monetary system

The problem of the increasingly concentrated global imbalances in the current international currency system (see Kregel 2019) and the poor performance of the adjustment mechanism are hotly debated by economists (see Chinn and Ito 2019; Kolerus 2021). Before the outbreak of the global financial crisis, the authors of numerous studies identified potential threats linked, in particular, with the US's growing current account deficit. The rapid adjustment of the deficit would inflict turbulences on the US economy and impact the global economy because of the role that the country and its currency play in the international markets. It was summed up by Obstfeld (2005), who said, "America's deficit, the world's problem."

The problem of the excessive and still growing current account deficit of the US's balance of payments, and possible scenarios for adjusting it, were studied by many authors, e.g., Dooley, Folkerts-Landau, and Garber (2003), Summers (2004), Debelle and Galati (2005), Ferguson Jr. (2005), Collignon (2006), Coughlin, Pakko, and Poole

(2006), Blanchard (2007), Barrel, Holland, and Hurst (2007), Clarida, Goretti, and Taylor (2006), Xafa (2007), and Feldstein (2008). As indicated by Faruqee et al. (2007), "The key question from the mainstream is not *if* but *when* (and *how*) the inevitable adjustment will occur."

Works also emerged (although much less numerous) in which the problem of global imbalances was examined from the viewpoint of Asian countries, e.g., Makin (2008) and Adams and Park (2009). After the outbreak of the crisis, further studies on global imbalances were published, e.g., Ca' Zorzi, Chudik, and Dieppe (2012), Lane and Milesi-Ferretti (2012), Obstfeld (2012b), and Tao Yang (2012). A fascinating approach was presented by De Cecco (2012), who stated that reserve-building by Asian and other emerging economies may have helped to reduce the damage caused by financial institutions in advanced economies, and that these non-liberalised, large financial systems may have acted to stabilise the structurally unbalanced markets of the advanced, liberalised economies. According to Caballero, Farhi, and Gourinchas (2015, p. 54), "economic policy enters a regime of increased interdependence across the world, with either negative or positive spillovers depending on the policy instrument. Exchange rate policy becomes a zero-sum game of currency wars where each country can depreciate its exchange rate to stimulate its economy, at the expense of other countries". A broad review of the literature devoted to the conditions and consequences of the absence of a current account balance was carried out by Ciocyte and Rojas-Romagosa (2015). Meanwhile, Alberola, Estrada, and Viani (2020, p. 15) noted that global imbalances played an important role in the run-up to the global financial crisis, and after the crisis, current account imbalances significantly diminished.

The point of departure for considerations in this paper is the so-called impossible trinity. In accordance with its principles, a country may not accomplish three goals of the economic policy at the same time: (1) stabilise the exchange rate, (2) pursue an independent monetary policy, and (3) maintain fully liberalised cross-border capital movements. By being forced to select two out of the three goals, a country can identify its priorities as to the balances in the internal market and in external relations. If a country stabilises its exchange rate and maintains free capital flows with the external world, it gives up active control over its monetary policy. In this case, internal balance becomes a derivative of the external balance.

In the gold currency system, current account balances were stabilised by the free movement of gold between the countries (for more, see Bordo 2005). In the Bretton Woods system, which was put in place after WWII, the point of gravity in the domestic economic policy shifted towards the internal market: countries stabilised their exchange rates and pursued active monetary policies, giving up full liberalisation of capital flows. In accordance with the IMF statute, the cornerstone of the framework of the system, in case of significant balance of payment imbalances, countries could devalue/revalue their currencies by +/–10% without seeking the IMF's approval. Thus, the operation of the adjustment mechanism in the system was subjected to discretionary decisions of the monetary authorities of the countries – members of the system.

One fact that is obvious, but little exposed, is worth stressing: the current account surplus of one country means a balance of payments deficit of another country. If the deficit of the latter is to be reduced, this country's partner must reduce its surplus. The contemporary international currency system significantly differs from its predecessors. The collapse of the Bretton Woods system started in 1971 with the formal suspension of the convertibility of the US dollar to gold in external relations (for more on the Bretton Woods system, see Eichengreen 2010). The failures of subsequent reforms of the system made its member countries adopt a completely different, flexible approach to the founding principles of the new framework. This new system is referred to as the "non-system," in which international currency is not defined, and each country may adopt any exchange rate system, gold no more performs monetary functions, and there are no uniform rules as to the liberalisation of capital movements (for more on the system, see Farhi, Gourinchas, and Rey 2011).

In a multi-currency system, countries cannot give up pursuing an active economic policy vis-à-vis their internal markets (including an independent monetary policy). When restrictions on transborder restrictions were eliminated, it meant changing the operating exchange rate system. By liberalising their capital movements and maintaining monetary policy independence, highly developed countries that dominated the global economy had to adopt the floating exchange rate system. The external balance – like in the Bretton Woods system – became the derivative of the internal balance. Theoretically, opting for such a solution favours the effective performance of the adjusting mechanism. A depreciation of the domestic currency's rate of exchange triggered by a current account deficit should increase exports and decrease imports, reducing the deficit. Meanwhile, appreciation in surplus countries should lead to a reduction of the surplus (see, e.g., Devereux and Genberg 2007).

For the mechanism to operate smoothly, certain pre-conditions must be met, inter alia, transborder capital flows should be derivative of the current account balance and all countries within the system should adopt the same principles: openness to capital flows and the floating exchange rate system. The solutions implemented in the 1990s by the leading global economies were uniform: the liberalisation of capital flows and the system of floating exchange rates, which meant the condition was met. Developing countries, which maintained restrictions and deployed different varieties of the fixed-rate system, were considered to be in transition to the above-mentioned solutions. In theory, the principles of the multi-currency system allowed different countries to adopt various combinations of possibilities identified within the impossible trinity; in practice, it was geared towards the solutions adopted by developed countries. The content mentioned above is summarised in Table 1.

In the light of intertemporal exchange theory, external imbalances are justified by differences in countries' economic development level and their savings, while directions of capital flows concur with the neoclassical theory: developed countries are surplus countries, and through the financial markets, they make their financial resources available to developing countries (IMF, Group of Twenty 2019). The im-

pact of developing countries on the economy is relatively small; they absorb economic policy pursued by developed countries. However, the turn of the centuries brought about a significant change, which distorted the functioning of the multi-currency system. The growth of crucial developing economies, whose economic policy is different from the one adopted for the system (China, India), sped up. Restrictions on cross-border capital flows, the stabilisation of foreign exchange rates, and independent monetary policy were approved by developing countries as a preliminary stage in the sequence of steps that led them to the developed economies model. Over time, developed economies began to exert pressure on developing countries to change their policy and open up to the external world. Only a handful of economists (see Williamson 2006) argued that such a change in economic policy would not be favourable for developing economies. However, if such a change had taken place, perhaps the adjustment mechanism would have worked through the exchange rate channel, and the problem of the excessive external US–China imbalance would never have occurred. However, some developing countries rejected the model of developed countries and launched their own independent economic policies.

Table 1. The basic rules for different international currency systems

System / Specification	Gold-standard	Bretton Woods	Multi-currency
Exchange rate mechanism	Fixed rate (parity)	Fixed rate with fluctuation margins, periodically adjusted	Fixed or floated rate – country's decision
Adjustment mechanism	Acting automatically	Discretionary policy of countries – devaluation/revaluation	Discretionary policy of countries – devaluation /revaluation or market mechanism – depreciation/ appreciation
Cross-border capital flows	Free	Restricted	Restricted or free
Active monetary policy	No	Yes	Yes
Common operating rules for countries	Yes	Yes	No
The efficiency of the adjustment mechanism	Yes	No	No

Source: own study.

The international competitiveness of Chinese trade

The Chinese economy, whose development model is based on exports, sought to stabilise the exchange rate of the yuan to the US dollar at a level that would help it maintain its competitiveness. The central bank of China has been working towards accomplishing goals that are different from those of most central banks. It does not fight inflation or care about growth, but its goal is to "maintain the Renminbi exchange rate at adaptive and equilibrium level" (PBC 2021). China is a developing country that escapes any classifications or economic development paths followed by the developed countries. It is also a powerful actor in the group of dominant countries of the system, pursuing an economic policy in the spirit of neoclassical economics, which sees the policy differently and makes reference to Keynesian ideas by managing the exchange rate and maintaining restrictions vis-à-vis the free movement of capital. Importantly, China's policy remains within the principles of a multi-currency system, in which each country is free to choose the exchange rate mechanism and the degree of financial openness at a *de jure* level. Such a policy becomes problematic in international economic relations because it undermines the efficiency of the adjustment mechanism. By managing the exchange rate, China could not only boost the dynamics of economic growth through an expansive export-oriented policy, but also accumulate huge foreign exchange reserves, restoring the idea of mercantilism that seemed to have been forgotten. Tables 2 and 3 contain data concerning China's current account balance, investments, savings, and trade dynamics, while Table 4 presents the USD/RMB exchange rate.

Table 2. China – current account balance total, domestic investment and savings, foreign trade dynamics (bn USD, % of GDP, %), 2002–2009

Specification	2002	2003	2004	2005	2006	2007	2008	2009
Current account balance total (bn USD)	35.4	43.1	69.0	132.4	231.8	353.2	420.6	243.3
Current account balance (% of GDP)	2.4	2.6	3.5	5.7	8.4	9.9	9.1	4.6
Investment (% GDP)	36.9	40.4	42.7	41.0	40.6	41.2	43.2	46.3
Savings (% GDP)	39.3	43.0	46.2	46.7	49.0	51.1	52.3	51.1
Imports dynamics (%)	21.7	34.4	20.3	12.9	17.0	12.9	5.2	3.0
Exports dynamics (%)	25.1	33.5	27.0	24.0	26.2	19.5	9.8	–11.2

Source: author's calculations based on World Economic Outlook Database, 2020.

Examining the data from Table 2 reveals some interesting relationships. The undervalued yuan/US dollar exchange rate was one of the factors that allowed China to gain a competitive advantage in international markets. Over the period 2002–2005, we can see not only a quantum leap increase in the current account surplus but also increasing foreign trade dynamics (including imports of intermediate goods) and a significant increase in investment and savings. Immediately before the outbreak of the crisis, despite the strengthening of the yuan to USD exchange rate, China's surplus had been increasing in absolute and relative

terms, reaching a record-breaking USD 420 bn in 2008. It means that the change in China's foreign exchange policy (which maintained numerous restrictions on transborder movements of capital) did not hinder the demand for Chinese goods, even though the dynamics with which exports grew at that time exhibited a significant slowdown. The drop reported for 2008 amounted to ca. 10 p.p. compared to 2007, but the real breakdown came in 2009 despite China's efforts invested in stabilising the exchange rate of the domestic currency. Shrinking external demand, a derivative of the global crisis, was the factor that triggered the adjustment. The return to the managed floating exchange rate in 2010 strengthened the Chinese currency, which contributed to the worsening of indicators covered by the analysis in 2011 (see Table 3).

Table 3. China – current account balance total, domestic investment and savings, foreign trade dynamics (bn USD, % of GDP, %), 2010–2019

Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Current account balance total (bn USD)	237.8	136.1	215.4	148.2	236.1	304.2	202.2	195.1	25.5	141.3
Current account balance (% of GDP)	3.9	1.8	2.5	1.5	2.2	2.8	1.8	1.6	0.2	1.0
Investment (% of GDP)	47.9	48.0	47.2	47.3	46.8	44.8	44.1	43.2	44.0	43.1
Savings (% of GDP)	51.8	50.0	50.0	48.9	49.0	47.5	45.9	44.8	44.2	44.0
Imports dynamics (%)	23.4	11.7	5.8	9.7	3.7	–0.7	5.8	7.8	0.2	4.0
Exports dynamics (%)	28.8	10.54	6.8	9.6	4.3	–2.4	1.7	8.6	4.0	0.2

Source: author's calculations based on World Economic Outlook Database, 2020.

Analysing the data from Table 3 demonstrates that, hurt by the consequences of the financial crisis 2008+, the Chinese economy was unable to regain its position in the international market. Although in absolute terms the value of its current account surplus remains impressive (we need to bear in mind that the current account includes more than the trade in goods), its relative value compared to GDP clearly decreased. At the same time, the growth dynamics of exports and imports slowed down. We also need to highlight the huge savings/investments in the Chinese economy, which oscillate around 43–50% of GDP. China is a developing country, which is why a high accumulation of savings comes as no surprise. However, considering that its competitive advantages in international markets do not derive from its natural resources (as is the case of, e.g., petroleum exporting countries), maintaining this level of investment/savings, also in times of crisis, is impressive.

Undoubtedly, the crisis triggered the adjustments of external imbalances seen through the lens of the relationship of the current account balance to GDP ratio. Be-

tween 2008 and 2009, the current account surplus was almost halved in relative and absolute terms. An earlier change in the exchange rate policy (2005), which strengthened the yuan to USD exchange rate, neither reduced the surplus nor prevented further increases (see Duarte and Schnabl 2015; Nasir and Jackson 2019). By contrast, the period 2005–2007, i.e., just before the crisis, saw dynamic increases in the surplus. Under such circumstances, there is no doubt that the adjustment mechanism in a multicurrency system failed to operate effectively, and the exchange rate proved to be an insufficient instrument while the outbreak of the financial crisis generated by the crisis in the US economy was the factor that triggered adjustments and helped China offset its significant external imbalances.

Table 4. USD/RMB exchange rate, as at the end of December of each year, 2009–2019

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
USD/RMB exchange rate	6.83	6.60	6.29	6.23	6.06	6.22	6.48	6.94	6.53	6.88	6.96

Source: Federal Reserve Economic Data, n.d.

Note that between 1997 and 2005, the Central Bank of China stabilised the RMB to USD exchange rate at 8.28. A change in the currency policy in July 2005 (adopting a managed floating rate) strengthened the RMB against the USD, while the outbreak of the financial crisis encouraged China in July 2008 to stabilise the exchange rate again at 6.83. The return to the managed floating rate took place in July 2010.

The US current account deficit before and after the crisis 2008+

As mentioned above, according to economic theory, the growing current account surplus reported by some countries means a deepening current account deficit experienced by others. China's growing current account surplus was closely linked with the deepening current account deficit of the main recipient of Chinese exports, i.e., the United States (see Table 5); in the period 2002–2006 (the US suffered from the crisis as early as 2007), there is a clear increase in the US current account deficit in absolute and relative terms. Tables 5 and 6 contain data concerning the United States' current account balance, investments, savings, and trade dynamics.

As observed by Edwards (2005), "never in the history of modern economics has a large industrial country run persistent current account deficits of the magnitude posted by the US since 2000", by which he suggested that reducing the American deficit could produce negative consequences. The dynamics of the US exports and imports proved to be volatile, although, with the exception of exports in 2002, positive. A significant change in indicators included in the study took place as late as 2009, when the current account deficit was reduced, accompanied by a rapid slowdown in the dy-

namics of exports and imports (which in that year swung to negative values); domestic savings and investments also dropped. Considering that the United States is the leader of the global economy and the current international currency system, the country's savings of less than 14% of GDP and investments below 18% of GDP are far from the standards of highly developed countries, not to mention developing countries. In the period preceding the crisis, domestic savings in the US ranged from around 17–18%, i.e., disproportionally low compared to the investment needs of the country. In the post-crisis period, there was an increase in domestic savings and decreased investments in proportion to the GDP, which means that the US economy was less dependent on external sources of funding. At the same time, it is still hard to identify any clear trend as to the dynamics of imports and exports, which are highly volatile.

Table 5. US – current account balance total, domestic investment and savings, foreign trade dynamics (bn USD, % of GDP, %), 2002–2009

Specification	2002	2003	2004	2005	2006	2007	2008	2009
Current account balance total (bn USD)	–450.8	–518.8	–631.6	–745.2	–806.0	–711.0	–681.4	–372.5
Current account balance (% of GDP)	–4.1	–4.5	–5.2	–5.7	–5.8	–4.9	–4.6	–2.6
Investment (% of GDP)	21.7	21.7	22.7	23.4	23.5	22.6	21.1	17.8
Savings (% of GDP)	18.32	17.4	17.7	18.2	19.2	17.6	15.2	13.9
Imports dynamics (%)	3.7	5.8	11.4	7.0	6.2	2.1	–3.4	–15.3
Exports dynamics (%)	–3.3	2.9	8.8	7.7	9.9	7.0	5.8	–11.9

Source: author's calculations based on World Economic Outlook Database, 2020.

Table 6. US – current account balance total, domestic investment and savings, foreign trade dynamics (bn USD, % of GDP, %), 2010–2019

Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Current account balance total (bn USD)	–431.3	–445.7	–426.8	–384.8	–365.2	–407.8	–432.9	–365.3	–449.7	–480.2
Current account balance (% of GDP)	–2.9	–2.9	–2.6	–2.1	–2.1	–2.2	–2.3	–1.9	–2.2	–2.2
Investment (% of GDP)	18.7	19.1	20.0	20.4	20.8	21.0	20.3	20.6	21.0	21.0
Savings (% of GDP)	15.4	16.5	18.7	19.2	20.3	20.1	18.6	19.2	19.1	18.6

Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Imports dynamics (%)	15.4	6.1	2.6	1.8	5.6	5.8	1.4	4.7	5.0	0.5
Exports dynamics (%)	15.0	7.1	3.8	3.2	4.6	−0.3	0.3	4.1	4.2	−0.1

Source: author's calculations based on World Economic Outlook Database, 2020.

The financial crisis began on the US market in 2007, and one can clearly see that values covered by the study, i.e., current account deficit, domestic savings and investments, and exports and imports dynamics, dropped in that particular year. While the crisis unfolded and "spilled over" into the global economy, these parameters further deteriorated until the critical year of 2009, which can be considered the turning point from which indicators that reflect the performance of the US economy started to gradually improve (Table 6). Like the Chinese economy, adjustments of external imbalances in the American economy were an effect of the financial crisis. Previously, the United States had failed to act to reduce its huge deficit; it was using foreign savings to finance the expansion of its economy. It simply took advantage of its privileged position as leader of the global economy, which issues international currency and runs the most developed financial market (in quantitative and qualitative approach).

The investigation into the China–US case raises a question about the validity of the theory of intertemporal exchange, according to which the rich, ageing societies of highly developed countries temporarily make their savings available to developing countries, whose investment needs are disproportionate to their savings. However, the example of the US–China relationship is completely the opposite. A rich and highly developed country has relatively small savings and widely uses the savings of other countries, including developing ones. We also need to look at the economic growth and GDP per capita indicators in China and the US to see that there are significant differences between these countries in the period covered by the study (Tables 7 and 8). China can be considered a "catching up" country with impressive economic growth performance until 2007 – the drop by almost 5 p.p. in 2008 does not change the fact that the growth continued at a very high rate of ca. 9% year-to-year. Despite doubling the GDP per capita value over that period, it remained at a very low level of less than USD 3k. Against this background, attention should be paid to the fact that in 2019, despite the slowdown in the economic growth dynamics, GDP per capita in China exceeded USD 10.3k. The value of GDP per capita in the US leaves no doubt that American citizens are much wealthier than the Chinese. Yet, in the long run, domestic savings in the US are unable to exceed the magic 20% of GDP, while in China, they are higher than 44% of GDP. For China and the US, intertemporal exchange theory does not work; it is China that makes its savings available to the US and has a share in funding American investment. Surely the argument that explains the increasing external imbalances between the countries with intertemporal exchange does not hold water in this case.

Table 7. Economic growth and GDP per capita in China and the United States, 2002–2009 (%, USD)

Specification	2002	2003	2004	2005	2006	2007	2008	2009
China, year-to-year economic growth (%)	9.1	10.0	10.1	11.3	12.7	14.2	9.6	9.2
China, GDP per capita (k of USD)	1.15	1.29	1.51	1.77	2.11	2.70	3.47	3.84
USA, year-to-year economic growth (%)	1.7	2.9	3.8	3.5	2.9	1.9	–0.1	–2.5
USA, GDP per capita (k of USD)	37.97	39.41	41.63	44.03	46.21	47.87	48.28	47.01

Source: author's calculations based on World Economic Outlook Database, 2020.

Table 8. Economic growth and GDP per capita in China and the United States, 2010–2019 (%, USD)

Specification	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
China, year-to-year economic growth (%)	10.6	9.5	7.9	7.8	7.3	6.9	6.7	6.9	6.8	6.11
China, GDP per capita (k of USD)	4.52	5.58	6.33	7.08	7.70	8.17	8.12	8.64	9.92	10.29
USA, year-to-year economic growth (%)	2.56	1.6	2.3	1.8	2.5	2.9	1.6	2.3	3.0	2.2
USA, GDP per capita (k of USD)	48.40	49.82	51.54	53.03	54.95	56.72	57.81	60.11	63.06	65.25

Source: author's calculations based on World Economic Outlook Database, 2020.

Conclusions

External imbalances are natural to domestic economies. Countries are unable to offset trade in goods or services or the flows of income to arrive at a zero balance current account. From the point of view of economic stability of countries, it is important not to exceed safe balance total levels, i.e., ca. +/–4% of GDP between key actors of the global economy. Dynamic increases in external imbalances between China and the US, referred to as global imbalances, have never been suppressed in any way by these countries. China, a country that implements an exports-driven economic growth model, was totally disinterested in doing so while the US did not have the tools for that purpose. The current international monetary system proved to be completely inefficient in this regard. The absence of clearly stated operating principles that are binding For all members means there are no procedures/mechanisms that could be activated when

there are significant imbalances between countries within the global economy. In other words, the current monetary system does not have an efficient adjustment mechanism to contain excessive current account deficits/surpluses and bring countries back to the condition of relative equilibrium (see Fisher 2019).

Considering the case of China and the US, we cannot use the global theory of intertemporal exchange to explain global imbalances because directions of capital flows – from a developing to a developed country – are exactly opposite to what the theory proposes. In the absence of any other new solutions for the international monetary system, we may expect that another episode of escalating external imbalances between the countries may trigger the next financial and economic crisis. By the same token, it will become a highly imperfect adjustment mechanism for external imbalances – this is the price that the global economy pays for the full freedom of its rules. The truth of these words is confirmed not only by a significant reduction in external imbalances in the studied countries, but also by a significant decrease in the interest of economists in the subject of global imbalance after the 2008 financial crisis + (most of the research in this area was published before 2015).

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Nieefektywność mechanizmu wyrównawczego we współczesnej gospodarce światowej Przypadek Stanów Zjednoczonych i Chin

We współczesnym międzynarodowym systemie walutowym mechanizm wyrównawczy nie działa prawidłowo, co utrudnia eliminację nadmiernych nadwyżek/deficytów na rachunkach bieżących bilansu płatniczego kluczowych krajów uczestniczących w handlu międzynarodowym. Zmiany dostosowawcze następują nie w wyniku procesów zachodzących na rynku lub decyzji władz krajowych, ale są przede wszystkim efektem wydarzeń kryzysowych w gospodarce globalnej. Celem artykułu jest analiza funkcjonowania mechanizmu dostosowawczego we współczesnym międzynarodowym systemie walutowym oraz uwarunkowań powstawania znaczących nierównowag na poziomie globalnym (na przykładzie USA–Chiny). Nierównowagi zewnętrzne można uznać za immanentną cechę strukturalną współczesnego międzynarodowego systemu walutowego. Brak sprawnego mechanizmu wyrównawczego w tym systemie prowadzi do potencjalnie cyklicznego powstawania takich nierównowag i ich korygowania przez wydarzenia kryzysowe. Oznacza to, że okres pokryzysowy może być jedynie etapem przed kolejnym okresem narastania nierównowagi i jej korekty w efekcie wystąpienia zjawisk kryzysowych. Konieczne staje się w tej sytuacji skorygowanie dotychczasowych zasad systemu, dzięki czemu działanie mechanizmu wyrównawczego zostanie usprawnione.

Słowa kluczowe: nierównowaga globalna, gospodarka światowa, mechanizm wyrównawczy, USA, Chiny

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Methodological Approaches to the Evaluation of Innovation in Polish and Ukrainian Regions, Taking into Account Digitalization

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Abstract

The article offers aqualimetric assessment of the innovation in regional economic systems, taking into account digitization. The study was based on the methodology of general scientific methods of cognition and special methods of scientific research in the field of the development of productive forces and regional economy. Namely, we used the dialectical method of scientific cognition to identify contradictions and interrelations of innovative development of the subjects of regional economic systems; analysis and synthesis to identify the mechanism for identifying and

implementing priority areas of innovation in the regions; the grouping method for clustering regions according to the calculated values of the integrated index of innovation of the regions of Ukraine and Poland; statistical and economic-mathematical modeling for calculations and modeling of innovation of regions, and other methods. The calculations and analysis of the values of integrated indices of innovation activity in the regions of Ukraine and Poland are performed. These regions are grouped according to this indicator. The cartographic analysis is presented, and the region leaders, region outsiders, and regions with the average value of the integrated index of innovation are singled out. This study has theoretical and applied significance for the development of productive forces and regional economy as it provides for the development of a methodological approach to assessing the innovation activity of the regions of Ukraine and Poland, taking into account digitalization processes.

Keywords: innovation, innovation activity, social innovation, infrastructure, modernization, digitization

JEL: B41, O3, O35, R1

Introduction

Ukraine's strategy to join the high-tech, competitive environment necessitates the formation of an innovative development model. This transition requires a continuous and focused process of searching for, preparing, and implementing innovations that can not only improve production efficiency, but also fundamentally change its development. Modernizing the domestic economy leads to the search for such innovative forms of management that are able to quickly adapt to today's changing environment, and are competitive and profitable in conditions of fierce competition, uncertainty, and risk.

Creating a new effective modern business model requires a change in traditional market relations, management methods, and new management decisions, which is currently impossible without information technology. Increasing spending on research, development, and the implementation of digital technologies in enterprises should be associated with the key role of digitalization in innovation (the development and availability of digital infrastructure, improving the quality of communication networks, introducing new data transmission technologies, etc.). In turn, this will lead to the development of digital technologies in all economic spheres in the world.

Literature review

The study by Fan, Urs, and Hamlin (2019) on the example of Romania demonstrates that city-regions have become the focused locations for economic development and policy intervention for innovation. As the existing literature mostly studied innova-

tive city-regions of the Global North, there is an urgent need to examine the emerging latecomers, particularly those from transitional economies. In this paper, Cluj-Napoca, Romania, was used to study the rising innovative city-regions in transitional economies, their role in the global innovation networks, and the development of domestic innovation capability.

Falck, Koenen, and Lohse (2019) evaluated one of the largest place-based innovation policies in Germany – the Innovative Regional Growth Cores (IRGC) program. It subsidizes collaborative development and commercialization projects of firms and public research institutes co-located in regions of Eastern Germany, with the explicit goal of generating local spillovers to promote regional economic development. They studied three potential types of effects with respect to a broad set of outcomes at the firm and regional level: the policy's effects on directly subsidized firms; spillover effects on non-subsidized innovative firms located in the same region; aggregate effects on regional-level economic outcomes.

Also in Germany, Richter examined how social enterprises foster social innovation in rural regions. By applying the social network approach and a cross-case analysis of social enterprises in rural regions of Austria and Poland, he showed how rural social enterprises mobilize ideas, resources, and support from external sources not primarily for their own benefit but for that of their rural region. As *embedded intermediaries*, they contribute to transformational change and wellbeing, albeit they are only one of many forces that drive rural development (Richter 2019, p. 181).

Social entrepreneurs and their networks demonstrate an unrelenting focus on systemic social change that disregards institutional and organizational norms and boundaries. Realizing that basic social services are essential, also for businesses, has meant that innovations such as saving food stores, keeping schools open, and making the bank branches stay in business are pressing issues (Revko 2017, p. 312).

Xu and Li (2020) consider that with the rapid development of the knowledge economy and network, innovative human capital is an important factor in regions. At present, there are some features of Chinese innovative human capital, such as the low quantity of human capital storage, a lack of talent, and unbalanced distribution. As people are carriers of innovation, innovative human capital combinespeople and innovation, which is the core of regional economies.

According to Popelo et al., (2021, p. 685), the implementation of an innovative model of state economic development requires significant modernization transformations and the complex use of not only the newest technology, but also scientific approaches to management. This is especially true for ensuring sustainable development of priority segments of the national economy.

Hlaváček and Siviček (2017, p. 65) focused on mapping the innovation potential of the regions in the Czech Republic, Slovakia, and Poland. They have their own elected institutions, which may influence the development of the innovation potential of the regions. The correlation analysis and calculation of the aggregate index were used to compare the regions. The research was based on their own construction of the In-

novation Potential Index, which uses six indicators: a) GDP per capita in EUR, b) the share of inhabitants with a university degree in the population, c) the share of people involved in research and developmentin the workforce, d) gross fixed capital formation (GFCF) by region, and e) the number of patents and utility models per region. Better conditions for growing innovation potential can be seen in the metropolitan areas rather than in agricultural and old industrial regions. The main advantage of old industrial regions is that they can improve their innovative potential by transforming the economic potential, which is weak in the peripheral and agrarian regions.

Eva Ivanová and Jana Masárová (2016, p. 210) attempted to evaluate the innovative performance of Slovak regions. They evaluated the innovation performance in terms of the creation or substantial improvement of new materials, products, equipment; the creation of new processes, technological procedures, systems, and services or substantial improvement; publications and citations; and patents and utility models. The standardized variable method was used to evaluate the innovation performance of the Slovak regions.

The primary purpose of the study conducted by Gajdos and Żmurkow (2013) was to analyze the supply of highly qualified personnel in the context ofprospects for the future innovative development ofvoivodships in Poland. Analyzing these problems and the relationship between them was based on studies of the educational profile of regions and the analysis of potential trends and possibilities ofcreating a highly skilled labor force coming from the higher education system, as well as on the research of the innovation level and profile of particular voivodships.

The work of Inkinen (2015) shows that conceptually innovative cities are experiencing extensive change as they transform and change in order to become competitive providers of first-class living for a highly-skilled global workforce. Integrating spatial characteristics into the analysis of knowledge-intensive cities opens new theoretical openings for urban analysis, which serve as a platform for open innovation and the economy.

Avila-Lopez, Lyu, and Lopez-Leyva (2019) demonstrated that to achieve innovation, it is necessary to regularly evaluate policy design and financing needs. They recommend following practices that are increasingly used in other countries to promote innovation. The governmental agencies responsible for the funding of S&T (Science and Technology) and innovation projects should develop monitoring and assessment systems based on qualitative and quantitative information and indicators.

Methodical approach and algorithm for assessing innovation in the regions of Ukraine and Poland

The innovative path of development chosen today by the developed countries of the world significantly depends on their achievements and success in digitalization. Therefore, the development and implementation of digital innovations are vital for the successful functioning of the country as a whole and its regions, in particular, for individual business structures. Countries' digitalization strategies are directly linked

to economic development and the creation of innovative enterprises, with the digital economic sphere based on innovative technologies.

The digital transformation of all spheres of life on the basis of innovation leads to positive economic and social effects. It provides a powerful impetus for states and regions, as well as for society, business structures, and individuals. Thus, we can say that innovative development based on digitization is a means of economic growth and a factor that ensures competitiveness in the context of integration and globalization.

To assess the innovative activity of regional economic systems, taking into account digitization, we offer a methodical approach to the qualimetricassessment of innovation in the voivodships of Poland and the oblasts of Ukraine using a matrix of pair correlations. Such an approach makes it possible to avoid linear dependence in the matrix. It is important, as the last causes multicollinearity when calculating innovationand makes it impossible. Also, such a method allows us to confirm the validity of the selected indicators for calculations. Thus, the input data of the matrix of paired correlations is a sample of estimated indicators for the province or region for a certain period. In turn, the estimates are statistical data, and therefore, they have a set of autocorrelations, and they can be distinguished using pairwise correlation, according to which: $|k|\times 0.7$. Estimates that have a correlation greater than $|k|$ are further analyzed to determine the presence between the indicators of linear-functional relationships. In this case, we used an approximate linear relationship of the form: $xp = a * xq + b$, or $yp = c * yq+d$.

Estimates in which the correlation is less than $|k|$ are used to calculate the integrated index of innovation, taking into account digitization for the voivodships of Poland and the oblasts of Ukraine. The use of matrices of pair correlations, due to the classical assumptions about the independence of the estimation indicators (x) and random error values of the regression model ((cov(x,)0)), makes it possible to prevent calculation of the integrated index of innovation, taking into account digitization.

Therefore, to evaluate innovation, taking into account the digitalization of the voivodships of Poland and the oblasts of Ukraine, we propose the following algorithm. A visualization of the stages of evaluating innovation, taking into account digitization, is presented in Figure 1.

First, we define the evaluation indicators. In order to substantiate the indicators of evaluation of innovation, one must follow certain principles. The first one is systematic, due to a certain set of indicators that should reflect the specific features of innovation, taking into account digitization. The second one is optimality – they should be kept to a minimum. The third one is universality, which, in our case, makes it possible to make calculations for the voivodships of Poland and the oblasts of Ukraine. The final one is consistency – certain indicators should be logically related to each other, but not duplicated.

Prior to the assessment, taking into account the principles of systematization, optimality, universality, and consistency, the following indicators were identified: the number of industrial enterprises that implement innovations (units), the volume of in-

novative products sold per capita (euro), and in relation to the total volume of industrial products sold (%), the amount of funding for innovation per capita (euro), and the share of households that have Internet access at home (%).

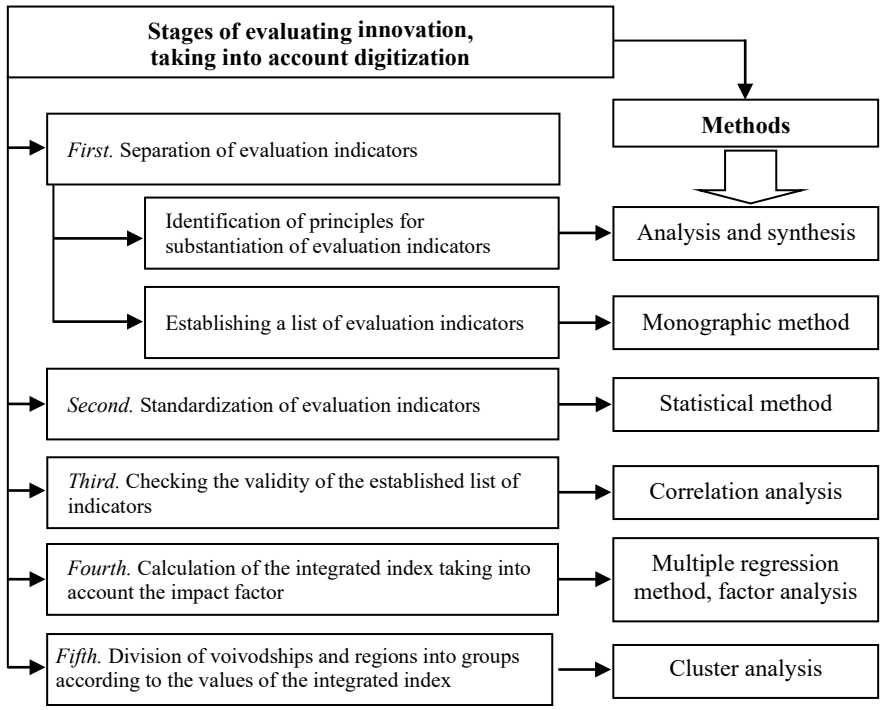

Figure 1. Stages of evaluating innovation, taking into account digitization
Source: suggested by the authors.

Then, the evaluation indicators are used to eliminate the possible impact of higher-order indicators and differences caused by different units of measurement. Rationing allows us not only to homogenize all the indicators, but also to maintain the existing functional relationships between them. For normalization, a method of mathematical expectation can be used:

$$x_{ij}^{r} = \frac{x_{jir}}{x_{j\breve{o}ir}}, \tag{1}$$

$$X_{ij}^{r} = \left(x_{1ir}, x_{2ir} \ldots x_{jir}\right), \tag{2}$$

where:

– x_{ij}^{r} – normalized value of the j-th evaluation indicator of innovation, taking into account digitization j = 1, …, 5, which characterizes the i-th region;

- r – research period (years) 2010–2019 (r = 1, …, 10);
- x_{jir} – natural value of the j-th partial indicator;
- xj_{cpir} – estimation of mathematical expectation of the j-th selected estimation indicator of the i-th region for the studied period;
- X_{ij}^{r} – the matrix of the defined estimation indicators.

Third, we analyze the evaluation indicators using correlations and regression ratios. To find the correlation of indicators (rij) we use the formula:

$$r_{xi,xj} = \frac{cov(xi, xj)}{D\left[x_i^2\right] \cdot D\left[x_j^2\right]}, \tag{3}$$

where:

- xi, xj – estimated indicators of the i-th region;
- $cov\ (x_i, x_j)$ – covariance between samples of normalized evaluation indicators xi, xj;
- $D[x_i^2]$, $D[x_j^2]$ – are the corresponding variances of the estimated indicators that are not equal to the zero value.

Fourth, the preliminary calculations allow us to determine the integrated index of innovation using the multiple regression method. It makes it possible to determine the impact factors (K) among the indicators that represent the regression function:

$$K = \left[(X_1^T \cdot X_1)^{-1} \cdot X_1^T\right]^T, \tag{4}$$

where:

- K – impact factor, respectively, for indicators $x_1 - x_5$.
- X_1 – the matrix of normalized evaluation indicators of regions for a certain period (r = 10) has the following form:

$$X_1 = \begin{pmatrix} x_{1_1} & x_{1_2} & \dots & \dots & x_{1_{10}} \\ x_{2_1} & x_{2_2} & \dots & \dots & x_{2_{10}} \\ \dots & \dots & \dots & \dots & \dots \\ x_{j_1} & x_{j_2} & \dots & \dots & x_{j_{10}} \\ x_{j_{s1}} & x_{j_{s+1}} & \dots & \dots & x_{j_{s+1}} \end{pmatrix}$$

where x_{j_s} – normalized evaluation indicators.

Having obtained a quadratic matrix, the integrated index of innovation is similarly calculated for Polish voivodships and oblasts of Ukraine.

Fifth, regions are grouped according to the results of the calculation of the integrated index of innovation.

Analysis of the dynamics of integrated indices of innovation in the regions of Ukraine and Poland

Methodologically, this research isbased onstatistical and dynamics methods used insynthetic analysis, which characterizes the innovation of the Ukrainian regions and Polishvoivodships, taking into account digitization. All indicators were taken for the period 2010–2019. The ten-year period makes it possible to track the changes that have taken place in the integrated indices and to identify existing trends. All calculations are performed using Mathcad software, which makes it possible to obtain high-accuracy calculations. The Mazowieckie voivodship is taken arbitrarily as an example for considering the clarity of the calculations. Table 1 presents the input estimates and their normalized values.

Rationing the evaluation indicators makes it possible to determine the current coefficients of influence (K) of variables x1–x5 on the integral index (scale 0–1.00) from multiple regression in the absence of signs of simultaneity and multicollinearity in the relationships between variables ($|r1| \neq 0$). Checking the correlations between variables, in general, is as follows.

Substituting the value, we get:

$$r1 := \begin{pmatrix} \mathrm{corr}(x1,x1) & \mathrm{corr}(x1,x2) & \mathrm{corr}(x1,x3) & \mathrm{corr}(x1,x4) & \mathrm{corr}(x1,x5) \\ \mathrm{corr}(x2,x1) & \mathrm{corr}(x2,x2) & \mathrm{corr}(x2,x3) & \mathrm{corr}(x2,x4) & \mathrm{corr}(x2,x5) \\ \mathrm{corr}(x3,x1) & \mathrm{corr}(x3,x2) & \mathrm{corr}(x3,x3) & \mathrm{corr}(x3,x4) & \mathrm{corr}(x3,x5) \\ \mathrm{corr}(x4,x1) & \mathrm{corr}(x4,x2) & \mathrm{corr}(x4,x3) & \mathrm{corr}(x4,x4) & \mathrm{corr}(x4,x5) \\ \mathrm{corr}(x5,x1) & \mathrm{corr}(x5,x2) & \mathrm{corr}(x5,x3) & \mathrm{corr}(x5,x4) & \mathrm{corr}(x5,x5) \end{pmatrix}$$

$$r1 = \begin{pmatrix} 1 & 0.252 & -0.223 & -0.229 & 0.47 \\ 0.252 & 1 & 0.797 & 0.355 & -0.509 \\ -0.223 & 0.797 & 1 & 0.402 & -0.807 \\ -0.229 & 0.355 & 0.402 & 1 & -0.514 \\ 0.47 & -0.509 & -0.807 & -0.514 & 1 \end{pmatrix}$$

Checking the correlations between variables confirms the validity of their choice and makes it possible to move to the next stage – calculating the integrated index of innovation using the method of multiple regression. Figure 2 presents the results of the calculations of the coefficients of influence on the integrated index.

Table 1. Estimates and their normalized values in accordance with the proposed methodological approach for the Mazowieckie voivodship, 2010–2019

Indicator	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
X1	695	623	552	604	773	827	705	902	838	1161
Normalized value x1	0.905	0.811	0.719	0.786	1.007	1.077	0.918	1.174	1.091	1.512
X2	2425.45	1974.38	1523.31	1698.34	2078.95	1521.68	1525.60	1599.75	1933.45	2.149.5
Normalized value x2	1.316	1.071	0.827	0.921	1.128	0.826	0.828	0.868	1.049	1.166
X3	13.02	10.59	8.16	8.09	9.45	7.74	8.32	8.09	8.43	8.5
Normalized value x3	1.44	1.172	0.903	0.895	1.045	0.856	0.920	0.895	0.933	0.940
X4	1456.46	1086.76	1488.19	1120.76	1040.75	1000.00	896.93	1300.44	1043.72	1070.56
Normalized value x4	1.386	1.034	1.417	1.067	0.991	1.000	0.854	1.238	0.993	1.019
X5	69.0	71.4	73.1	75.8	77.4	78.5	78.4	79.4	76.6	69.0
Normalized value x5	0.91	0.942	0.964	1.0	1.021	1.036	1.035	1.034	1.047	1.01

Source: compiled by the authors based on statistics and calculation results.

The influence of variables (x1–x5) for the Mazowieckie voivodship in descending order has the following sequence: x5, x2, x3, x1, x4. As a result of the calculations, we obtain the value of the integrated index, which is presented for the Mazowieckie voivodship, as well as all for other voivodships, in Table 2.

If we analyze the results of the calculations according to the proposed methodological approach to assessing innovation, it can be noted that from 2010 to 2017, according to the determined arithmetic mean of the integrated index, there is a gradual increase from 0.569 to 0.583. However, in 2018 there was a decrease to 0.576; 2019 had the same value. The arithmetic mean value of the average integral index for 2010–2019 was 0.576.

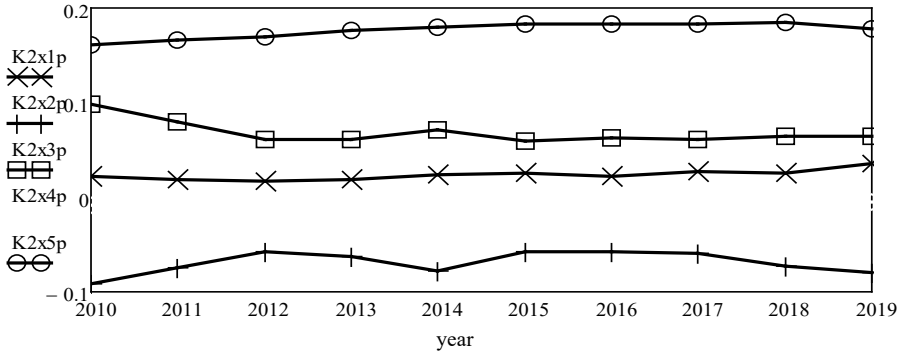

Figure 2. Coefficients of influence on the value of the integrated index of innovation taking into account digitization
Source: calculated by the authors.

Mazowieckie voivodship takes first place in terms of the value of the average integrated index, with an index value of 0.867; Slaskie voivodeship comes second with a value of 0.858; third place goes to Pomorskie voivodship with 0.846.

Swietokrzyskievoivodship has the lowest value of the integrated indices with 0.334, followed by Podlaskie voivodship – 0.344 and Warminsko-Mazurskie voivodship – 0.360. The difference between Mazowieckie and Swietokrzyskie voivodships is 2.6 times.

The proposed methodological approach was also tested, and the integrated index of innovation was calculated for the regions of Ukraine. The results of the calculations are given in Table 3.

Table 2. The value of the integrated index of innovation, taking into account the digitalization of Polish voivodships

Region name	The value of the integral index										The average value of the integrated index for 2010–2019	Rank of the region
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Dolnoslaskie	0.653	0.654	0.659	0.660	0.664	0.670	0.673	0.668	0.664	0.661	0.663	6
Kujawsko-pomorskie	0.514	0.507	0.494	0.505	0.517	0.516	0.528	0.522	0.526	0.520	0.515	9
Lubelskie	0.380	0.380	0.384	0.389	0.383	0.388	0.395	0.396	0.375	0.389	0.386	13
Lubuskie	0.411	0.414	0.410	0.410	0.406	0.406	0.397	0.409	0.397	0.413	0.407	12
Lodzkie	0.602	0.613	0.622	0.612	0.622	0.623	0.619	0.624	0.616	0.609	0.616	7
Malopolskie	0.728	0.735	0.750	0.756	0.757	0.751	0.746	0.749	0.737	0.736	0.745	5
Mazowieckie	0.855	0.859	0.857	0.859	0.865	0.882	0.878	0.877	0.869	0.865	0.867	1
Opolskie	0.404	0.409	0.400	0.416	0.410	0.411	0.398	0.414	0.408	0.409	0.408	11
Podkarpackie	0.585	0.597	0.601	0.592	0.603	0.605	0.595	0.611	0.594	0.591	0.597	8
Podlaskie	0.340	0.344	0.346	0.345	0.344	0.344	0.345	0.352	0.337	0.344	0.344	15
Pomorskie	0.834	0.835	0.842	0.844	0.848	0.856	0.860	0.853	0.848	0.844	0.846	3
Slaskie	0.845	0.847	0.858	0.856	0.863	0.862	0.859	0.861	0.869	0.856	0.858	2
Swietokrzyskie	0.330	0.330	0.338	0.329	0.337	0.331	0.335	0.342	0.335	0.333	0.334	16
Warminsko-mazurskie	0.356	0.353	0.348	0.353	0.367	0.355	0.368	0.367	0.373	0.361	0.360	14
Wielkopolskie	0.817	0.810	0.803	0.829	0.829	0.832	0.849	0.820	0.820	0.829	0.824	4
Zachodniopomorskie	0.447	0.452	0.459	0.447	0.453	0.448	0.452	0.459	0.455	0.452	0.452	10
The arithmetic mean value of the integrated index by voivodships	0.569	0.571	0.573	0.575	0.579	0.580	0.581	0.583	0.576	0.576	0.576	–

Source: calculated by the authors according to the proposed methodological approach.

Table 3. The value of the integrated index of innovation, taking into account the digitalization of the regions of Ukraine

Region name	The value of the integral index										The average value of the integrated index for 2010–2019	Rank of the region
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Vinnytska	0.120	0.130	0.136	0.140	0.138	0.130	0.120	0.130	0.106	0.102	0.125	13
Volynska	0.065	0.050	0.057	0.075	0.066	0.044	0.065	0.050	0.052	0.051	0.058	18
Dnipropetrovska	0.181	0.258	0.301	0.323	0.306	0.332	0.181	0.258	0.234	0.229	0.260	5
Donetska	0.054	0.062	0.065	0.061	0.042	0.033	0.054	0.062	0.027	0.027	0.049	22
Zhytomyrska	0.056	0.060	0.063	0.065	0.064	0.060	0.056	0.060	0.048	0.047	0.058	19
Zakarpatska	0.044	0.032	0.033	0.044	0.032	0.032	0.044	0.032	0.032	0.031	0.036	25
Zaporizka	0.134	0.163	0.130	0.115	0.112	0.117	0.134	0.163	0.137	0.134	0.134	12
Ivano-Frankivska	0.191	0.174	0.152	0.132	0.114	0.093	0.191	0.174	0.065	0.063	0.135	11
Kyivska	0.340	0.330	0.320	0.305	0.310	0.330	0.340	0.330	0.367	0.359	0.333	2
Kirovogradska	0.196	0.186	0.168	0.147	0.142	0.149	0.196	0.186	0.171	0.167	0.171	10
Luhanska	0.053	0.056	0.059	0.039	0.019	0.017	0.053	0.056	0.029	0.028	0.041	23
Lvivska	0.189	0.182	0.236	0.209	0.188	0.230	0.189	0.182	0.170	0.166	0.194	8
Mykolayivska	0.070	0.066	0.046	0.085	0.047	0.050	0.070	0.066	0.048	0.047	0.060	15
Odeska	0.195	0.211	0.221	0.227	0.224	0.211	0.195	0.211	0.171	0.167	0.203	7
Poltavska	0.206	0.335	0.199	0.272	0.255	0.199	0.206	0.335	0.210	0.206	0.242	6
Rivenska	0.053	0.061	0.059	0.054	0.046	0.043	0.053	0.061	0.052	0.051	0.053	21
Sumska	0.061	0.065	0.062	0.059	0.055	0.053	0.061	0.065	0.059	0.058	0.060	16
Ternopilska	0.052	0.074	0.066	0.052	0.050	0.065	0.052	0.074	0.054	0.053	0.059	17
Kharkivska	0.274	0.320	0.342	0.320	0.260	0.352	0.274	0.320	0.346	0.338	0.315	3
Khersonska	0.055	0.060	0.063	0.064	0.064	0.060	0.055	0.060	0.049	0.048	0.058	20
Khmelnytska	0.345	0.378	0.300	0.269	0.225	0.233	0.345	0.378	0.168	0.165	0.281	4
Cherkaska	0.041	0.044	0.045	0.040	0.037	0.036	0.041	0.044	0.037	0.036	0.040	24
Chernivetska	0.200	0.211	0.208	0.157	0.151	0.165	0.200	0.211	0.178	0.174	0.186	9

Region name	The value of the integral index										The average value of the integrated index for 2010–2019	Rank of the region
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Chernihivska	0.062	0.067	0.070	0.072	0.071	0.067	0.062	0.067	0.055	0.053	0.065	14
Kyiv City	0.636	0.687	0.718	0.739	0.728	0.687	0.636	0.687	0.556	0.544	0.662	1
*The arithmetic mean value of the integrated index for all regions (**I_{in} срарцф**)*	0.155	0.171	0.165	0.163	0.150	0.151	0.155	0.171	0.137	0.134	0.155	–

Source: calculated by the authors according to the proposed methodological approach.

The results of the calculations of the integrated index of innovation of the regions of Ukraine make it possible to note that if we consider the trend of changes in the arithmetic mean of the integrated index for all regions, there is no single trend. Thus, the highest value of the arithmetic mean of the integrated index at 0.171 was observed in 2011 and in 2017. Starting from 2017, there is a significant decrease in the arithmetic mean, to 0.137 in 2018 and 0.134 in 2019. For the study period 2010–2019, the average value for all regions was 0.155.

If we consider the regions, the highest value of the average integrated index is in Kyiv City – 0.662, Kyiv region – 0.333, and Kharkiv region – 0.315. Zakarpattia has the lowest average – 0.036, followed by Cherkasy – 0.040, Luhansk – 0.041, and Donetsk – 0.049. The difference between the value of the average integrated index of Kyiv City and the Zakarpattia region is 18.4 times.

The dynamics of changes in the arithmetic mean of the index of innovation of the voivodships of Poland and the regions of Ukraine are presented in Figure 3.

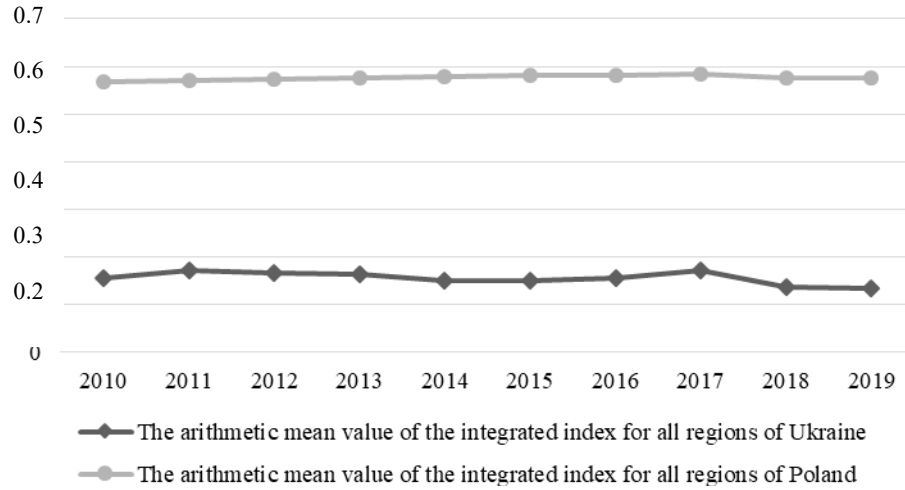

Figure 3. Dynamics of changes in the arithmetic mean of the integrated index of innovation taking into account digitization of the regions of Poland and Ukraine, 2010–2019
Source: constructed by the authors based on the results of calculations.

Grouping of the regions of Ukraine and Poland according to the integrated index of innovation activity

The calculations make it possible to group regions according to the calculated values of the integrated index of innovation; they are presented in Tables 4 and 5.

Table 4. The value of the integrated index of innovation, taking into account the digitization of the Polish regions

Region name	The average value of the integrated index for 2010–2019	The level of value of the average integral index	Rank of the region
Dolnoslaskie	0.663	Average	6
Kujawsko-pomorskie	0.515	Average	9
Lubelskie	0.386	Low	13
Lubuskie	0.407	Low	12
Lodzkie	0.616	Average	7
Malopolskie	0.745	High	5
Mazowieckie	0.867	High	1
Opolskie	0.408	Low	11
Podkarpackie	0.597	Average	8
Podlaskie	0.344	Low	15
Pomorskie	0.846	High	3
Slaskie	0.858	High	2
Swietokrzyskie	0.334	Low	16
Warminsko-mazurskie	0.360	Low	14
Wielkopolskie	0.824	High	4
Zachodniopomorskie	0.452	Low	10

Source: calculated by the authors according to the proposed methodological approach.

Table 5. The value of the integrated index of innovation taking into account the digitalization of the Ukrainian regions

Region name	The average value of the integrated index for 2010–2019	The level of value of the average integral index	Rank of the region
Vinnytsia	0.125	Low	13
Volyn	0.058	Low	18
Dnipropetrovsk	0.260	Average	5
Donetsk	0.049	Low	22
Zhytomyr	0.058	Low	19
Zakarpattia	0.036	Low	25
Zaporizha	0.134	Low	12
Ivano-Frankivsk	0.135	Low	11
Kyiv	0.333	High	2
Kirovograd	0.171	Low	10
Luhansk	0.041	Low	23
Lviv	0.194	Low	8
Mykolayiv	0.060	Low	15
Odesa	0.203	Low	7
Poltava	0.242	Low	6
Rivne	0.053	Low	21
Sumy	0.060	Low	16

Region name	The average value of the integrated index for 2010–2019	The level of value of the average integral index	Rank of the region
Ternopil	0.059	Low	17
Kharkiv	0.315	High	3
Kherson	0.058	Low	20
Khmelnytsk	0.281	Average	4
Cherkasy	0.040	Low	24
Chernivtsi	0.186	Low	9
Chernihiv	0.065	Low	14
Kyiv City	0.662	High	1

Source: calculated by the authors according to the proposed methodological approach.

The grouping of regions by the average value of the integrated index makes it possible to note that the voivodships of Poland have a more even distribution (Figure 4).

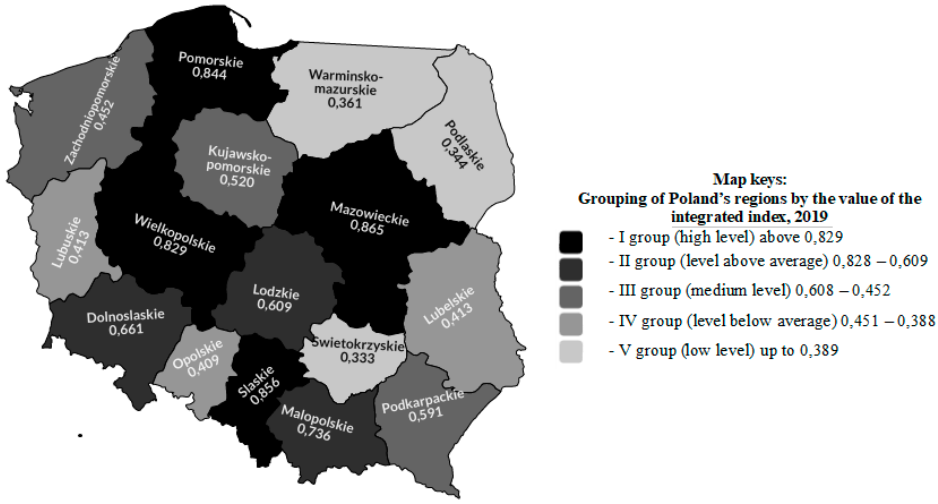

Figure 4. Map of regional differentiation of the integrated index of innovation, taking into account digitization in Poland, 2019
Source: compiled by the authors.

Thus, group I, with a high integrated index, consists of four voivodships (the biggest one in Poland): Mazowieckie, Slaskie, Pomorskie, and Wielkopolskie. Group II consists of three voivodships with an above-average level: Malopolskie, Dolnoslaskie, and Lodzkie voivodships. Due to their medium level, a further three voivodships (Podkarpackie, Kujawsko-pomorskie, and Zachodniopomorskie) were classified into group III. Group IV also consists of three voivodships with a below-average level: Lubelskie, Opolskie, and Lubuskie. Finally, group V contains voivodships with a low average level: Podlaskie, Warminsko-Mazurskie, and Swietokrzyskie.

However, in Ukraine, there is a different picture for the grouping of regions (Figure 5), as the difference between Kyiv City, with the highest integrated index, and the Zakarpattia region is very high.

Eighty percent of regions (twenty in total) belong to the group with a low integrated index. In the group with an average level, there are only two regions; Kharkiv, Kyiv regions and Kyiv City had a high integrated index in 2019.

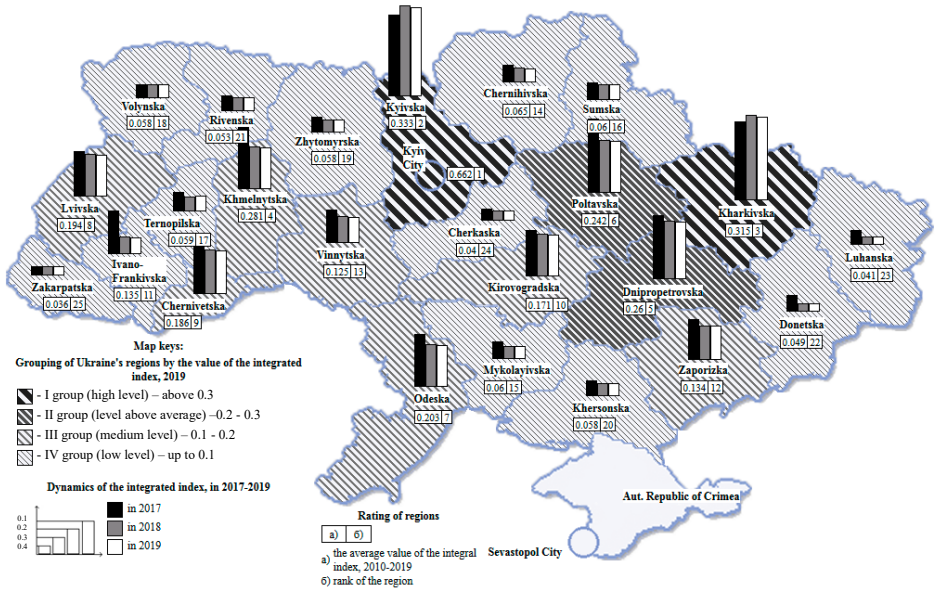

Figure 5. Map of regional differentiation of the integrated index of innovation activity taking into account digitization processes in Ukraine, 2019
Source: built by the authors.

Discussions and conclusions

The modernization priorities of economic development, the intensification of competition, the saturation of markets, and limited resources require enterprises to take a broad, innovative approach and maximize the innovative potential of the regions. Innovations are an incentive for the competitive development of enterprises; they create leading positions and the opportunity to enter world markets.

In the current conditions of the COVID–19 pandemic and the decline of economic indicators, fierce competition dictates the need to intensify innovation as a dominant component of the rapid development of regions and the most effective way to increase their competitiveness.

We have demonstrated that innovation is a defining characteristic of modern scientific, technical, industrial, socio-economic, and other social processes. The fate of a country depends on mastering innovative development mechanisms, i.e., will it move in the direction of becoming a developed country, or will it remain a stagnant country on the sidelines of scientific, technological, and social progress? This is due to the general laws of social development, according to which the world is moving from a predominantly reproductive to an innovative type of development.

The scientific novelty of this study is the development of a methodological approach to assessing innovation within the regions of Ukraine and Poland, taking into account digitalization, which, unlike existing studies, involves the use of analysis and synthesis, monographic, statistical, and multiple regression, and factor, correlation, and cluster analysis. It shows the development of the mechanism of definingand realizing directions of innovation within regions.

The authors proposed a methodological approach to assessing innovation, taking into account digitization, which includes the following stages: 1) separating evaluation indicators of their rationing based on a statistical method, 2) verifying the established list of indicators using correlation analysis, 3) calculating the integrated index of innovation, taking into account digitization. There was also multiple regression and factor analysis, and grouping regions by calculated values. The proposed methodological approach was tested for thevoivodships of Poland and the regions of Ukraine. The results of the analysis showed that the arithmetic mean value of the integrated index in Poland, except for the last two years, tended to increase, but in Ukraine, except for a significant decline in the arithmetic mean index for the last two years, there was no positive trend. The difference between the value of the integrated index of Mazowieckie and Swietokrzyskie voivodships is 2.6 times, and the difference between the integral index of Kyiv City and the Zakarpattiaregion is 18.4 times.

According to the results of the study, the authors consider it appropriate to develop a mechanism for identifying and implementing priority areas of innovation in order to accelerate the transition of the economy to an innovative path of development. This mechanism should improve the structure of priority areas of science and technology; use the program-target approach to realize scientific and technical, and innovative medium-term defined priorities of national value; anticipate an effective program management mechanism. Innovative priorities for economic development encourage the widespread introduction of the achievements of advanced scientific and technological developments, which give impetus to structural changes in the economy, stimulating the production of new high-tech products.

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Podejścia metodologiczne do oceny innowacyjności regionów Polski i Ukrainy z uwzględnieniem procesów cyfryzacji

Artykuł przedstawia kwalimetryczną ocenę innowacyjności regionalnych systemów gospodarczych z uwzględnieniem procesów cyfryzacji. Badania oparto o generalne naukowe metody poznawcze oraz specjalne metody badań naukowych w obszarze rozwoju sił wytwórczych i gospodarki regionalnej. Zastosowano dialektyczną metodę poznania naukowego do identyfikacji sprzeczności i wzajemnych powiązań innowacyjnego rozwoju podmiotów działających w ramach regionalnych systemów gospodarczych; metodę analizy i syntezy w celu określenia mechanizmów identyfikacji i wdrażania priorytetowych obszarów innowacji w regionach; metodę grupowania w celu pogrupowania regionów według obliczonych wartości zintegrowanego wskaźnika innowacyjności regionów Ukrainy i Polski; metodę modelowania statystycznego i ekonomiczno-matematycznego do obliczenia i modelowania innowacyjności regionów, a także inne metody. Przeprowadzono kalkulację i analizę wartości zintegrowanych wskaźników działalności innowacyjnej w regionach Ukrainy i Polski. Regiony te zostały pogrupowane według wartości tego wskaźnika. Przedstawiono analizę kartograficzną i wyodrębniono regiony będące liderami, regiony zapóźnione oraz regiony o średniej wartości zintegrowanego wskaźnika innowacyjności. Niniejsze opracowanie ma znaczenie teoretyczne i aplikacyjne dla rozwoju sił wytwórczych i gospodarki regionalnej, gdyż prezentuje propozycję podejścia metodologicznego do oceny aktywności innowacyjnej regionów Ukrainy i Polski z uwzględnieniem procesów cyfryzacji.

Słowa kluczowe: innowacyjność, działalność innowacyjna, innowacje społeczne, infrastruktura, modernizacja, cyfryzacja

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Overview of EU and Global Conditions for the Transformation of the TCLF Industry on the Way to a Circular and Digital Economy (Case Studies from Poland)

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Abstract

The article aims to review the changes that have taken place in the European and global TCLF (Textiles-Clothing-Leather-Footwear) sector over the last decade from the perspective of new requirements of pursuing a circular and, especially in recent years, a digital economy. The paper describes the changes in the components of this industry (formerly called the light industry) in the European Union and the world economy in the context of sustainable development requirements and the effects of climate change. Recent European and global programs mainly aim to achieve the circular

economy's strict requirements, including reducing pressure on natural resources, to achieve climate neutrality by the end of 2050. This positive change for our planet is also supported by the pursuit of the development of the digital economy.

Keywords: textiles, clothing, leather, footwear, transformation, circular economy, digital economy, European Union, world economy, Poland

JEL: 013

Introduction

The aim of this article is to present an overview of the changes that have taken place in the European and global TCLF (Textiles-Clothing-Leather-Footwear) sector over the last decade from the perspective of the new requirements of pursuing a circular and, especially in recent years, a digital economy. The paper describes the changes in the components of this industry (formerly called the light industry) in the European Union and the world economy in the context of sustainable development requirements and the effects of adverse climate changes.

To compete in European and global markets, firms must not only offer high-quality products, but they must also provide innovative and attractive product designs. Every firm that wishes to compete in the open, contemporary global market should focus on creating innovative projects based on creative designs and ideas put forward by their employees. The European Commission and other international organizations with global reach, such as UNCTAD, are concentrating on inspiring regional authorities to develop active policies to help firms become more competitive in this area. It is estimated that the creative sector (including modern eco-design) is a driving force of economic growth for the entire EU (as well as other highly developed countries), creating over 5% of the EU's GDP and systematically increasing this share (Wysokińska 2015, p. 14).

In the new *circular economy* EU action plan for a greener and more competitive Europe (Annex to the new Communication… 2020), the European Commission has announced that it will launch initiatives to restore resources to the economy. These initiatives will cover the entire life cycle of products, from design and production to use, repair, reuse, and recycling. The plan addresses areas where action at the EU level brings added value. The Action Plan is the cornerstone *of the European Green Deal*, the EU's Action Plan for Climate Neutrality. Half of all greenhouse gas emissions come from the extraction and processing of resources. Achieving the climate neutrality goal by 2050 will not be possible without a full transition to a circular economy.

Between 1970 and 2018, global extraction and processing of raw materials such as fossil fuels, metals, and minerals tripled and continues to grow, causing greenhouse gas emissions, loss of biodiversity, and water stress. A circular economy model, where value and resources exist in the economy for as long as possible and the generation

of waste is limited, reduces pressure on natural resources (European Commission 2020b; see also: UN Environment Programme 2019; Report from the Commission to the European Parliament… 2019).

In the Action Plan, several proposals were adopted regarding various industries, including the clothing industry, for which a comprehensive policy framework was announced that aims to strengthen industrial competitiveness and innovation, support the EU market for sustainable circular textile products, including the textile reuse market, and introduce new business models to enhance competitiveness and innovation in this sector, and stimulate the EU market for product reuse (European Commission 2020a, p. 11; see also: Annex to the new Communication… 2020).

The state of development of the European TCLF sector

The European textile industry is becoming increasingly innovative and competitive and it plays a significant role in economic development (Dziuba and Jabłońska 2017, p. 14). The TCLF sector is one of the leading industrial sectors in Europe and a source of new trends and innovations. It is estimated that the European sector's annual turnover is over 200 billion euros, and about 225,000 firms employ 2.2 million people, 66% of whom are women (The European Skills Council n.d.).

Textiles are in fourth place in terms of the greatest pressure on using virgin raw materials and water, and fifth place in greenhouse gas emissions. The future strategy's objective will be to support the development of the sustainable textile products market within a closed-loop, including the secondary use market for textile products. The new approach will focus on new business models that relate to both production and consumption. The European Commission will also provide guidance on the selective collection of textile waste, which the Member States should implement by 2025. It also announced the development of cooperation with industry and market players to identify bottlenecks in textile products' circularity and to stimulate market innovation.

The European EU textile and clothing industry is one of the leaders in world markets. Exports from the EU to the rest of the world represent approx. 30% of the world market, while the EU single market is also one of the most important in terms of both size and especially quality. The European Commission works to ensure a level playing field in international trade. It does so multilaterally within the World Trade Organization, on a bilateral level through free trade agreement negotiations, and in dialogues, such as the Euro-Mediterranean dialogue, mainly focused on the textile and clothing industry, and in bilateral dialogues with Colombia and China.

The EU textiles and clothing sector's leading role has been attributed to its high-class specialization and flexibility, and its ability to constantly adapt its structure to market needs and develop products in response to new demands (such as technical textiles for

industrial applications). Therefore, despite the negative trade balance, the sector has increased exports by 13% and imports by 4% in recent years.

The textile and apparel industry is a global industry with ever-increasing trade flows around the world. Tariff barriers, technical regulations, standards, and conformity assessment procedures are obstacles to trade development, and the European Commission is constantly working to reduce them. The Commission is also applying the World Trade Organization's (WTO) Agreement on Technical Barriers to Trade by non-EU countries and is fighting to remove unnecessary technical obstacles in non-EU countries in the context of WTO requirements.

In parallel to the multilateral framework, the Commission conducts a bilateral dialogue on industrial policy and related regulatory issues with non-EU countries to facilitate industrial relations and improve trade conditions. This dialogue takes place within a horizontal framework in which the textile and clothing industry plays an important role. The Euro-Mediterranean dialogue on the textile and clothing industry is a particularly important multilateral dialogue. This region plays a strategic role as it enables the entire production chain to be kept geographically close. One-third of the EU's textile exports go to the pan-Euro-Mediterranean area (European Commission n.d., *Textiles and clothing…*).

The European footwear industry comprises a wide variety of industrial products and processes. The European Commission works to promote innovation, companies' competitiveness in this field, and the fight against counterfeiting. It also supports protecting the health of consumers and the environment. Therefore, the footwear sector is a diverse industry with a wide range of materials and products, from different types of men's, women's, and children's footwear to more specialized products such as snowboard boots and safety footwear. After the global financial crisis of 2007–2010, the footwear sector comprised 21,000 companies with a turnover of EUR 24 billion. It generated EUR 6.2 billion of added value (around 0.5% of total EU production), directly employing 280,000 people.

Two-thirds of total footwear production in the EU is concentrated in three countries: Italy, Spain, and Portugal. Italy alone is responsible for around 50% of production. The European footwear industry comprises many small enterprises with an average of 10–15 employees and an average turnover of just over EUR 1 million. Most of these enterprises are located in regions with low industrial diversification. However, the number of firms and employment in the footwear sector declined in recent decades due to the relocation of production to economies with lower labor costs.

Many European companies moved into high-quality and value-added segments and niche markets. They include high-end footwear, children's footwear, footwear for specific applications (safety, golf, ski boots), and tailor-made footwear. European footwear products are in great demand, both in the EU and world markets, because of their quality, design, and style.

While the EU continues to face a footwear trade deficit, exports continue to rise. In the post-financial crisis period, exports increased by 48% in the early 2010s. Russia, the United States, and Switzerland remain the main export markets, but exports

to countries such as China, the United Arab Emirates, and Turkey recorded the most significant increases. The leading suppliers of footwear to the EU are China (almost 50% of total imports) and Vietnam (14% of total imports) (European Commission n.d., *Textiles and clothing…*).

In response to the challenges of the European footwear industry, the Commission has commissioned an in-depth assessment of the situation and prospects for future development. The study includes reports on restructuring, research and innovation, and education and training, as well as an analysis of the sector's competitive position and policy recommendations. Essential here are European standards relating to footwear, such as testing methods, terminology, minimum performance requirements for individual components of footwear and entire shoes, and environmental aspects.

European leather industry

The EU is one of the major players in the global leather market, and its leather-based industry consists of a wide variety of industrial products and processes. The European Commission works to promote companies' innovation and competitiveness in this field while protecting the health of consumers and the environment. The leather industry includes a variety of industrial processes. Leather tanning involves the processing of raw materials, i.e., the processing of raw hides and the finishing of the hides for use in the production of a wide variety of products. The footwear, clothing, furniture, automotive, and haberdashery industries are the most important EU tannery markets. The tanning industry uses hides and skins (by-products from the meat and dairy industry) that would otherwise be disposed of by landfill or incineration. Leather is the main product of the tanning sector. It is an industrial intermediate used in the downstream sectors of the consumer goods industry. The most important outlets for EU tannery production are: footwear – 41%; furniture – 17%; automotive – 13%; the manufacture of leather goods – 19%; clothing – 8%; others – 2%.

Leather processing also generates other by-products used in several industrial sectors, such as pet and other animal food, fine chemicals (including photography and cosmetics), and fertilizers. The leather and related goods sector also generates significant economic effects as it comprises around 36,000 companies with a turnover of EUR 48 billion. These enterprises employ approximately 435,000 people. Tanneries in the European Union are usually small and medium-sized family businesses. Regional concentration is strong, and the industry often plays a key role in the local economy, being the prime source of employment and wealth.

The tanning industry is global, and the EU tanners depend heavily on access to raw materials and export markets. Indeed, the EU is the source of some of the most valuable calfskins. The EU tanning industry continues to be the world's largest leather supplier in the international market despite the shrinking EU share in world mar-

kets caused by the expansion of leather industries in other regions of the world, such as Asia and the Americas.

European tanners face two types of trade barriers: impeding the export of finished leather and restricting access to raw materials. Access to European raw materials has also become more difficult recently because beef production and the slaughter rate have decreased in recent years. Thus, access to raw materials outside Europe is now increasingly important. However, many countries outside the EU maintain bans and restrictions on the export of rawhides. Therefore, improving market access is expected most of all in the context of World Trade Organization regulations, where the European Commission supports the complete withdrawal of all export restrictions by various WTO members. To ensure that European industry has fair access to the raw materials it needs, the European Commission developed an integrated strategy outlined in its 2008 Communication "The Raw Materials Initiative: Meeting Our Critical Needs for Growth and Jobs in Europe" (European Commission n.d., *The EU leather industry*). According to statistical data, 50% of leather produced in the European Union is currently used in the footwear industry. The clothing industry accounts for 20%, while leather for upholstery accounts for 17% of European tanneries' production (European IPPC Bureau 2013).

In the coming years, a critical condition for the development of TCLF industries in the EU will be *digitization*, which in the next decade will remain the main factor of social and economic changes and a carrier of values of increasing importance. Digitization is becoming universal and global. In the future, the TCLF industry will focus on investing and developing modern technologies and processing textile raw materials, especially from renewable resources. It will also focus on developing biomaterials engineering and multifunctional chemical fibers for special applications, including nanofibers. A considerable part of the assortment will be products with unconventional applications: in medicine (biomaterials, bioactive and biodegradable fibers), technology (intelligent textiles for the development of textronics), and agriculture (ecological textile products).

The development potential is to be found in robotics, automation, artificial intelligence, the circular economy, and the eco products market. The industry invests in technologies that reduce the impact of products (and production) on the environment, the reuse of materials, the reduction of energy consumption, and the implementation of *Responsible Research for Innovation – RRI solutions*. A great development opportunity is the acquisition and use of larger and larger volumes of data (Internet of Things, big data) and the development of analysis techniques (artificial intelligence). The digitization of business is clearly associated with positive changes, as it significantly increases work efficiency, improves communication and activities in groups, and allows for better customer service. Moving from an analog to a digital work style will enable businesses to be more agile and competitive. Digitization is currently the most effective tool for managing and implementing innovation.

An important aspect of the EU's policy is and will be to reduce the number of hazardous substances, especially in textiles (*Clothes and textiles* n.d.). For many years, the EU has restricted or banned many dangerous chemicals in textiles, e. g. azo and some other dyes (found in textiles and leather products), chromium VI (in leather products), dimethyl fumarate (DMF, used to prevent mold), and some phthalates (textiles, plastic shoes). Many textile manufacturers also reduce the number of hazardous chemicals in their products. The evaluation of traditional restricted substances usually focuses on product testing, but this can be ineffective and lead to a costly product recall. By focusing on chemicals and input products, manufacturers can reduce many of the hazards of restricted substances.

The TCLF sector in Poland

The Polish textile and clothing market is one of the most attractive in Central and Eastern Europe, with a long cultural and economic tradition. The region that has always stood out from the rest of the country is the Lodz region, where one of the world's largest textile industry centers was established in the 19th century. Since then, this industry has been an integral part of the national economy despite various political upheavals and organizational changes. According to European Commission data, Poland ranks 8th in Europe in terms of clothing production, with domestic production reaching EUR 22.1 billion in 2018. Besides, Poland is considered a tycoon in the field of textile and clothing exports in Europe. The value of exports in 2018 amounted to PEUR 11.9 billion (43% of the revenue from the sale of clothing and 61% of the revenue from the sale of textiles comes from exports). At the end of 2018, 44,447 firms were registered in the sector. Eight thousand four hundred thirty-two companies, i.e., almost 19% of the entire national potential in this area, are enterprises with their headquarters in the Lodz region, and it is estimated that the number will increase by almost 40% by 2035.

Poland also ranks high among the top fifteen exporters and importers of footwear in Central Europe. The exports of Poland's footwear industry in 2015–2019 in creased from EUR 943 million to EUR 2.2 billion, while imports increased from EUR 1.4 billion to EUR 2.7 billion. The main export direction for Polish shoes is the EU. For many years, the largest recipient has been Germany, with nearly 39% of Polish exports in 2019, followed by the Czech Republic, Romania, and Italy (PKO Bank Polski S.A. 2020).

The hide processing technology includes chemical processes and mechanical operations that shape the structure of the hide. They protect against the destruction of hides and give them the characteristics typical for a specific ready-made assortment. Leather industry waste is both biologically unstabilized waste (including hazardous tanning waste, i.e., trimmings) and waste that results from the process of proper tanning, which is resistant to biological degradation. It is estimated that for every 4 tons of raw hides subjected to tanning, 1 ton of waste is generated. Production residues usually ac-

count for 2 to 20% of tanned leather weight – more than 2 kg of waste for every square meter of finished leather. According to the Central Statistical Office (GUS) data, the leather and leather goods manufacturing sector generated 55,100 tons of waste in 2019 (Główny Urząd Statystyczny 2020).

Analysis of selected segments of the global textile, clothing, footwear, and leather market based on the latest available data in the UN international statistics (COMTRADE database) – Poland's position[1]

Textiles

After the 2008–2010 crisis, the global textile market was characterized by upward trends, especially strong in 2016–2018 (recent years for which statistical data from international databases of the UN and Eurostat are available). Growth trends can be observed both in the global textile yarn market – where increases from USD 48 to USD 54.5 billion were recorded, as well as in the markets of fabrics (especially artificial ones) and crochet and knitted fabrics. The value of exports increased by 3.2% in the analyzed period (compared to a –1.4% average increase in *textiles made of chemical fibers (SITC 653 group*[2]*)* in the period 2014–2018). The leading exporters included China, South Korea, Taiwan, Italy, Turkey, India, Japan, Germany, the United States, and Spain. In turn, in 2018, the value of exports of *knitted or crocheted fabrics (SITC 655 group)* increased by 5.1%, i.e., to USD 37.0 billion (compared to the average growth rate of 2.1% in 2014–2018). China, South Korea, and other Asian countries were the leading exporters in 2018, accounting for 49.1, 8.4, and 6.6% of world exports, respectively. Vietnam, Cambodia, and the United Kingdom were the main destination countries, with 15.4, 9.6, and 6.1% of world imports, respectively. In 2018, the country with the highest net export value was China (USD +16.5 billion), followed by South Korea (USD +3.0 billion).

Commodity groups of great importance and dynamic development in world trade in the analyzed period also included *special yarns, special textile fabrics and related products (SITC 657 group)*, and *made-up articles, wholly or chiefly of textile materials, n.e.s.*[3] *(SITC 658 group)*. They are particularly important groups from the point of view of Poland. It was among the world's 15 largest exporters, ranking 9th in exports of the latter group (which accounted for almost 2% of global exports) and 15th in exports of the former, accounting for 1.7% of world exports. In the import of goods from the

1 Based on: *International Trade Statistics Yearbook–2018* (2019).

2 Commodity group of the Standard International Trade Classification.

3 n.e.s. – not elsewhere specified.

first group, Poland ranked 7th (2.8% of world imports), and in the import of goods from the second group, it was 13th (1.6% of world imports).

According to UN analyses and assessments, the value of exports of *special yarns, special textile fabrics and related products (SITC 657 group)* increased by 6.4% in 2018 (compared to 1.1% average growth for the period 2014–2018) to USD 52.7 billion, while imports increased by 7.7% to USD 47.7 billion. The export of this raw material accounted for 2.3% of global exports of the SITC Section 6 and 0.3% of the total world exports of goods. In 2018, the largest exporters were China, Germany, and the United States, which accounted for 25.7, 10.5, and 9.1% of global exports, respectively. On the import side, the United States, China, and Germany were in the lead, with 11.2, 6.5, and 5.8% of the share, respectively.

On the other hand, UN analyses showed that in 2018, the value of exports of *made-up articles, wholly or chiefly of textile materials, n.e.s. (SITC 658 group)* increased by 5.8% (compared to 0.4% average growth in 2014–2018) to USD 61.2 billion. Imports increased by 6.5%, reaching USD 55.1 billion. The export of this raw material accounted for 2.6% of the world exports of the SITC Section 6 and 0.3% of the total world exports of goods. In 2018, the leading exporters were China, India, and Pakistan, which accounted for 44.6, 8.4, and 6.6% of global exports, respectively. On the import side, the United States, Germany, and Japan were in the lead, with 29.1, 7.9, and 6.6% of the share, respectively.

Men's and boys' and women's and girls' clothing (UN international nomenclature Division 84)

The global market of clothing and accessories for clothing after the global financial crisis was characterized by strong growth trends, especially from 2011 until 2018. The UN results were presented especially for 2016–2018 – the most recent years for which statistical data from international UN and Eurostat databases are available.

Men's or boys' outerwear of textile materials, not knitted or crocheted

In 2018, the value of exports of *men's or boys' outerwear made of textiles, not knitted or crocheted (SITC 841 group)* increased by 3.4% (compared to 0.1% of the average growth rate in the period (2014–2018)), reaching USD 81.0 billion, while imports increased by 7.0%, reaching USD 73.9 billion. Exports of these goods accounted for 3.6% of the world exports of SITC Section 8, and 0.4% of the total world exports of goods. The leading exporters were China, Bangladesh, and Vietnam, which accounted for 27.1, 9.1, and 7.4% of global exports, respectively.

The main target countries were the United States, Germany, and Japan, with 19.5, 9.9, and 6.8% of global imports, respectively. The high concentration of the largest trading countries on the world market is also characteristic. The 15 largest partner countries accounted for 78.5 and 74.7% of total global exports and imports, respec-

tively. The largest trade deficits were recorded in North America (USD –15.0 billion), Europe (USD –11.8 billion), and Australia and New Zealand (USD –1.3 billion).

Women's or girls' outer garments of textile materials, not knitted or crocheted

In 2018, the value of *exports of women's or girls' outerwear made of textile, not knitted or crocheted (SITC 842 group)* increased by 3.7%. (compared to 0.7% average growth rate in the period 2014–2018), reaching USD 101.5 billion, while imports increased by 8.9%, to USD 94.4 billion. The exports of these goods accounted for 4.5% of the world exports of the whole SITC Section 8, and 0.5% of the total world exports of goods. The largest exporters were China, Italy, and Germany, with 33.5, 6.0 and 5.5% of the share in world exports, respectively. The main target countries were the United States, Germany, and Japan, with 16.8, 9.0, and 6.8% of global imports, respectively.

The top 15 countries accounted for 83.8 and 75.1% of total global exports and imports, respectively. In 2018, China was the country with the highest export value (USD +32.2 billion), followed by Vietnam (USD +5.5 billion). In turn, the largest trade deficits were recorded in North America (USD –16.7 billion), Europe (USD –14.8 billion), and Latin America and the Caribbean (USD –2.4 billion).

Poland had a relatively high position, putting it among the 15 leading global exporters and importers. It ranked 12th in exports (which accounted for 2.1% of global exports in 2018, with dynamics of 46.7% in the last two analyzed years). It was ranked 11th in imports (which accounted for 2.4% of global imports in the same year, with import dynamics of 46.5% in 2018 compared to the previous year).

Men's or boys' outerwear made of textile fabrics knitted or crocheted

In 2018, the export value of *men's or boys' outerwear made of woven, knitted or crocheted fabrics (SITC 843 group)* increased by 3.7%. (compared to –0.2% in the period 2014–2018), reaching USD 32.6 billion, while imports increased by 8.6%, reaching USD 27.0 billion. The exports of this commodity group accounted for 1.5% of the world exports of SITC Section 8 and 0.2% of the total world exports of goods. China, Vietnam, and Cambodia were the leading exporters in the last analyzed year. These countries accounted for 30.1, 7.5, and 6.2% of the world export, respectively. The main target countries were the United States, the United Kingdom, and Germany, with 25.8, 6.4, and 6.2% of the share of global imports, respectively.

The 15 largest countries accounted for 80.2 and 74.8% of total global exports and imports, respectively, proving a high degree of trade concentration. The country with the highest value of exports was China (USD +9.3 billion), followed by Vietnam (USD +2.4 billion). The largest trade deficits were recorded in North America (USD –7.3 billion), Europe (USD –4.4 billion), and Australia and New Zealand (USD –487.1 million).

Women's or girls' outerwear of knitted or crocheted textile fabrics

In 2018, the value of exports of *women's or girls' outerwear, made of knitted or crocheted textile fabrics (SITC 844 group)* increased by 5.7% (compared to –2.0% average growth rate in the period 2014–2018), reaching the level of USD 58.0 billion, while imports increased by 5.3%, reaching the value of USD 48.2 billion. The export of these products accounted for 2.6% of the world exports of SITC Section 8 and 0.3% of the total world exports of goods. China, Vietnam, and Cambodia were the leading exporters in 2018, accounting for 36.0, 7.0, and 5.2% of world exports, respectively. The main target countries were the United States, Germany, and the United Kingdom, with 23.0, 9.9, and 6.3% of the share in world imports, respectively.

The 15 largest countries accounted for 80.2 and 74.8% of total global exports and imports, respectively, proving a high degree of trade concentration. The country with the highest value of exports was China (USD +9.3 billion), followed by Vietnam (USD +2.4 billion). The largest trade deficits were recorded in North America (USD –7.3 billion), Europe (USD –4.4 billion), and Australia and New Zealand (USD –487.1 million).

Textile articles of clothing, even knitted or crocheted, n.e.s.

In 2018, the value of exports *of textile articles of clothing, even knitted or crocheted, n.e.s. (SITC 845 group)* increased by 6.3% (compared to 0.5% average growth rate in the period 2014–2018), reaching USD 158.8 billion, while imports increased by 6.8%, reaching USD 154.1 billion. The exports of this commodity group accounted for 1.5% of the world exports of SITC Section 8 and 0.2% of the total world exports of goods. China, Bangladesh, and Vietnam were the main exporters in 2018. These countries' exports accounted for 28.2, 7.0, and 5.7% of the world export, respectively. The main target countries were the United States, Germany, and Japan, with 16.8, 9.0, and 6.8% of global imports, respectively.

The top 15 countries accounted for 78.1 and 75.8% of total world exports and imports, respectively. In 2018, the country with the highest value of exports was China (USD +42.1 billion), followed by Bangladesh (USD +11.1 billion). The largest trade deficits were recorded in North America (USD –15.0 billion), Europe (USD –11.8 billion), and Australia and New Zealand (USD –1.3 billion).

Articles of apparel, of textile fabrics, whether or not knitted or crocheted, n.e.s.

In 2018, the value of exports of *Articles of apparel, of textile fabrics, whether or not knitted or crocheted, n.e.s. (SITC 846 group)* increased by 4.9% (compared to –0.5% the average rate for 2014–2018) to USD 31.6 billion, while imports increased by 2.8%, reaching USD 27.4 billion. This group's export accounted for 1.4% of the world exports of SITC Section 8, and 0.2% of total world exports of goods. In 2018, the leading exporters were China, Italy, and Turkey, with a 43.1, 7.3, and 4.0% share in global exports, respectively. The main target countries were the United States, Japan, and Germany, with 18.0, 8.0, and 7.9% of world imports, respectively.

The 15 largest countries accounted for 82.3 and 67.9% of total global exports and imports, respectively. In 2018, the country with the highest export value was China (USD +13.3 billion), followed by Italy (USD +1.4 billion). The largest trade deficits were recorded in North America (USD –4.7 billion), Europe (USD –3.5 billion), and Latin America and the Caribbean (USD –484.7 million).

In the global import of products belonging to this product group, Poland had a relatively high position (15), which meant a 1.6% share with the import growth dynamics in 2018, equaling 19.1%, compared to the previous year.

Articles of apparel and clothing accessories of other than textile fabrics; headgear of all materials

In 2018, the value of exports of *articles of apparel and clothing accessories of other than textile fabrics; headgear of all materials (SITC 848 group)* increased by 9.5% (compared to 1.1% average growth in 2014–2018) to USD 35.1 billion, while imports increased by 7.7% to USD 32.4 billion. The export of this group accounted for 1.4% of the world exports of SITC Section 8, and 0.2% of total world exports of goods. In 2018, China, Malaysia, and Italy were the leading exporters, with 37.7, 12.8, and 6.5% of the share in global exports, respectively. The main target countries were the United States, Germany, and Japan, with 16.8, 9.0, and 6.8% of global imports, respectively.

The top 15 countries accounted for 86.2 and 72.7% of total world exports and imports, respectively. In 2018, the countries with the highest value of exports were China (USD +12.5 billion), followed by Malaysia (USD +4.3 billion). The largest surpluses were recorded in East Asia (USD +33.2 billion), Southeast Asia (USD 21.1 +billion), and South Asia (USD +2.6 billion). The largest trade deficits were recorded in North America (USD –8.2 billion), Europe (USD –4.1 billion), and Latin America and the Caribbean (USD –1.0 billion).

Leather and shoes

Leather

In 2018, the value of *leather (SITC 611 group)* exports decreased by 8.2% (compared to a –4.6% average growth rate in 2014–2018), reaching USD 22.6 billion, while imports decreased by 5.4%, reaching USD 23.5 billion. This group's exports accounted for 1.4% of global exports of SITC Section 6, and 0.2% of the total world exports of goods. The leading exporters were Italy, the United States, and Brazil, with 19.4, 8.9, and 6.4% of the share in global exports, respectively. The main target countries were China, Italy, and Vietnam, with world import shares of 18.8, 13.2, and 7.7%, respectively.

The top 15 countries/areas accounted for 70.7 and 74.2% of total global exports and imports, respectively. In 2018, Brazil was the country with the highest value of exports (USD 1.4 billion), followed by Italy (USD 1.3 billion). The largest trade surpluses in this product group were recorded in Latin America and the Caribbean (USD +1.7 billion),

North America (USD +1.4 billion), and Australia and New Zealand (USD +519.9 million). The largest trade deficits were recorded in East Asia (USD –3.8 billion), Southeast Asia (USD –2.0 billion), and West Asia and North Africa (USD –5.0 million).

Footwear

In 2018, the value of *footwear (SITC 851 group)* exports increased by 4.9% (compared to an 0.8% average growth rate in 2014–2018), reaching USD 145.3 billion, while imports increased by 7.2% to USD 144.0 billion. Footwear exports accounted for 6.5% of world exports of SITC Section 8, and 0.8% of the total world exports of goods. The leading exporters in 2018 were China, Vietnam, and Italy. These countries had 32.4, 11.9, and 8.5% of the share in global exports, respectively. The main target countries were the United States, Germany, and France, with 19.1, 9.3, and 5.9% of global imports, respectively.

In 2018, the top 15 countries accounted for 84.8 and 71.0% of total global exports and imports, respectively. The country with the highest value of exports was China (USD +42.5 billion), followed by Vietnam (USD +16.2 billion). The largest trade deficits were recorded in North America (USD –28.3 billion), Europe (USD –15.2 billion), and Latin America and the Caribbean (USD –4.2 billion).

In the international footwear trade, Poland's relatively good position should be noted, as it is among the 15 leading global exporters and importers, ranking 14th in both exports and imports, accounting for a 1.4% share in global exports and a 1.9% share in global imports in 2018. In turn, the annual export dynamics of footwear in 2018 compared to 2017 amounted to 40.7%, and the import dynamics amounted to 46.9%.

Conclusion

The textiles, clothing, and footwear markets were characterized by relatively stable growth after the 2008–2010 financial crisis and the dynamic development of exports and imports between 2016 and 2018. They presented a high concentration of the strongest trading partners and the dominance of Asian partners (China, South Korea, Vietnam, Taiwan, India, and Japan) as well as relatively large shares of partners from Southern Europe (Italy and Spain), with the significant position of Turkey, Germany, and Great Britain and the United States.

Poland's position was relatively good in several groups of commodities, i.e., in the trade in textiles such as goods from SITC Section 6*: special yarns, special textile fabrics and related products (SITC group 657)* and *made-up articles, wholly or chiefly of textile materials, n.e.s. (SITC group 658).* These are particularly important groups for Poland, ranking among the world's 15 largest exporters: 9th in exports of the latter group (which accounted for almost 2% of global exports) and 15th in exports of the first group (which accounted for 1.7% of world exports). In turn, in the im-

port of goods from the first group, Poland ranked 7th (2.8% of world imports), and in the import of goods from the second group, 13th (1.6% of world imports).

Among the articles of apparel and clothing accessories belonging to Section 8, Poland achieved a high position in trade in *women's and girls' outerwear of textile fabrics, not knitted or crocheted (SITC group 842)*. It was among the world's 15 leading exporters and importers, ranking 12th in exports (which accounted for 2.1% of global exports in 2018, with dynamics of 46.7% in the last two analyzed years). It was ranked 11th in imports (accounting for 2.4% of global imports, with import dynamics of 46.5% compared to 2017).

In the *SITC 846 group*, which includes *clothing accessories, of textile fabrics, whether or not knitted or crocheted*, Poland achieved a relatively high position (15), which meant a 1.6% share, with dynamics of import growth in 2018 (compared to the previous year) at 19.1%.

In the international *footwear* trade, Poland's relatively good position puts it among the 15 leading exporters and importers of the world, ranking 14th in both exports and imports (which accounted for 1.4% share in global exports and 1.9% share in global imports in 2018). In turn, the annual export dynamics of footwear in 2018 compared to 2017 amounted to 40.7%, and the import dynamics amounted to 46.9%.

Annex

The TCLF industry in Poland – Łukasiewicz Research Network – Institute of Biopolymers and Chemical Fibers (IBWCh) and Łukasiewicz Research Network – Institute of Leather Industry – Case Studies

An example of selected achievements of the Institute of Biopolymers and Chemical Fibers – IBWCh

Since the Institute of Biopolymers and Chemical Fibers (IBWCh) began operations, scientific research on artificial fiber production, including cellulose, has been an outstanding achievement. Until the 1990s, these cellulose fibers were produced by the viscose method. The Institute uses a specialized pilot line from Blaschke (Germany) – a spinning machine – to produce viscose and cellulose fibers. This line made it possible to improve the viscose process and analyze the influence of various types of cellulose pulp on the viscose or cellulose fiber properties. The new preparations and methods were implemented in the viscose fibers' factories of Wistom in Tomaszów Mazowiecki, Chodakowskie ZWCh in Sochaczew, Wiskord in Szczecin, Celwiskoza in Jelenia Góra, and Viscoplast in Wrocław.

Since the beginning of the 1990s, there has been intensive research on developing an alternative to viscose technologies to produce cellulose fibers. The IBWCh team, under the supervision of prof. Dariusz Wawro, has carried out many international projects, e.g., Biocelsoll, Marie-Curie ITN, a project within EPNOE (the European Polysaccharide Network), Wobama, or Elmo (Kuzmina et al. 2010; Wendler et al. 2010; Ek et al. 2014; Kuzmina et al. 2014; Wawro et al. 2014; Wawro et al. 2015). The team has extensive experience in forming classic cellulose fibers from alkaline cellulose solutions and modified with other biopolymers, such as plant polysaccharides or hydrolysates (Ek et al. 2014; Wawro and Stęplewski 2010) and animal proteins, such as fibroin and keratin (Strobin et al. 2006; Wrzesniewska-Tosik et al. 2007). Thanks to the introduction of biopolymers into the structure of cellulose fibers, the properties of the fibers, including bioactivity, were changed. The hydrothermal cellulose activation method developed at the Institute deserves special mention. The Institute currently carries out research services for industrial partners (Wawro, Stęplewski, and Bodek 2009).

Selected projects implemented in recent years as part of the Łukasiewicz Research Network – Institute of Leather Industry

Management of environmentally harmful waste from the leather industry in agrotechnics

Two projects are carried out in international consortia under the NCBR program: "New treatment for rape seeds based on collagen hydrolysates, in order to increase the drought resistance of the rape seedling" (Eureka program) and "New treatment based on collagen hydrolysates for increasing the drought resistance of Leguminosarum seedlings" (Era.Net *Rus Plus Innovation program*). The projects included activities to increase the yields of various plant species using the leather industry's by-products. The results of the research will be applicable in many sectors of the economy, especially

in agriculture. Among other things, a new material based on collagen preparations and seed coating technology was developed to increase their resistance to drought. They also developed a way of using waste biomass to develop a new foliar preparation that contains a fungicide and plant biostimulants. A team of researchers from Łukasiewicz Research Network – Institute of Leather Industry and Lodz University of Technology assessed the possibility of using a disk granulator to coat legume seeds with collagen hydrolysates obtained from tannery waste, which is burdensome for the natural environment. The resulting coatings are designed to increase resistance to drought and pests during seed germination. As part of the research, the team proposed a way to manage solid waste from the leather industry. Due to its unique properties, the resulting collagen hydrolyzate was used in the pelleting of legume seeds to reduce the risk of seeds not germinating during drought (Ławińska et al. 2017, p. 1877).

Environmental responsibility

The LIFE + CO2Shoe project "LIFE12 ENV/ES/000315" has developed carbon footprint calculation tools for the footwear sector to estimate the greenhouse gas (GHG) emissions generated by footwear production. The project covered four EU Member States: Spain, Italy, Portugal, and Poland (countries which concentrated 79% of footwear companies in the EU in 2013) (*European footwear sector…* n.d.). The project aimed to provide footwear companies with a tool to allow the industry to identify the most important aspects of production that can reduce greenhouse gas emissions. In order to calculate the carbon footprint, a proprietary method developed by the consortium was used, based on the relevant standards: ISO 14040: 2006 Environmental management – Life cycle assessment – Principles and framework and ISO 14044: 2006 Environmental management – Life cycle assessment – Requirements and guidelines. The research material consisted of various footwear types: children's, women's, men's, and work shoes. During the project, 36 models of footwear produced in the European Union were tested. It allowed them to calculate the average carbon footprint of a pair of footwear – 10.6 CO2e (kg) (Serweta et al. 2019, p. 94). Carbon footprint calculations make it possible to identify the most environmentally damaging steps of the production process. In the analyzed models, footwear materials had the most significant impact on the carbon footprint, on average accounting for 57.4% of the total value.

Individual operations for the treatment of tannery waste for reuse

As part of the cooperation, work is carried out on the agglomeration methods of waste shavings from chrome and chrome-free tanning processes with mineral additives. Tanning shavings are characterized by many unfavorable physical properties, including very low apparent volume. They take up a lot of space, which makes them difficult to store and transport. These wastes have irregular, fluffy shapes, causing them to stick together into larger fragments. As a result of the conducted work, a loose agglomerated

granular bed is obtained, which combines both mineral and organic components; it is easy to store, transport, and dose. The obtained agglomerates can be used to produce composites based on collagen fibers instead of the previously used loose, moist, dusty shavings. The developed methods make it possible to process and change the physical properties of the waste product – shavings from chrome and chrome-free tanning processes, which are often stored on the premises of the tanning plant and sent for disposal (Ławińska, Obraniak, and Modrzewski 2019, p. 107; Ławińska et al. 2020, p. 1; Ławińska, Modrzewski, and Obraniak 2020, p. 119).

As part of the National Science Center's MINIATURA project, research was carried out to assess the possibility of using waste from the leather industry, especially waste leather tanned in the wet-blue technology, and readily available cheap natural minerals, for the formation of new composites with high physicomechanical parameters. The structure and high tensile strength of collagen fibers allow them to be used as a component of a composite. This topic combined with the issue of using mineral additives is part of the current issues of the sustainable development of the global economy, including the renewal and biodegradability of composite materials (Ławińska, Serweta, and Modrzewski 2018, p. 81; Ławińska, Serweta, and Modrzewski 2019, p. 106; Ławińska, Modrzewski, and Serweta 2019).

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Przegląd unijnych i światowych uwarunkowań transformacji przemysłu TCLF (włókienniczego, odzieżowego, skórzanego i obuwniczego) na drodze do gospodarki cyrkularnej i cyfrowej (przykłady z Polski)

Celem artykułu jest przegląd zmian dokonujących się w europejskim i światowym sektorze TCLF (włókienniczym, odzieżowym, skórzanym i obuwniczym) na przestrzeni ostatniego dziesięciolecia z punktu widzenia nowych wymogów dążenia do gospodarki cyrkularnej a w ostatnich latach do gospodarki cyfrowej. W artykule przeprowadzono charakterystykę zmian w częściach składowych tego przemysłu (nazywanego w przeszłości przemysłem lekkim), w Unii Europejskiej oraz w gospodarce światowej w kontekście wymogów zrównoważonego rozwoju oraz niwelowania skutków niekorzystnych zmian klimatycznych. W ostatnich programach europejskich i światowych chodzi bowiem głównie o osiągnięcie surowych wymogów gospodarki cyrkularnej, w tym zwłaszcza na zmniejszenie presji na zasoby naturalne o osiągnięcie celu neutralności klimatycznej do końca 2050 r. Tym pozytywnym dla naszej planety zmianom, sprzyja również dążenie do rozwoju gospodarki cyfrowej.

Słowa kluczowe: tekstylia, odzież, skóra, obuwie, transformacja, gospodarka cyrkularna, gospodarka cyfrowa, Unia Europejska, gospodarka światowa, Polska

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Digital Distribution as an E-commerce Sales Channel

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Abstract

In a matter of decades, digital technologies have transformed the way we communicate with others, conduct business, produce goods and services, as well as the way we live, work, and spend our spare time. These, often rapid, developments hold a lot of promise for the future, in terms of wealth generation, technological advances, and improving the quality of life. At the same time, they also bring challenges associated with a lack of skills, new and fast-emerging markets, consumer protection, industrial re-organization, trust, security, and privacy.
The private life of society, as well as the world of business, have moved to the virtual world. The transformation to e-business is complex, and to be successful, a balance needs to be struck between strategy, a customized business model, the relevant processes, and the technology used.
The aim of the article is to present the essence of digital distribution and the key factors in the dynamics of its development. Secondary data on the development of digital distribution in the world and in Europe over the past 20 years are presented, and the forecasts for the coming years are calculated.

Keywords: digital distribution, e-commerce, sales channel, digital product

JEL: L81, M39, D12

Introduction

What would the world be like today without the Internet? Contrary to appearances, the answer is not difficult – more or less like 50 years ago. While interpersonal communication would certainly be limited, the degree of intimacy would undoubtedly be greater. A similar process of changes occurred when the first mobile phones appeared. They

evolved into smartphones with Internet access and numerous games and applications, without which we cannot imagine functioning in society today.

The Internet did not come about overnight as a result of a technological breakthrough. It is a response both to civilization's technological development and the needs of modern society, where many changes in customs and views have occurred (Maigret 2015, pp. 452–453). The Internet has made it possible for society to have instant access to a lot of information from the country and the world; it has opened new paths for business development, education, and entertainment (Hoffman, Novak, and Stein 2012, pp. 28–38).

The Internet that we use today, i.e., the network of computer networks based on the Transmission Control Protocol (TCP)/Internet Protocol (IP) suite of protocols – is now a relatively old technology. Research on its design commenced in 1973, and the network became operational in January 1983. For the first two decades of its existence, it was the preserve of a technological, academic, and research elite. From the early 1990s, however, it began to percolate into mainstream society and is now widely regarded as a General Purpose Technology (GPT), without which modern society could not function. So, in a relatively short period, the technology went from being something regarded as exotic to an apparently mundane utility, like mains electricity (Naughton 2016, p. 5).

The Internet entered its commercial phase between 1984 and 1989. It was facilitated by the upgrading of backbone links, the writing of new software, and the growing number of interconnected international networks (Cohen-Almagor 2011, p. 45). In March 1989, Tim Berners-Lee and Robert Cailliau submitted to CERN a project to create a network of hypertext documents called the World Wide Web. It was intended to be a collection of hypertext documents to facilitate work at CERN. In December 1990, Tim Berners-Lee created the HTML foundations and the first website. Two years later, the first graphical web browser, Mosaic, was written.

In Poland, on July 30, 1990, the national top-level domain ".pl" was registered at the Computer Center of the University of Copenhagen. The analog line, later transformed into the Internet network, was launched on September 26, 1990, and had a speed of 9600 bit/sec. The Internet in Poland has been officially available since December 20, 1991.

The web provides limitless income potential for the enormous number of companies that exist in the global economy. Internet access is largely transforming traditional businesses into modern companies, and the network is becoming a strategic part of those companies' operations.

The 21st century will surely be remembered by historians as a period of unprecedented change in the business world. Within a few years, entire industries have been radically transformed, hundreds of thousands of new companies appeared, huge fortunes were won or lost by entrepreneurs and investors. All were the results of digital technology. Many people have referred to this process as the "e-business revolution" (electronic business revolution), an idea that has captured the imagination of many companies, governments, and people everywhere.

The practice of advanced countries has proven that even the use of new technologies requires a series of investments in technical means, especially human resources, and the benefits of e-business are more and more evident at both the micro and macro levels. A lack of initiative and involvement in the process of transitioning to the digital economy can have serious consequences both for the survival/maintenance/development of the organization and the economic sector, region, or country as a whole (Caraiani 2008, p. 84). The sales process has also been shortened and streamlined. There is no longer any need for face-to-face meetings with customers and suppliers – this can be done entirely online and in much less time. Anywhere in the world, depending on the company's profile. The same applies to marketing and advertising and the delivery of products or services. Traditional forms of advertising are constantly being replaced by the continuously developing online market of advertising services. It can be safely assumed that most enterprises have access to the Internet and use it on a daily basis to conduct their business. Every company needs a website, but it must be readable for the visitor and contain the most crucial information about the company (Kotler 2003, p. 58).

Petouhoff stated, "What social and digital devices have done is really transform marketing, customer service, and even sales" (Petouhoff 2006, pp. 1–8). In order for a company to be competitive, it must constantly change and renew itself, adjusting to the new changes of technology.

The essence and development of digital distribution

Distribution is one of the four elements of the marketing mix. Distribution is the process of making a product or service available to the consumer or business user who needs it. This can be done directly by the producer or service provider or using indirect channels with distributors or intermediaries.

Distribution is fundamental to ensuring that products reach target customers in the most direct and cost-efficient manner. In the case of services, distribution is principally concerned with access (Dent 2011, p. 5–15). Although distribution, as a concept, is relatively simple, in practice, distribution management may involve a diverse range of activities and disciplines including detailed logistics, transportation, storage, inventory management, as well as channel management, including selecting channel members and rewarding distributors (Armstrong et al. 2014, p. 297).

Distribution as a component of e-commerce has been facilitated thanks to Internet technology. The width of the distribution channel on the Internet is unlimited – the Internet has no place or time limitations, and the delivery of any product takes place either directly via a link where the files can be retrieved from in the case of electronic products) or via suppliers.

The distribution of products sold on the Internet is divided into several components. We can distinguish the distribution of:

– standard products (books, electronics, household appliances, etc.) distributed by post or courier,
– products sold online and distributed electronically (programs, licenses, gadgets, reports, newspapers, etc.),
– products or semi-finished products (parts of components, prints, documents), distributed in various ways between two cooperating companies or within branches of one company.

The forms of distribution on the Internet, depending on the nature of the product, are presented in Figure 1.

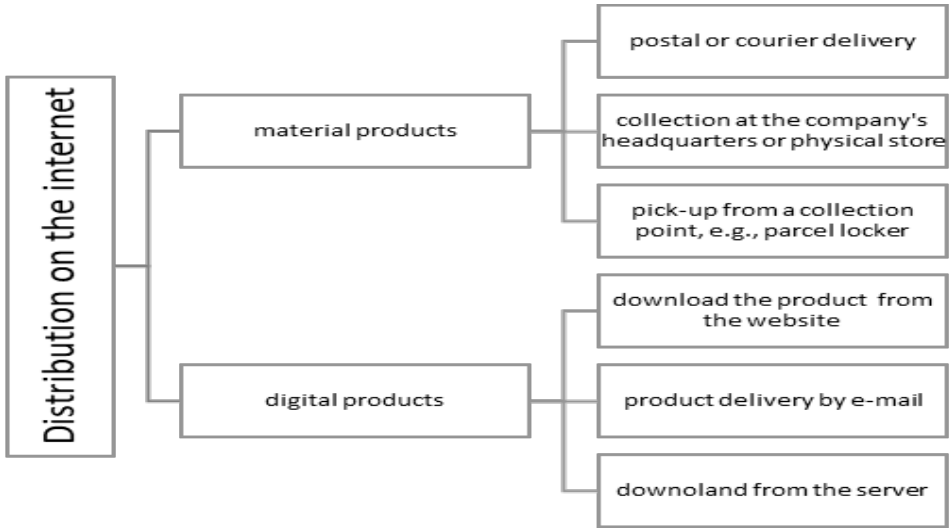


Figure 1. The forms of distribution on the Internet, depending on the nature of the product
Source: own study.

At the level of the ESD (Electronic Software Delivery) marketing instrument, enterprise distribution covers the ways, in what form (physical or digital), and how (e.g., through a specific online distribution platform) a product reaches the recipient.

Digital distribution essentially means distributing content through an online delivery medium via the Internet, thus bypassing physical distribution methods such as compact discs, videocassettes, or paper. With advancements in network bandwidth capabilities, the adoption of online distribution of content became prominent in the 21st century. Content distributed online may be downloaded or streamed, and it often consists of films, television programs, digital books, music, video games, and software (Ojala 2016, p. 451). Streaming content involves downloading and using the data at the user's "on-demand" request instead of allowing it to be permanently stored.

Digital distribution has surpassed physical distribution in key markets and will soon become the dominant distribution model for multimedia content (Peltz 2013, p. 99).

The increase in the number of Internet users, which reached 3.5 billion globally, has resulted in an unprecedented increase in the consumption of online content. For example, the demand for video on smartphones has doubled over the past three years. These factors support the development of the global digital distribution market. By online content, we mean digital goods or e-goods, i.e., intangible goods that exist in digital form (Lambrecht et al. 2014, p. 3). Examples include digital media such as e-books, downloadable music, Internet radio, Internet TV, and streaming media; fonts, logos, photos, and graphics; digital subscriptions; online advertising (purchased by an advertiser); Internet coupons; electronic tickets; documentation processed electronically from many different fields; downloadable software and mobile applications; online games.

Not all companies, especially online stores, have to create digital products, but having them in their portfolio can significantly diversify the range and increase sales. There are several key reasons why digital products should be created.

1. Only one copy of a digital product is made. It is not necessary to design and manufacture multiple products to ensure supply.
2. There is no need to invest in warehousing and logistics, such as preparing products for shipping.
3. Online sale of products can be fully automated (for example, the product is sent to an e-mail immediately after purchase).
4. Digital products are usually cheap to create. There is no need for a huge financial base to prepare prototypes, manufacture physical products, or replenish stock, and the revenue from the product becomes profit as a whole.
5. Most of the work related to preparing a digital product can be done by the seller.
6. A digital product can be sold as a bundle, allowing for a higher price for the physical product.
7. Modern clients have never invested so much time and budget in developing their talents, knowledge, and interests. This consumer trend can be used to develop sales of digital products such as online training or guides.

In the 1990s, the digital distribution of computer games was especially good for PCs. However, there was no dominant form or platform in this industry. Nonetheless, Sega, who created the Sega Channel, had a dedicated digital distribution channel, with monthly access costing US $12.95. One of the most popular games via the Sega Channel was "Test Drive" (Katz 2015, pp. 32–36).

The cyber revolution started with digital music distribution. In 1999, Napster and its successors revealed the potential of digital music distribution, but failed to develop a legal business model. Prior to Apple's iTunes Music Store, all previous legal attempts failed.

The rapid development of digital content distribution began at the turn of the 20th and 21st centuries when the Internet developed rapidly, and bandwidth and speeds increased, enabling faster and easier access to digital content. It applied to computer

games, books, movies, and music. One effect of technological facilitation and changing trends is the popularity of e-books, i.e., books in electronic form.

Delivery is the act of moving goods from the supplier to the recipient, which must take place at a specific place and time. Online delivery is within the scope of the concept of delivery, but it differs from the traditional non-digital delivery mode. With ESD, the good is delivered digitally (Nishio and Kishino 2003, p. 196), i.e., in the form of data. Electronic delivery usually takes place by enabling the product to be downloaded via the Internet from an external server from the supplier to the recipient's computer or other device. Access to a specific product, e.g., video material, may be time-limited, forcing the consumer to consume it immediately. The technique of delivering multimedia information is called streaming. It can be compared to purchasing a cinema ticket, which entitles you to watch a certain film, a certain number of times, at a certain place and time.

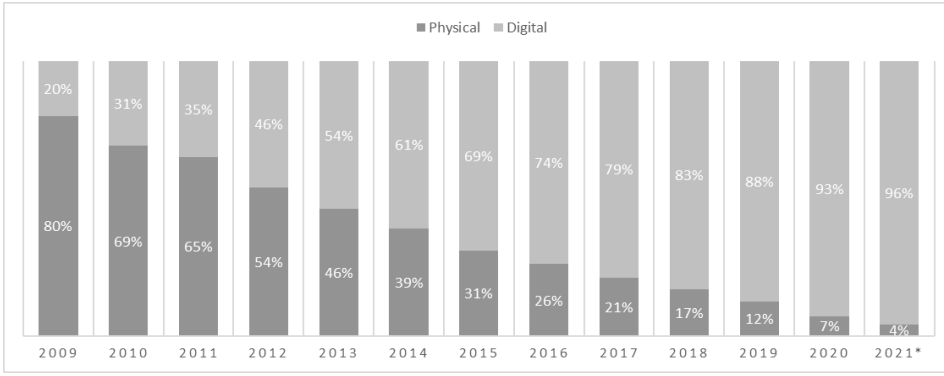
Digital delivery takes place over the Internet, which is a medium something like a channel or pipe through which water flows. The source is the supplier's server, and the tap is the electronic distribution platform. It is a gross simplification, a kind of diagram to show how electronic delivery is done. In order to sell and then deliver a digital product, one needs the tools to do so. Such a tool is primarily an e-commerce or m-commerce, web, desktop, or mobile application through which distribution takes place. Manufacturers or suppliers provide their own software for users to order, pay, collect, and consume the product. The clearest example of an online distribution platform is an online store that sells e-books. The user connects to the e-commerce platform, i.e., the store's website, from the browser level, orders, pays, and then downloads a specific product.

A general issue is the large number of incompatible data formats in which content is delivered, possibly restricting the devices that may be used, or making data conversion necessary. Streaming services can have several drawbacks: they require a constant Internet connection to use the content; some content cannot be stored locally; the content cannot be transferred to physical media (Furr and Shipilov 2019, pp. 94–103).

Vendors in the digital distribution market focus on developing content distribution software and solutions to meet customers' requirements. They compete in terms of quality of service and the way they address and meet their users' expectations. Key vendors operating in the global digital distribution market include Google, Inc., aiScaler Ltd, AT&T Inc, Akamai Technologies, Highwinds Network Group Inc, Ericsson, Limelight Networks, and Level 3 Communications. The digital distribution enterprises are also focused on modifying their pricing models to strengthen their position in the global digital distribution market.

Digital distribution in Europe and around the world

The global digital distribution market can be segmented on the basis of content type, end-user, application, and geography. Based on content type, the digital distribution market can be divided into static content and streaming content. Based on the end-user, the digital distribution market can be classified into small and medium-sized enterprises and large enterprises. The digital distribution market can be segregated, based on application, into e-commerce, online gaming, advertising, healthcare, education, and others.



* Forecast values.

Figure 2. Game sales in the United States by distribution type in 2009–2017
Source: own study.

In terms of region, the global digital distribution market can be categorized into North America, Europe, Asia-Pacific, the Middle East & Africa (MEA), and South America. Compared to the market in other regions, the digital distribution market in North America is expected to constitute the leading share during the forecast period and to witness significant growth. The US and Canada are expected to drive the growth of the digital distribution market in the region, supported by technological advancements in communication. Another factor propelling the growth of the digital distribution market in North America is the presence of leading players in the region. Analyzing game sales in the United States by distribution type in 2009–2017 (Figure 2), it can be noticed that digital distribution is replacing the sale of boxed versions of games in this market. It is anticipated that by 2025, sales of games in the US will be made only through the digital channel.

In Asia-Pacific, the prominent countries contributing to the growth of the digital distribution market are South Korea, China, Japan, India, and Singapore. The digital distribution market in the region is primarily driven by the considerable growth of small and medium-sized enterprises due to the rise in industrialization. Furthermore, the increased use of smartphones is another key driver of the digital distribution

market there. Digital distribution organizations are focusing on emerging economies such as Bangladesh, India, China, Thailand, and Malaysia. These countries hold the maximum potential to adopt advanced technologies due to increasing industrialization (*Digital Distribution Market*... https://www.transparencymarketresearch.com/digital-distribution-market.html) (accessed: 31.12.2020).

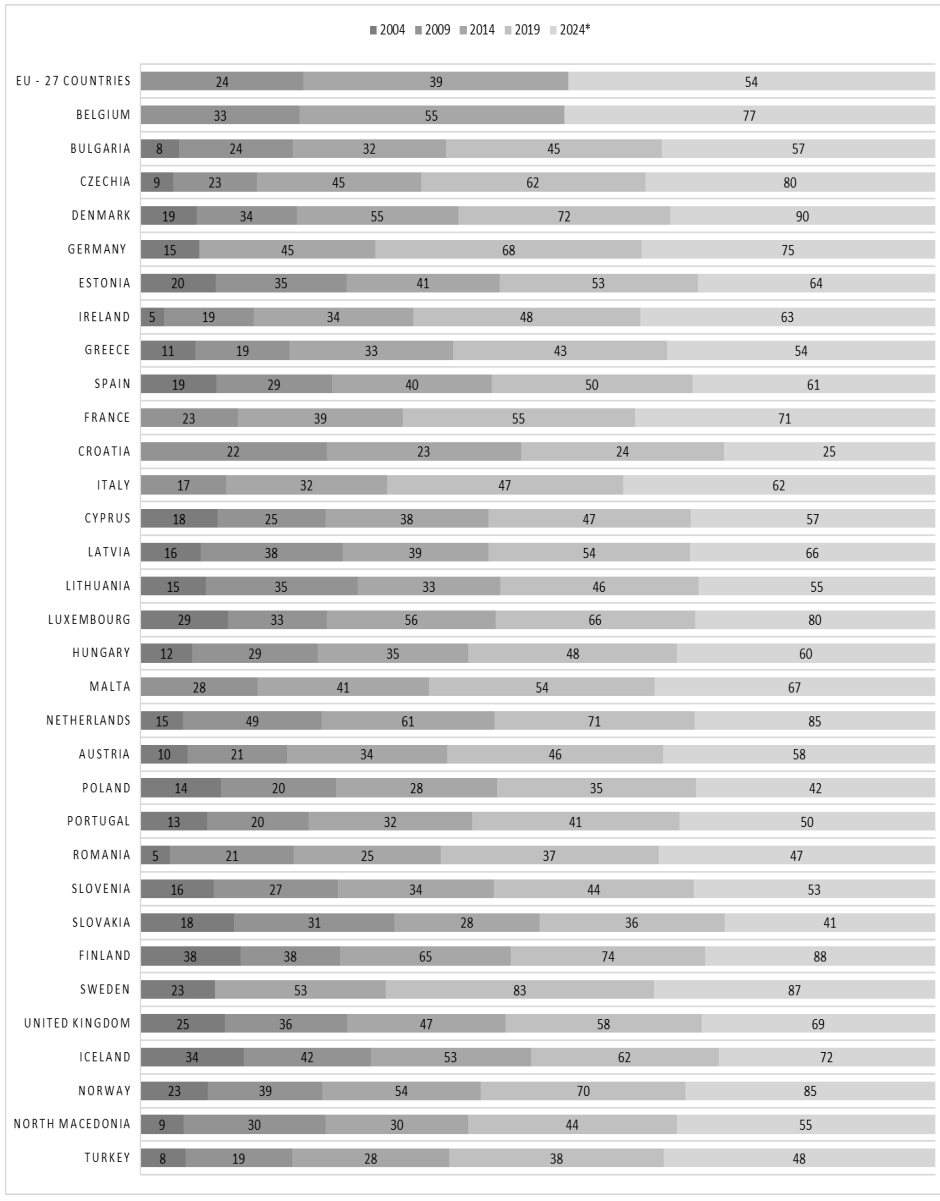
In 2014, half of all Europeans (50%) ordered goods and services online, and 16% bought content online. The most frequently purchased digital goods and services for private use were tourist and holiday accommodation (27%), tickets for events (20%), and books, magazines, and newspapers (including e-books) (19%). Meanwhile, 14% of individuals purchased films and music over the Internet, and 9% had downloaded or accessed music or films online (Eurostat Survey). The development of digital distribution in European countries is shown in Figure 3.

Currently, Scandinavian countries are in the lead in the sale of digital products in the European arena: Denmark is in first place, followed by Finland, Sweden, and Norway. Croatia is characterized by the lowest growth dynamics. According to forecasts, by 2024, at least half of Europeans will be buying digital products.

In 2019, 64% of people in Europe used the Internet to collect information about goods and services, and 52% read newspapers and magazines online, thus paving the way for new ways of consumption. When it comes to online content consumption, 38% of people played or downloaded games, images, movies, or music, often for free (Eurostat, n.d.). The percentage of people using the Internet to play or download games, pictures, movies, or music in 2019 is shown in Figure 4.

The countries that dominate when it comes to the percentage of people using the Internet to play or download games, pictures, movies, or music are the Scandinavian countries. On the other end of the scale are the countries of the Mediterranean and Central and Eastern Europe.

The drive for digital distribution is a natural corollary of technological progress. Digital distribution is gaining more popularity and shows that packaging box and the paper manual are not something that the consumer must necessarily have. A lower price, however, is sufficient to induce the customer to abandon the traditional format for one that will only be available on their computer's hard drive. Traditional distribution used to be a cheap and simple method of delivering a product to the buyer. Unfortunately, it is no longer the cheapest or the most convenient solution.



* Forecast values.

Figure 3. The development of digital distribution in European countries in 2004, 2009, 2014, 2019, and 2024 (data as a percentage)
Source: Eurostat, n.d.

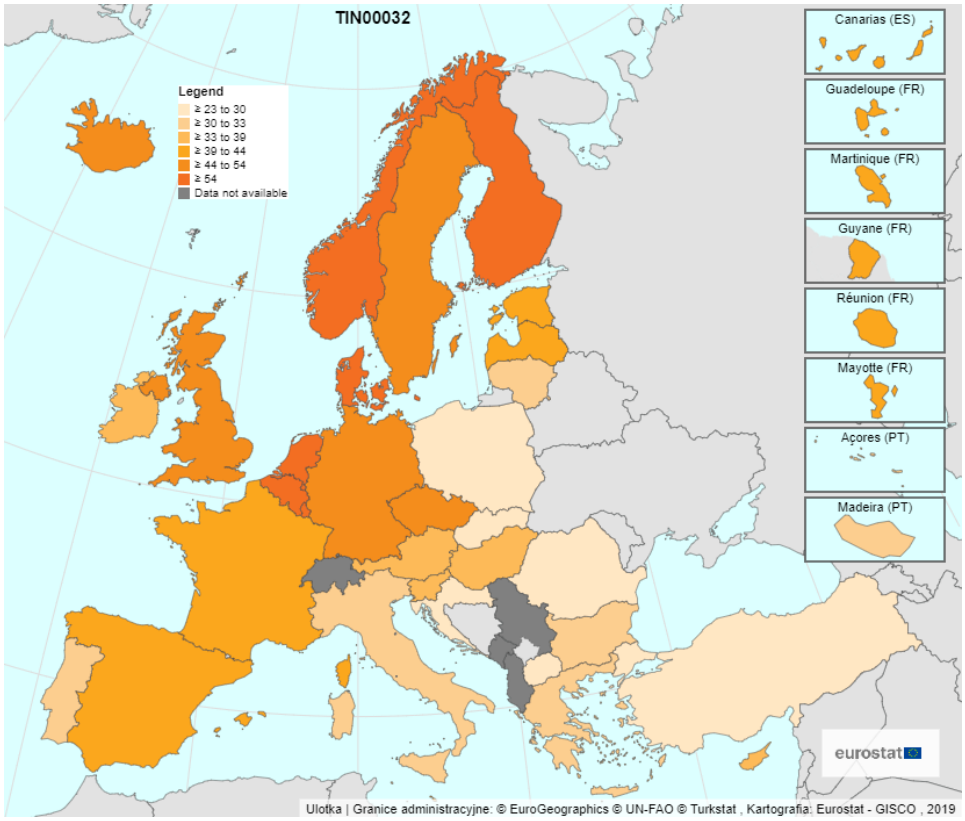


Figure 4. The percentage of people using the Internet to play or download games, pictures, movies, or music in 2019
Source: Eurostat, n.d.

Conclusion

The ICT sector, as the generator of new technologies that are applicable across a wide range of other sectors, and the provision of high-speed Internet, have led to the increased digitization of manufacturing and content delivery, the exploitation of platforms for eCommerce, and the need for new skills. At the same time, the way the Internet is used not only by businesses, but also by consumers, has also changed, raising questions about trust, security, and the protection of personal data.

It has to be borne in mind that each of these themes should be looked at from the perspective of both the suppliers of technology and infrastructure and the consumers (i.e., how it is used), be it individual users, enterprises, or public authorities.

The expansion of online distribution has sparked controversy over traditional business models and brought challenges and new opportunities for traditional retailers

and publishers. Online distribution affects all traditional media markets, including music, the press, and broadcasting.

However, in the context of a Digital Single Market, it is not sufficient to assess the extent to which Internet users consume content online. It is also necessary to monitor where that content is obtained from, whether it is obtained legally, and whether there are obstacles preventing users from obtaining their desired content (in particular, obstacles related to geographical restrictions).

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Dystrybucja cyfrowa jako kanał sprzedaży w handlu elektronicznym

W ciągu dziesięcioleci technologie cyfrowe zmieniły sposób, w jaki komunikujemy się z innymi, prowadzimy interesy, wytwarzamy towary i usługi, a także sposób, w jaki żyjemy, pracujemy i spędzamy wolny czas. Te, często szybkie, zmiany są obiecujące na przyszłość, jeśli chodzi o tworzenie bogactwa, postęp technologiczny i poprawę jakości życia. Jednocześnie niosą ze sobą wyzwania związane z brakiem umiejętności, nowymi i szybko rozwijającymi się rynkami, ochroną konsumentów, reorganizacją przemysłu, zaufaniem, bezpieczeństwem i prywatnością.
Prywatne życie społeczeństwa, a także świat biznesu przeniósł się do świata wirtualnego. Transformacja do e-biznesu jest złożona i aby odnieść sukces, należy zachować równowagę między strategią, dostosowanym modelem biznesowym, odpowiednimi procesami i stosowaną technologią.
Celem publikacji jest zapoznanie czytelnika z zagadnieniami określanymi jako dystrybucja cyfrowa, rozumiana jako sposób zarządzania treścią, np. oprogramowanie, filmy, muzyka czy gry komputerowe. Jest to łatwy sposób na dodawanie dodatków do innych produktów, lepiej znanych jako DLC, które można pobrać z globalnej sieci. To są zagadnienia, z jakimi radzi sobie cyfrowa dystrybucja, wraz z następującymi po niej procesami, które pozwalają na dostarczenie zamówionego towaru do klienta. Przedstawiono także dane dotyczące rozwoju dystrybucji cyfrowej na świecie i w Europie na przestrzeni ostatnich 20 lat.

Słowa kluczowe: dystrybucja cyfrowa, e-commerce, kanał sprzedaży, produkt cyfrowy

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The COVID–19 Pandemic's Impact on the Social Economy in European Countries

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Abstract

Since the outbreak of the COVID–19 pandemic, there have been 1 billion identified cases and more than 2 million deaths around the world. The current global problem of the pandemic, with the introduction of unpopular measures such as border closures and total quarantine, revealed a dilemma between economic growth and maintaining human health and intensifying traditional global problems such as hunger, poverty, and social inequality to new levels. Even countries with social economic models were confronted with the negative effects of the pandemic. The aim of the article is to examine the developmentof social economy model factors (Liberal, Continental, Scandinavian, Mediterranean, and Transitive) during a pandemic. The objects of study arecountries thatare centers of social economy models (Belarus, Slovakia, Ireland, Sweden, and Poland). The research method is factor modeling of global and national (local) social factors thathaddifferent consequences of the pandemic in the countries. Countries with different social economy models can use the results and recommendations to develop social policy to counter the pandemic.

Keywords: social economy models, health care, global and local social factors, pandemic, factor analysis, factor loading

JEL: A13, B55, C50

Introduction

The COVID–19 pandemic has become critically relevant to human civilization. It has intensified traditional social problems at a qualitatively new level. Non-traditional forms of employment, flexible working hours, and remote work and study have become increasingly important since the outbreak of the COVID–19 pandemic. They all have the following determinants:mobility (spatial, between activities, temporal); flexibility (schedule, workplace, etc.); informatization and technologization; virtual interaction with employers and colleagues; the lack of a stationary workplace; the possibility to work in another country. Although the closure of borders reduced migration and reoriented migration in the labor market, the share of people who are remotely employed is constantly growing.

In the first wave of the pandemic, each country responded to the epidemiological situation in its own way, and only the European Union proposed a number of consolidated initiatives and measures, such as public monetary support and targeted financial and economic support for small and medium-sized businesses. For transitive economies, the worst-case scenario was projected, which envisaged reduced salaries and company closures, staff dismissals, increases in accounts payable, and decreased-purchasing power (Halasiuk 2020).

At present, the latest trend of the post-pandemic development has increased both global opportunities and threats. On the one hand, quarantine measures have led to significant economic losses, bankruptcies, and rising private sector debt. On the other hand, there will be perspectives of a major redistribution of health budgets, medical science and, reducing the mobility of the labor market.

In 2020–2021, a significant economic recession was predicted for all countries of the world community, especially for the countries of the European Union with 8% decline of GDP. Only China's economy will grow, as the COVID–19 pandemic began there, and it remains ahead of the wave of the disease. The pandemic will affect regional social differentiation between countries. Although some world economists forecast economic growth in 2021, there are still pessimistic scenarios for the second, third wave of COVID–19 in 2021. Global GDP will reach its pre-pandemic levelno earlier than 2022 (The Economist Intelligence Unit 2020).

All the above pandemic trends will affect competitiveness at the national and global levels, small business development (Schmitz 1995), the functioning of the capital market, the quality of life, employment and its different forms, and health and education, socialization.

Literature review

The social economy models (Liberal, Continental, Scandinavian, Mediterranean, and Transitive) and thei countries, that present them, have been studied by Esping-Andersen (1990), Sapir (2005), Halushka (2009), Stukalo and Simakhova (2018), and Baltgailis (2019). They identified the main peculiarities, trends, and characteristics of the development of the social economy models.

Different aspects of the impact of the COVID–19 pandemic on the social economy and social sphere indifferent countries have been studied by Vanini (2020), Williams and Kayaoglu (2020), Abodunrin, Oloye, and Adesola (2020), Stukalo and Simakhova (2020), and Bai et al. (2020). They investigated the impacts of Coronavirus on national, regional, and global economies, social politics, and the protection of the population during apandemic. The pandemic has shown "how quickly we can make lifestyle changes" (Schwab and Malleret 2020). Under such conditions, it is important to describe what factors in the development of social economics led to different results in countries that present different social economy models during the pandemic and to formulate predictedtrajectories to mitigate the adverse effects of COVID–19. This determined the relevance of the chosen topic for research.

Aims

The aim of the article is to research the development factors of each social economy model (Liberal, Continental, Scandinavian, Mediterranean, and Transitive) during the pandemic.

Methods

The main research method is factor modeling of global and national factors. Factor analysis will increase the objectivity of the multi-criteria assessment and determine a set of factors that are different but that comprehensively characterize the state of socio-economic development.

According to previous research, we have countries that present social economy models determined by the distances to the cluster center (Stukalo and Simakhova 2018):

- Belarus (Transitive social economy model);
- Slovakia (Mediterranean social economy model);
- Ireland, Poland (Liberal and Continental social economy models);
- Sweden (Scandinavian social economy model).

Thus, countries of Western, Eastern, Northern, and Central Europe, with different social economy models, have been investigated.

To present the key factors that influence the development of the social economy models, factor modeling was conducted using global and local indicators (Stukalo, Simakhova, and Baltgailis 2020): HDI (Human DevelopmentIndex); SPI (Social Progress Index); IEF (Index of Economic Freedom); GAWI (Global Age Watch Index); HPI (Happy Planet Index); Average monthly wages, USD; GDP per capita, USD; Inflation rate, %; Unemployment rate, %; Population growth, %; Migrants of the total population, %; Fertility rate per woman; Life expectancy at birth; Health care expenditures in GDP, %; Numberof doctors per 1, 000 population; State expenditures for education, % GDP; Population self-employment, % of employed population; Terrestrial and marine protected areas, % of the total territorial area.

Thus, to assess the social economy models in a pandemic, the whole range of indicators is used, which reflect not only the development of health care, but also the incomes of the population, employment, migration, demographics, etc., because the pandemic affects all aspects of life.

The use of factor analysis will increase the objectivity of multi-criteria assessment and determine a set of factors that are different but that comprehensively characterize the state of socio-economic development. The use of factor analysis in the study is necessary to scientifically substantiate the local indicators of social and economic development, which were formed in a purely informational phase of diagnosis, and to establish the existence of links between them. Suppose that the function of changing the performance indicator from the factors is given:

$$y = f(x_1, x_2, ..., x_m), \tag{1}$$

where x_j are factors (j=1, 2, …, m) and y is the performance indicator.

The values of the x_j factors are known at every n moment of time. Thus, the available values can be presented in the form of a matrix:

$$\begin{pmatrix} x_1^1, x_2^1, ..., x_m^1 \\ x_1^2, x_2^2, ..., x_m^2 \\ ..., ..., ..., ... \\ x_1^n, x_2^n, ..., x_m^n \end{pmatrix} \tag{2}$$

where x_j^i is the mean for the j-th factor at the moment of i(j=1, 2, …,m; i=1, 2, …,n).

Each row of the matrix corresponds to a vector in m-dimensional space, and the first and last rows are the initial and final reporting periods. The main purpose of factor analysis is to reduce the number of indicators (data reduction) and determine the relationships between the factors. The reduction in the number of factors occurs by identifying hidden common factors that explain the relationships between the traits or var-

iables inherent in a particular object of study. So, we will have fewerthan 18 factors. For factor modeling, the factors of Belarus will be accepted as X from X_1 to X_{18}, the factors of Slovakia – as У from $У_1$ to $У_{18}$, Ireland – as I from I_1 to I_{18}, Poland – as J from J_1 to J_{18}, and Sweden – as G from G_1 to G_{18}.

Results

The factor analysis was conducted using the Statistica 7. 0 package. Analyzing the correlation matrices made it possible to state that the correlation coefficients for Belarus's social indicators such as X2 and X3, and X2 and X5 are high (more than 0. 85 in value), X3 and X5, X2 and X9, X3 and X9, X2 and X12, X2 and X15, X2 and X18, X3 and X15, X3 and X18, X4 and X11, X4 and X13, X4 and X14, X5 and X9, X5 and X15, X5 and X18, X6 and X7, X6 and X8, X6 and X11, X6 and X13, X6 and X14, X7 and X8, X7 and X11, X7 and X14, X8 and X11, X8 and X14, X9 and X15, X9 and X18, X11 and X13, X11 and X14, X8 and X13, X13 and X14, and X15 and X18. However, high correlation coefficients have both positive and negative values. Factors such as X1, X10, X16, and X17 do not have a high correlation with other social indicators of Belarus' development. Most correlated with other indicators – i. e., X2, X11, X14 (6 pairs of high correlation indicators).

For Slovakia, the pair correlation coefficients for the following social indicators are high in value: U1 and U4, U1 and U5, U1 and U7, U1 and U8, U1 and U9, U1 and U11, U1 and U14, U1 and U16, U1 and U18, U2 and U10, U3 and U6, U3 and U10, U3 and U15, U4 and U5, U4 and U7, U4 and U8, U4 and U11, U4 and U12, U4 and U14, U4 and U16, U4 and U18, U5 and U7, U5 and U9, U5 and U11, U5 and U11, U5 and U14, U5 and U16, U5 and U18, U6 and U10, U6 and U15, U7 and U9, U7 and U10, U7 and U11, U7 and U14, U7 and U15, U7 and U16, U7 and U18, U8 and U12, U9 and U10, U9 and U11, U9 and U14, U9 and U15, U9 and U16, U9 and U18, U10 and U15, U11 and U14, U11 and U16, U11 and U18, U14 and U16, U14 and U18, and U16 and U18. As with Belarus, the value of the pairwise correlation between the social development indicators in Slovakia was both positive and negative. Only two indicators – U13 and U17 – do not have a high pair correlation with other indicators.

For Ireland, all social indicators are closely correlated with each other. There is no indicator that is not closely related to another indicator. The highest pairwise correlation coefficients in terms of value, both positive and negative, are for indicators: I1 and I4, I1 and I8, I1 and I10, I1 and I12, I1 and I13, I1 and I16, I2 and I5, I2 and I6, I2 and I7, I2 and I9, I2 and I10, I2 and I15, I2 and I17, I3 and I17, I4 and I7, I4 and I8, I4 and I9, I4 and I10, I4 and I12, I4 and I13, I4 and I16, I5 and I6, I5 and I9, I5 and I10, I5 and I15, I5 and I17, I6 and I7, I6 and I8, I6 and I9, I6 and I10, I6 and I11, I6 and I13, I6 and I14, I6 and I15, I6 and I17, I6 and I18, I7 and I8, I7 and I9, I7 and I10, I7 and I11, I7 and I13, I7 and I14, I7 and I18, I8 and I9, I8 and I10, I8 and I11, I8 and I13, I8 and I14, I8 and I18, I9 and I10, I9 and I11, I9 and I13, I9 and I14, I9 and I15,

I9 and I17, I9 and I18, I10 and I11, I10 and I13, I10 and I14, I10 and I15, I10 and I17, I10 and I18, I11 and I13, I11 and I14, I11 and I18, I12 and I13, I12 and I16, I13 and I14, I13 and I16, I13 and I18, I14 and I18, and I15 and I17.

The correlation coefficients for Poland's social indicators such as J1 and J4, J2 and J5, J11, J12, J17, J7 and J9, J13 and J15, J3 and J17, J5 and J11, J5 and J13, J8 and J11, J13 and J18, and J15 and J18 are high (more than 0. 94 in value). However, high correlation coefficients have both positive and negative values. Factors such as J6, J10, and J16 do not have a high correlation with Poland's social development indicators. Indicators J2 and J11correlated most with other indicators (4 and 3 pairs of high correlation indicators, respectively).

In Sweden, twosocial indicators do not have a high pair correlation with other indicators – G7 and G12. The highest pairwise correlation coefficients in terms of value, both positive and negative, are for the following: G1 and G2, G1 and G4, G1 and G6, G1 and G9, G1 and G11, G1 and G14, G1 and G16, G1 and G17, G2 and G13, G3 and G5, G3 and G8, G3 and G10, G3 and G15, G3 and G18, G4 and G6, G4 and G9, G4 and G11, G4 and G14, G4 and G16, G4 and G17, G5 and G8, G5 and G9, G5 and G10, G5 and G15, G5 and G17, G5 and G18, G6 and G9, G6 and G10, G6 and G11, G6 and G14, G6 and G16, G6 and G17, G8 and G15, G8 and G18, G9 and G10, G9 and G11, G9 and G14, G9 and G15, G9 and G16, G9 and G17, G9 and G18, G10 and G15, G10 and G17, G10 and G18, G11 and G14, G11 and G16, G11 and G17, G14 and G16, G15 and G17, G15 and G18, and G17 and G18.

Looking atthe results of the correlation matrices for five countries, we can see that the unemployment rate for three out of the five is highly correlated with other indicators. All data obtained as a result of the pairwise correlation will be taken into account in further factor modeling of social indicators by cluster centers.

According to the rules of factor analysis, for further research, only those factors that explain at least 75% of the total variance are taken into account. Thus, these factors of social economy development have the greatest impact on the dynamics of social model development. To confirm this hypothesis, we used two methods to determine the number of necessary factors: the Kaiser criterion and the "stone shift"criterion.

According to the Kaiser criterion, only factors with eigenvalues that are more than 1 are selected, i. e., if the factor does not select a variance equivalent to at least the variance of one variable, it is omitted (Khalafian 2007). According to the calculations based on this criterion, three factors can be identified for the development of the social economy for Belarus, Slovakia, and Sweden, and two for Ireland and Poland. Other factors do not fall under the criterion applied to the eigenvalues.

The "stone shift" criterion is a graphical method first proposed by Kettell (Khalafian 2007). To apply this criterion, we need to display the eigenvalues presented in Table 1 in the form of a graph. Kettel suggested finding a place on the graph where the decline in eigenvalues from left to right is slowed down as much as possible. It is assumed that to the right of this point, there is only a "factorial shift". We will use the graphical cri-

terion of "stone shift" to determine the main components of social economy model development in Belarus, Slovakia, Sweden, Poland and Ireland (see Figs. 1–5).

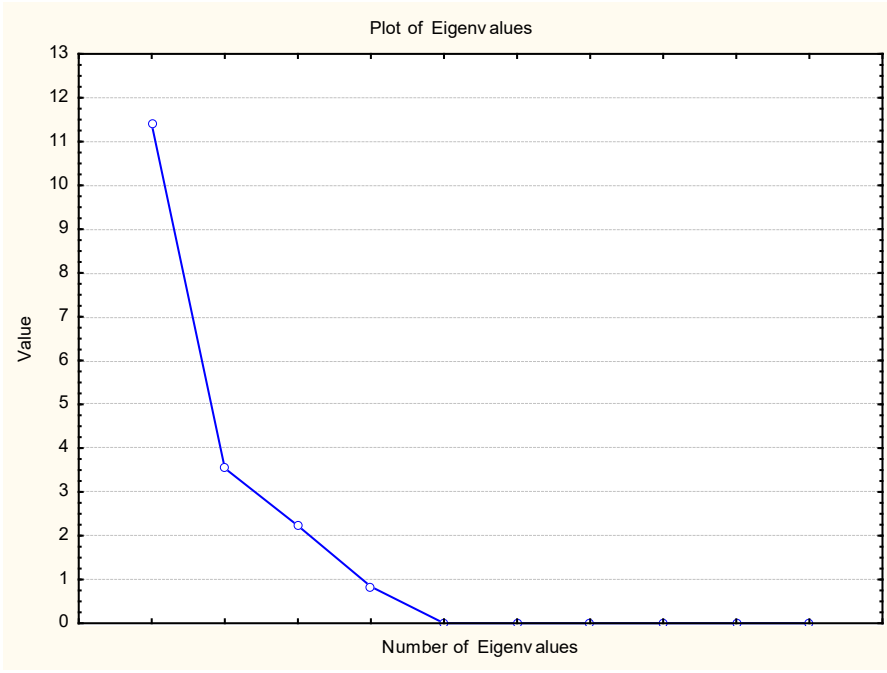

Figure 1. Eigenvalues of the main components for Belarus
Source: authors' calculation.

Using the graphical method of "stone shift", we can visually estimate the number of required principal components on the graph, on the abscissa of which arethe numbers of eigenvalues of the correlation matrix, and on the y-axis – the corresponding eigenvalues. Thus, for Belarus, according to Figure 1., it is necessary to allocate threemain components (Factors) as, after three drops, the schedule slows down. Therefore, according to both the Kaiser and "stone shift" criteria, three main factors should be distinguished for Belarus.

For Slovakia, according to Figure 2, it is also necessary to distinguish three factors of social economy model development.

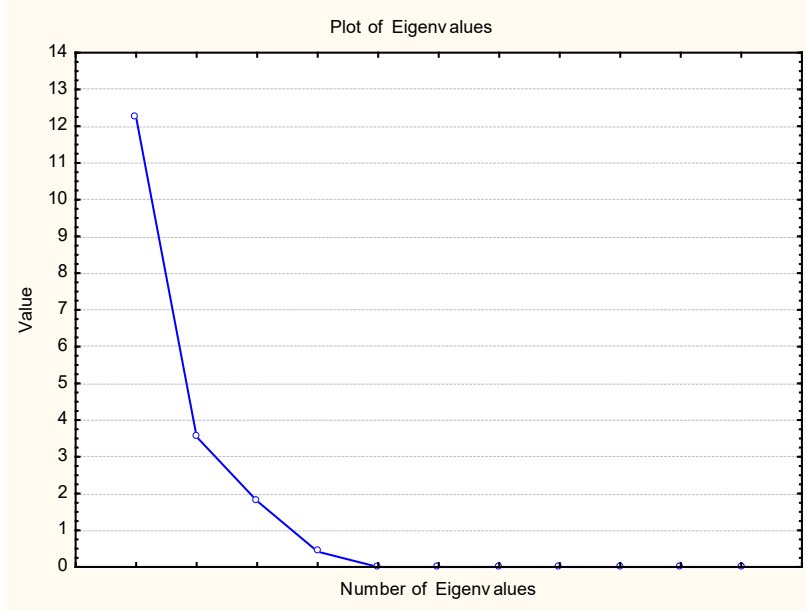

Figure 2. Eigenvalues of the main components for Slovakia
Source: authors' calculation.

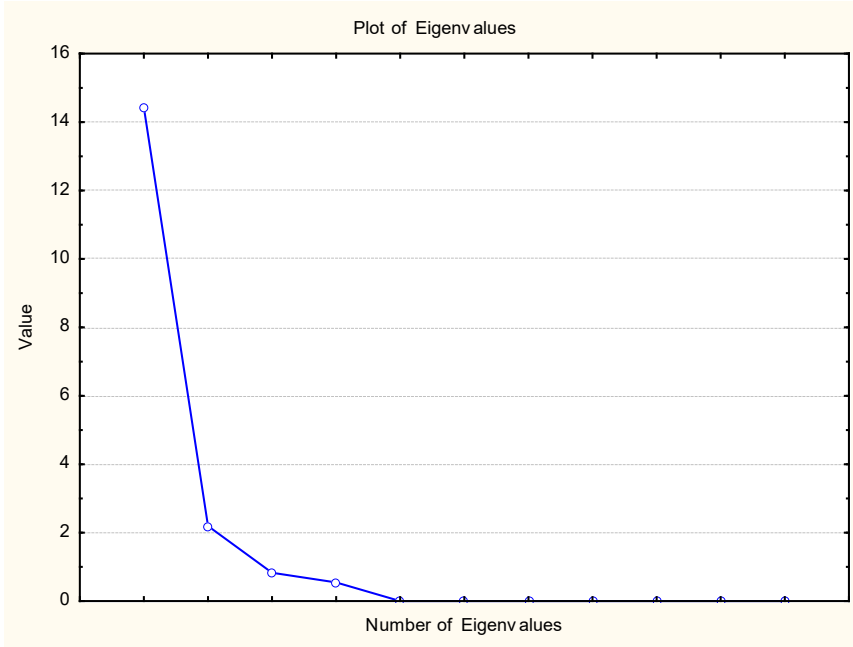

Figure 3. Eigenvalues of the main components for Ireland
Source: authors' calculation.

For Ireland, the graph of eigenvalues confirmed the need to identify two factors of social economy model development (Figure 3). The same is true for Poland (Fig. 4).

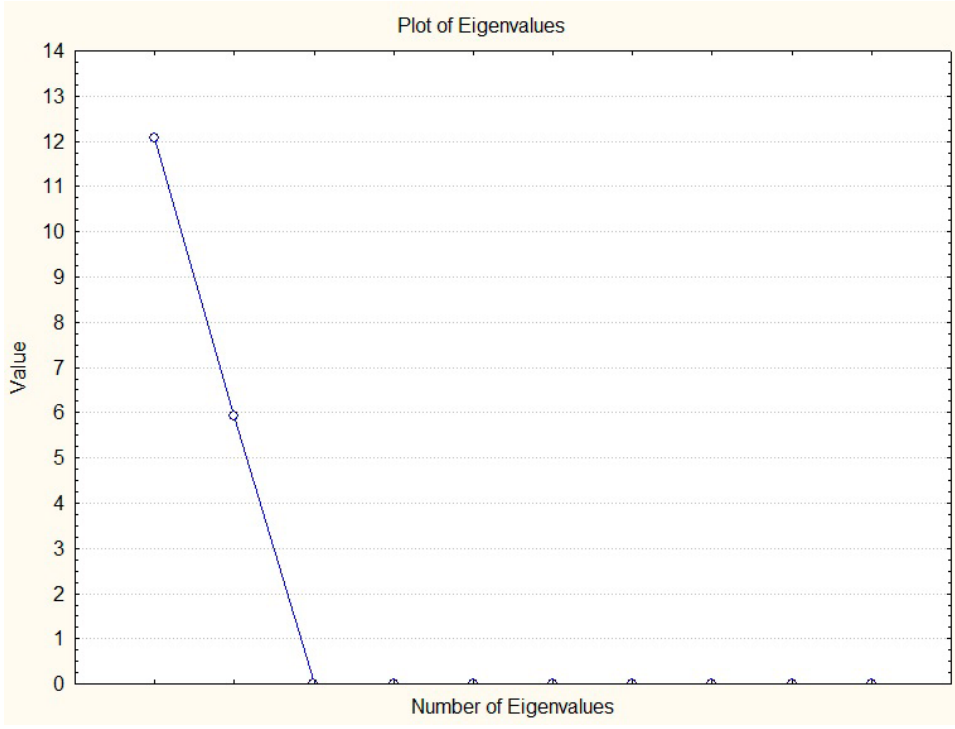

Figure 4. Eigenvalues of the main components for Poland
Source: authors' calculation.

Based on the data in Figure 5, it can be argued that the slowdown starts from 2 points, so according to the "stone shift" criterion, it is advisable to select two factors of social economy model development for Sweden.

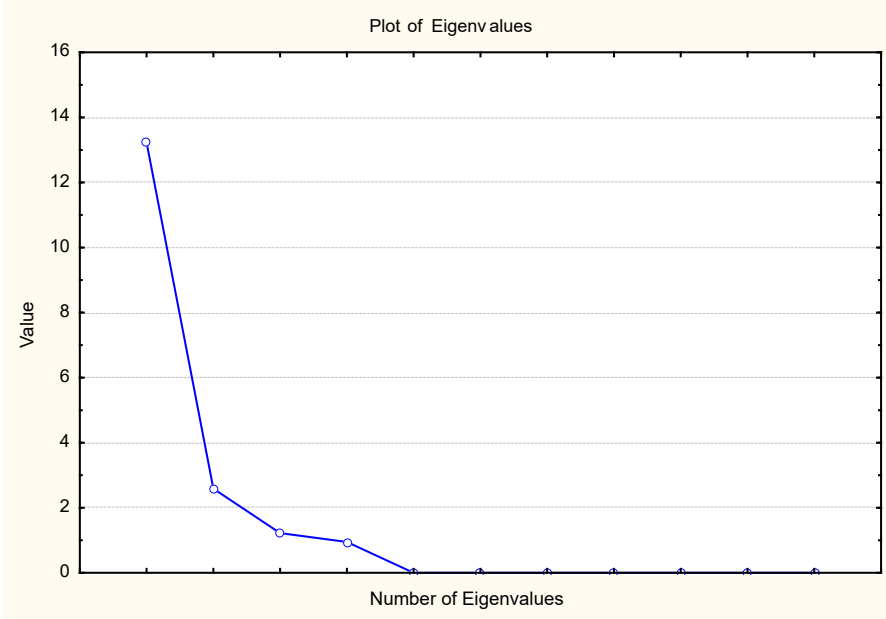

Figure 5. Eigenvalues of the main components for Sweden
Source: authors' calculation.

Now we will consider the graphical representations of the factor loadings of the primary features of the social economy model development factors, which are obtained by performing factor analysis with rotation, as well as the main components for Belarus, Slovakia, Ireland, Poland and Sweden (Figs. 6–10).

In Figure 6, for Belarus, the first factor characterizes the general state of social development, the second describes the base of economic socialization, whilethe third factor can be interpreted as the potential of the population for self-reliance and self-realization.

In Figure 7, for Slovakia, the first factor characterizes the general state of social development, the second shows the economic socialization potential, while the third describes the demographic situation.

In Figure 8, for Ireland, the first factor characterizes the general state of social development, while the second describes the demographic situation.

In Figure 9, for Poland, the first factor characterizes the general state of social development, while the second describes the potential of economic socialization.

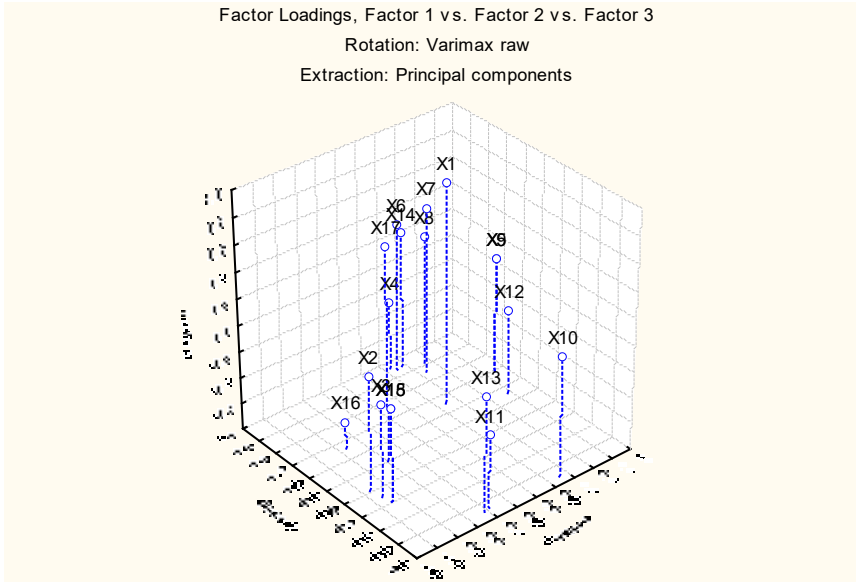

Figure 6. Factor loading for Belarus' social model development factors
Source: author's calculation from Barry, McGwire, and Porter (2015), NEF (2016), *Index of Economic Freedom* (2019), OECD (2019), *Social Progress Index* (2019), UNDP (2019), WHO (2019), World Bank (2019).

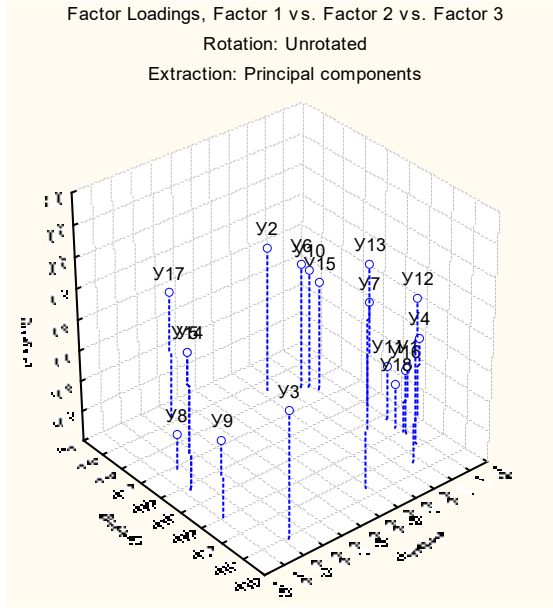

Figure 7. Factor loading for Slovakia's social model development factors
Source: author's calculation from Barry, McGwire, and Porter (2015), NEF (2016), *Index of Economic Freedom* (2019), OECD (2019), *Social Progress Index* (2019), UNDP (2019), WHO (2019), World Bank (2019).

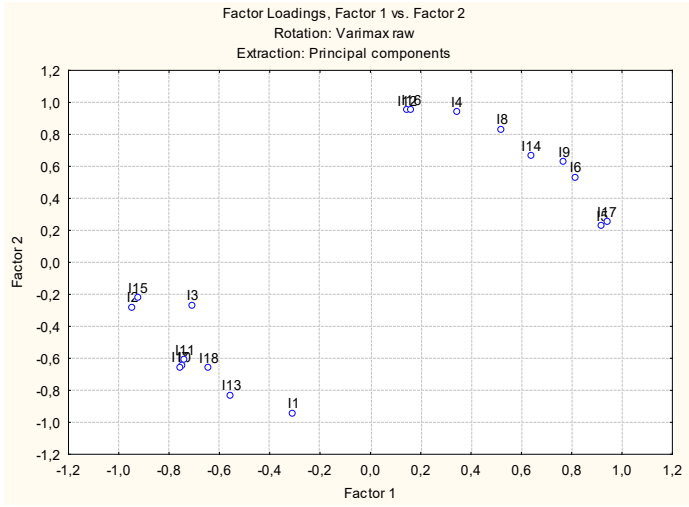

Figure 8. Factor loading for Ireland's social model development factors
Source: author's calculation from Barry, McGwire, and Porter (2015), NEF (2016), *Index of Economic Freedom* (2019), OECD (2019), *Social Progress Index* (2019), UNDP (2019), WHO (2019), World Bank (2019).

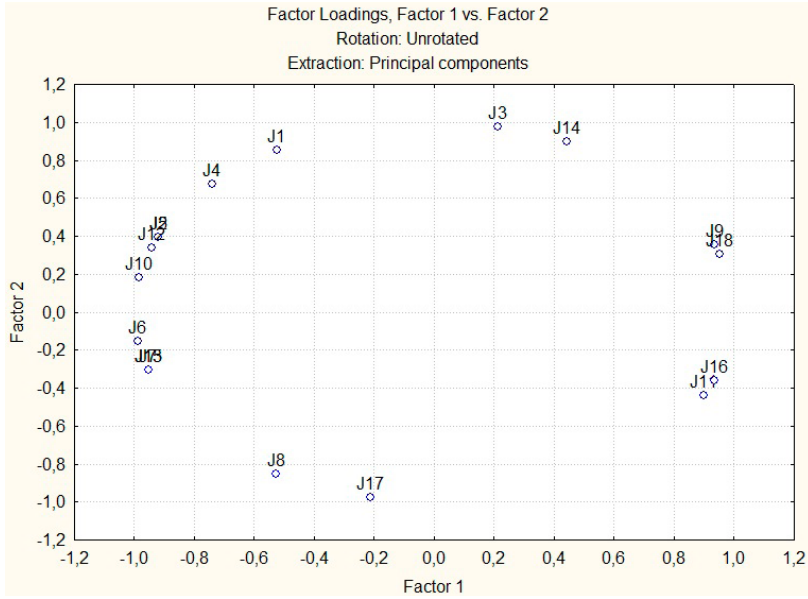

Figure 9. Factor loading for Poland's social model development factors
Source: author's calculation from Barry, McGwire, and Porter (2015), NEF (2016), *Index of Economic Freedom* (2019), OECD (2019), *Social Progress Index* (2019), UNDP (2019), WHO (2019), World Bank (2019).

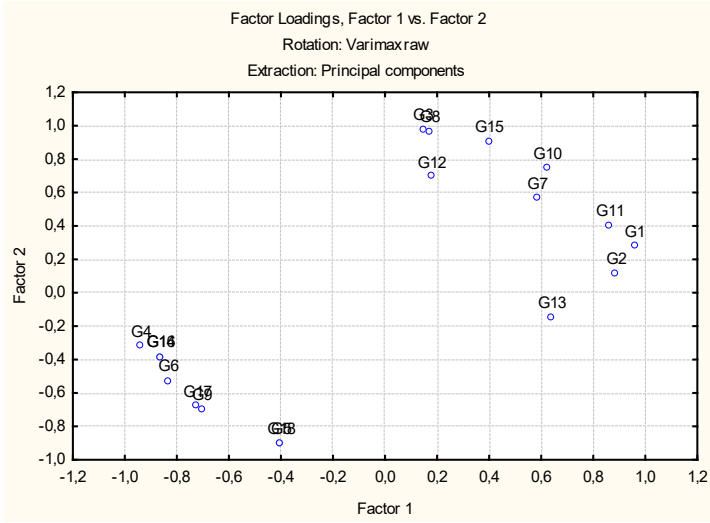

Figure 10. Factor loading for Sweden's social model development factors
Source: author's calculation from Barry, McGwire, and Porter (2015), NEF (2016), *Index of Economic Freedom* (2019), OECD (2019), *Social Progress Index* (2019), UNDP (2019), WHO (2019), World Bank (2019).

As can be seen from Figure 10, for Sweden, the first factor shows the general state of social development, while the second describes the base of economic socialization.

The study showed that all the social economy models had factors that characterize the state of health care. In Ireland, the indicator for health care spending in GDP was not part of any of the factors, indicating that the country was not ready for the challenges of the pandemic.

The calculations of coronavirus cases given in Table 1 show that the lowest mortality rate of 0. 77% was recorded in Belarus, a country with a transitive social economy model. In general, all countries with social economic models have low mortality from Coronavirus – up to 2. 7% (for Central European countries). The highest recovery rate (96. 5%) is in Sweden, with the Scandinavian social economy model. In Slovakia, 85. 1% of coronavirus patients have recovered, confirming the need to increase funding for medicine in this Central European country with a Mediterranean social economy model.

Table 1. Coronavirus cases

	Total Cases	Total Deaths	% of cases	Total Recovered	% of cases
Belarus	573,943	4,417	0.77	546,415	95.2
Slovakia	473,938	12,854	2.7	403,414	85.1
Ireland	416,690	5,306	1.27	368,837	88.5

	Total Cases	Total Deaths	% of cases	Total Recovered	% of cases
Poland	2,941,126	76,115	2.6	2,677,537	91.0
Sweden	1,161,933	14,916	1.3	1,120,852	96.5

Source: by the author from Worldometer, 2021.

Conclusion

In a pandemic, the health system must fully mobilize and transform public funding for the sector. It is important to coordinate the country's socio-economic policies along with the post-pandemic development because the restrictive quarantine measures in 2021 are expected to significantly reduce GDP, increase inflation, increase unemployment, curtail social programs not directly related to the pandemic, drop exchange rates, reduce output, and bankrupt businesses. According to Klaus Schwab, founder and Executive Chairman of the World Economic Forum, the post-pandemic world will be marked, "Global corporate citizenship means that companies must not only work with stakeholders, but be stakeholders themselves, alongside governments and civil society. Since corporations depend on global development, which inturndepends on stability and increased prosperity, it is in their direct interest to help improve the state of the world" (Schwab and Malleret 2020). Global corporate citizenship extends the concepts of corporate social responsibility and corporate governance in the context of a globalized economy and global markets.

The post-pandemic development for European countries is likely to be characterized by the following features:

- the major redistribution of markets for goods, services, intellectual property, and capital between companies in favor of those who are less creditworthy, have free capital for the profitable acquisition of new assets;
- deepening social inequality between and within the country;
- increasing the role and extent of government intervention in socio-economic processes;
- deepening the impact of the negative consequences of global problems and challenges for countries with transition economies and developing countries.

Given the significant future negative consequences of the pandemic for the social sphere of countries, it is vital to choose an anti-pandemic behavior that combines strict control over COVID–19 and the conditions for possible socioeconomic stability while strengthening the potential of the country's health system.

Thus, the projected trajectories of the development of the social-economic models that take into account the COVID–19 pandemic:

- focus on ensuring the socialization of the economy and creating conditions for self-employment and human capital development;
- encourage the development of non-traditional forms of employment.

For countries of Central Europe, the main propositions in the post-pandemic period are:

- health care reform;
- increasing spending on medicine;
- diversifying sources of financing for the social sector (medicine, etc.).

Among the directions for further scientific research is the study of mechanisms for the additional financing of the health care system for social-economic models.

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Wpływ pandemii COVID–19 na gospodarkę społeczną w krajach europejskich

Od wybuchu pandemii COVID–19 na całym świecie odnotowano 1 miliard zidentyfikowanych przypadków i ponad 2 miliony zgonów. Obecny globalny problem pandemii, wraz z wprowadzeniem niepopularnych środków, takich jak zamknięcie granic i całkowita kwarantanna, ujawnił konflikt istniejący między wzrostem gospodarczym, utrzymaniem zdrowia ludzi oraz nasileniem tradycyjnych problemów globalnych, takich jak głód, ubóstwo i nierówności społeczne. Z negatywnymi skutkami pandemii zderzyły się nawet kraje oparte o model gospodarki społecznej. Celem artykułu jest

zbadanie czynników rozwoju modelu gospodarki społecznej (liberalnego, kontynentalnego, skandynawskiego, śródziemnomorskiego i przejściowego) w czasie pandemii. Przedmiotem badań są kraje wykorzystujące model ekonomii społecznej (Białoruś, Słowacja, Irlandia, Szwecja i Polska). Zastosowana metoda badawcza to modelowanie czynnikowe globalnych i krajowych (lokalnych) czynników społecznych, które wywołały różne konsekwencje pandemii w poszczególnych krajach. Kraje o różnych modelach ekonomii społecznej mogą wykorzystać prezentowane wyniki i zalecenia do opracowania polityki społecznej służącej przeciwdziałaniu pandemii.

Słowa kluczowe: modele ekonomii społecznej, ochrona zdrowia, globalne i lokalne czynniki społeczne, pandemia, analiza czynnikowa, ładunek czynnikowy

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Selected Logistics Development Level Indicators – a Review and Comparative Analysis in European Union Countries

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Abstract

The logistics industry today is well developed. The efficient movement of goods, people, and information is a crucial link in each supply chain and the entire logistics system. For systems to function effectively, they must be properly assessed, compared, and analyzed. Therefore, there are many different indicators, both simple and complex. The purpose of this article is to review these indicators and conduct a comparative analysis for a selected indicator, the LPI (Logistics Performance Index), which measures logistics performance. The subjects of the study are European Union countries. Multivariate comparative analysis was used for the study.

Keywords: logistics system, logistic indicators, Logistics Performance Index, multivariate comparative analysis

JEL: L91, M20, O18

Introduction

Globalization and growing competition have a huge impact on the growing importance of logistics in the economic structure. Influential logistics services promote product mobility, ensure product safety and velocity, and help achievecost reduction when trading between nations. Logistics processes in the economy are vital for transport, storage, and other logistics operations. They may also be a part of competitiveness. Efficient logistics generate lower costs and make it possible to achieve higher additional effects.

Logistics is an activity that manages the flow of goods, money, and information between the points of delivery and demand, which include activities suchas transport, storage, packaging, and material handling. Logistics systems provide appropriate solutions to problems related to transport and storage, and in general, they increase the competitiveness of the company's and country's economy (Navickas, Sujeta, and Vojtovich 2011).

Within an enterprise,the efficiency of logistics activities may be verified using various indicators. Countries may use the Logistics Performance Index (LPI) to evaluate performance. On this basis, the strengths and weaknesses of an individual or area may be assessed to determine the direction of further development and improve the situation.

This article focuses on the possibilities of describing and assessing the development of logistics systems using various types of quantitative indicators. The subject of the article is areview of indicators and an assessment of the development of the logistics system. The logistics system has been characterized by six diagnostic features that are components of the LPI. The article aims to review logistic indicators and classify and group European Union (EU) countries in terms of the development of their logistics system. To achieve this, multidimensional comparative analysis, cluster analysis (a model-less method), and a taxonomic measure of development (a model method) were used.

Logistic systems – characteristics, classification, and types

Thinking in terms of systems is extremely important in logistics. The system concept itself is intended to show that the whole is more than the sum of its parts. On the other hand, knowledge of the whole comes before knowledge of the component parts (which create the whole). The guiding principle of systems theory is a holistic approach to reality. In this context, three basic research trends may be distinguished (Nowakowski 2011, pp. 37–38):

- philosophical and methodical,
- axiomatic and formal,
- analytical and systemic.

The systems approach may be characterized by features (Nowakowski 2011, p. 38):

- from part to its entirety, taking into account the role of the parts as a whole,
- from the structure of the system to the processes taking place within it,
- from objective (absolute) to epistemic science, which means being dependent on the reference system,
- from the concept of science as a "building" to the concept of a "network" as a scientific metaphor,
- from certain to approximate knowledge, which is the next step in the approximation of reality,

– from a linear model of cognition and implementation (basic sciences – applied sciences – development works – new technologies (process and products)) to a network model of interaction of each level with everyone,
– from absolute truth to contextual statements.

The system may be defined as:

– a set of elements thatare mutually related (Pfohl 1998, p. 27),
– an internally coordinated system of components that has a defined operating structure (for example, a production system composed of different machines),
– a set of methods of operation, performing complex activities (for example, a system for designing vehicle elements),
– a set of organization rules, norms, and standards in force in specified fields (for example, the company's financial system),
– a holistic and ordered set of tasks related to each other by specific and logical relations (in this context, any methodologically correct theory that concerns a sufficiently extensive fragment of reality is a system) (Nowakowski 2011, pp. 38–39).

Thinking in terms of the system is a comprehensive way of considering issues. There is an awareness that in order to explain the whole, it is not enough to explain the elements, but also the dependencies between them (Odlanicka-Poczobutt 2008, p. 71).

Logistic problems should be solved comprehensively; therefore, it is essential to take into account a series of actions (Odlanicka-Poczobutt 2008, p. 71):

– searching for the causes of disruption, e.g. unplanned of stock, extending product flow time cannot be limited to only part of the system (subsystem), it must be extended to other parts of it,
– decisions related to one element of the system must take into account itsimpact on the efficiency of the system as a whole, e.g., the impact of transport on the efficiency of the system,
– solving logistics problems requires the immediate integration of temporal and spatial elements of the system.

Identifying interdependencies and synergy are the two basic elements that make it possible to consider a logistics system.They can be defined as a set of logistics elements with appropriate properties and relationships between them. To characterize alogistics system, data should be collected (Dworecki 1999, p. 144; Barcik and Jakubiec 2011, p. 76; Nowakowski 2011; p. 47):

– purpose: orientated at the operation of all subsystems,
– output: resulting from the adopted goal, the form of the system performance (products or services),
– inputs: determining the power supply of the system (materials, energy, information, people),
– transformation process (processing input to output): determined by a sequence of basic processing operations,

- close and distant environment: created by receivers, suppliers, and formal and legal regulations, etc.,
- facilities and infrastructure: which includes machines, buildings, means of transport and transport infrastructure, and IT infrastructure,
- human resources: the workforce and the structure of employees, their qualifications, material status.

There are many ways to define a logistics system. For example, for Blaik (2001, pp. 71–72), a logistics system is a multi-structure and multi-faceted problem that considers many possible components and relationships. With such a high degree of complexity, shaping alogistics system, while taking into account many points of view, is not only very difficult, but in practice, usually impossible. Nowicka-Skowron pointed out that a logistics system is a consequence of implementing a systemic concept of logistics. This is a new quality thanks to the links between the elements that create the system (Nowicka-Skowron 2000, pp. 18–19). Meanwhile, according to Gołembska (2005, p. 47), a logistic system can be defined from two points of view:

- the links between elements of the system: a logistics system is a collection of subsystems such as supply, production, transport and storage, and sales, with links between subsystems and between their properties, with a constant tendency to increase the degree of organization of the system,
- the dynamics of the logistics system and the flows within it: the logistics system is deliberately organized and connected within a specific economic system; it is a physical flow of goods, with the flow of physical means and information.

Topolska and Topolski pointed to two significant consequences of the system approach in logistics. Firstly, it enables optimization involving whole-system solutions instead of sub-optimization of partial solutions. Secondly, it secures logistic decisions by taking into account synergy effects (Topolska and Topolski 2006, p. 70).

As shown in Table 1, logistics systems may be identified in various ways, depending on the degree of aggregation and the scope of the system. Classification may be distinguished by three criteria: institutional (by type and number of participants; it includes micrologistics, metalogistics, macrologistics, and international logistics systems), phase (according to the process of space-time transformation; it divides logistics into supply, production, distribution, and return; for more detail, see Grupa 2012, pp. 462–463), and functional (according to type and number of logistic activities that occur in the company, i.e., logistics processes and activities, such as transport, storage, inventory level, and structure shaping, shaping the level and structure of stocks, and packaging management (Frankowska and Jedliński 2012, p. 100; Kauf et al. 2016, pp. 32–33).

More detailed classification is presented by Szpon, Cyran-Dembińska, and Wiktorowska-Jasik (2005, p. 26), where some criteria were taken into account, including institutional, functional, structural and decision-making, object-structural, and efficiency.

Table 1. Logistics processes and activities

Process	Activities
Transport	Selecting the type of transport and the level of transport services Planning the transport network Scheduling vehicle traffic Selecting specific transport equipment Handling a complaint Controlling transport rate
Shaping the level and structure of stocks	Formulating the policy of stocks of raw materials, materials, and final products Studying short-term sales forecasts Identifying the inventory structure at storage points Identifying the quantity, size, and location of storage points
Logistics customer service	Arranging the scope of customer needs and requirements in terms of the customer service system Predicting customer reactions to the specified customer service system Setting up the final quality of the customer service level
Storage	Identifying the demand for storage space Designing inventory layout Receiving, completing, and releasing materials to and from the warehouse
Packaging management	Choosing packaging to facilitate: – loading, unloading, and reloading operations – storage processes – protection against damages

Source: Kauf et al. 2016, p. 27.

In the logistics system, apart from the physical flow system,there is an information system in which data is collected, properly processed, stored, and made available to managers, who, based on the information received, make specific logistics decisions (Świerczek 2006, p. 118). The systemic approach in logistics allowsfor many benefits, including describing and comparing differences in the logistics systems, taking into account interdependencies, explaining the links between logistics systems, or providing the basis for making decisions (Kauf et al. 2016, p. 34). Therefore, it is essential to perform analyses using various indicators, both simple and complex, which make it possible to evaluate the logistics system as a whole (an example of a measure is LPI – the logistics performance index, which is discussed in more detailin the following part).

Selected indicators for evaluating logistics systems – examples

The many ways to consider logistics systems may influence the various ways of analyzing and comparing them and the variety of indicators that are used for this assessment. The criteria that may be assessed include costs, efficiency, quality of services, the duration of the logistics cycle, and the system's resistance to risk (Lapkouskaya 2019, p. 164). Sometimes a more extensive scope is indicated and may point to (Piechura 2016): the

complexity and dynamics of the environmental conditions, the scope and degree of homogeneity of the enterprise's operation program, the structure of the production system and technology, the structure of the distribution and inventory system, the scope and size of logistics costs, the required level of supply service, the number of logistic decisions, the number of separate logistic decision-making areas, the size of the company, the type of industry, the business culture, the quantity and quality of information, the intensity of streams of material and product streams, the degree of mutual interaction between partial logistic areas, the nature and role of logistic tasks in the function structure and tasks of the company, and the level of knowledge and awareness of the essence and assumptions of the concept of logistics among employees.

There are many measures that assess logistics systems in terms of reliability, efficiency, and flexibility. To assess reliability, one may use indicators such as the coefficient of the lack of the logistic system's ability to perform supporting tasks, indicators of logistics support flexibility, and indicators relating to the reliability of the system in terms of its ability to support tasks without interruption (Kramarz and Zaczyk 2015, pp. 33–34). A more detailed list is presented in Table 2.

Table 2. Reliability indicators of a logistics system

Definition – indicator (unit of measure)	Calculation formula
Ensuring availability of the relevant products – the volume of demand which may be realized from stocks (%)	$\frac{\text{order possibile from stock}}{\text{all orders}}$
Completeness of order fulfillment – share of complete deliveries (%)	$\frac{\text{number of complete deliveries}}{\text{all orders}}$
Delivering the product without damage – the share of deliveries without damage (%) and the share of defective deliveries (%)	$\frac{\text{number of deliveries without damage}}{\text{all orders}}$ $\frac{\text{number of incorret deliveries}}{\text{all orders}}$
Order fulfillment in terms of destination – the share of deliveries delivered to the right place (%)	$\frac{\text{number of deliveries delivered to the right place}}{\text{all orders}}$
Timely realization of the order – share of deliveries made on time in the total number of deliveries during the period (%) and the average delivery time of products (days)	$\frac{\text{number of deliveries made on time}}{\text{all orders}}$ $\frac{\text{delivery time}}{\text{all orders}}$
Accuracy of the order– share of returned deliveries (%) and the share of deliveries with complaints (%)	$\frac{\text{number of product deliveries returned}\ \text{number of product deliveries which complained}}{\text{all orders}}$
Compliance of payment documents – share of documents issued that comply with the requirements in the total number of documents (%)	$\frac{\text{number of documents issued correctly}}{\text{total number of issued documents}}$

Source: own study based on Kramarz, Zaczyk 2015, p. 34 [as quoted in:] Stajniak 2012; Gajewska 2016, pp. 1323–1324; Strojny 2017, p. 4.

To ensure a high level of services provided, IT systems may be implemented in logistics departments, facilitating decision-making based on current information. The generally used types of measures that support managing a company are KPIs (Key Performance Indicators). The basis for building an effective structure that gives access to KPIs should be sought both in the data available to the company and in the mechanisms of recording them in IT systems. KPIs are performance or efficiency indicators used as measures for assessing the process of achieving the company's goals. Properly formulated KPIs and the proper setting of goals enable efficient commercial communication with clients. The following elements are involved in the process of creating a KPI: deciding what to measure, collecting data, analyzing data, reporting results, and taking action (Gajewska 2016, p. 1324).

Importantly, building a KPI is based on the simple measures listed in Table 2. For example, when referring an indicator to a logistics system and conducting an analysis for a warehouse (objective: control), the following elements should be taken into account (Innovative Business Solutions and Cloud 2020):

- occupancy rate – shows pallet places occupied in the warehouse, rack, zone, etc.,
- stock flow rate – points out how long the stock is in the warehouse,
- inventory flow rate – shows the inbound and outbound flows to/from the warehouse in a certain period,
- indicator of orders completed/shipped on time – related to timeliness, efficiency, and quality of deliveries,
- storage employee performance indicator – goal: to determine the optimal number of employees needed to operate the warehouse; to assess this, many use the indicator of the number of orders completed per employee,
- financial indicator – shows sales every step.

Another indicator that measures the condition of the logistics system and the economy is the PMI (Purchasing Managers' Index). It is based on the analysis of monthly questionnaires. The PMI is based on the equal weights (20%) of five components: new orders, production, employment, deliveries, and inventory. The activities (indicator) may be defined as (Forex Biznes 2015):

- new orders – from customers,
- production – the rate and direction of changes in the level of production,
- employment – increase or decrease,
- deliveries – fast or slow,
- investments – increase or decrease,
- customer inventory – inventory-level indicator kept by consumer organizations,
- prices –whether someone pays more or less for services and goods,
- backlogs in orders – decrease or increase,
- new export orders – the level of export orders,
- import – measures changesin imported materials.

An indicator value above 50 points means an increase in industrial activity, and below – a decrease. For example, in 2020 in Poland, the indicator reached its lowest

value in April (31.9 percentage points), and the highest in July (52.8 p.p.) (MacroNext 2020). The increase in July was mainly due to higher production and a recovery in the number of new orders, when the growing number of new orders contributed to the volume of production.

The LPI index in the European Union countries

This chapter presents the essence and issues of the LPI and a comparative analysis of the LPI among EU countries. Multivariate comparative analysis wasused. Research on the LPI was conducted by Tundys (2011), Guner and Coskun (2012), Pitel et al. (2019), and Ulutaş and Karaköy (2019).

LPI – characteristics

The LPI is a multidimensional assessment of logistics efficiency – assessed on a scale from 1 to 5. The index is analyzed based on the results of questionnaires sent to economic units that specialize in logistics around the world (Figure 1). The research has been conducted, on average, every two years since 2007, and the results make it possible to rank the surveyed countries in terms of their logistics efficiency.

The indicator may also determine the logistics potential of the region/country and the factors that contribute to the lack of logistics obstacles. A high LPI value may directly cause economic growth, and one of the factors may be the ability to attract foreign investments. There may be doubts about the reliability ofthe LPI and whether itreflects the essence of logistics activities in individual countries. The difficulty is in examining all enterprises and receiving answers to all the questions. That is why the questionnaire is addressed to over 1,000 specialists from shipping, transport, and logistics companies, which are the main carriers and forwarders in the world, and their activities are carried out in many countries and online. The advantages of the LPI include its accuracy, completeness, and thelarge number of respondents to whom the questions are addressed (Tundys 2011, pp. 737–738).

The international LPI is a summary performance indicator of the logistics sector that connects the data of six basic performance components: customs, infrastructure, international shipments, logistics quality and competence, tracking and tracing, and timeliness (Table 3). Some respondents do not provide information on all six components, so an interpolation method is used to fill in the missing values. Missing values are replaced by the adjusted average of the answers to each question by the mean deviation of the respondent.

The LPI is constructed from six indicators by principal component analysis (PCA), and a standard statistical technique is used to reduce the data set. In the LPI, the input data for the PCA are the results of the countries in questions 10–15, averaged for all respondents who provided data on the foreign market. The results are normalized,

minus the average of the sample, and divided by the standard deviation before conducting the PCA. The PCA score is a single indicator – the LPI, i.e., the weighted average of these scores. The weights are selected to maximize the percentage of variability of the six original LPI indicators, which is included in the overall index (for more detail, see Arvis et al., 2014; Arvis et al., 2018).

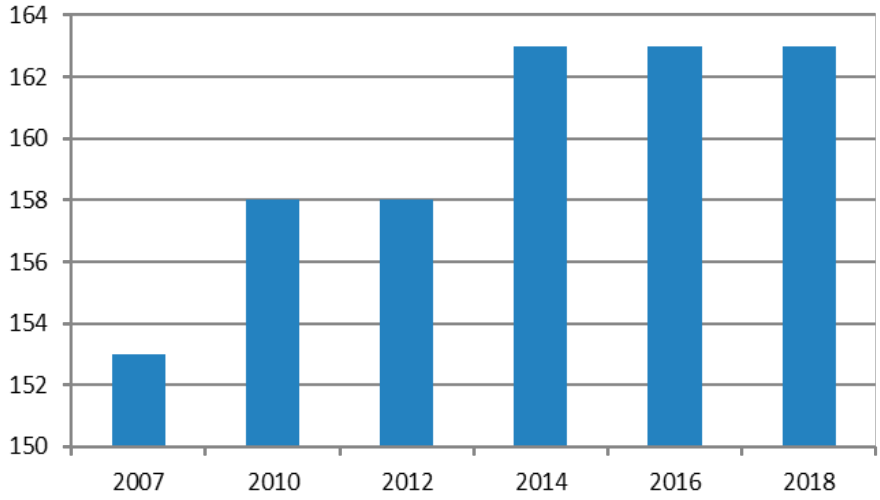

Figure 1. Number of countries analyzed by the LPI per year

Source: own study based on International LPI from 2007 to 2018: World Bank.

Table 3. The six primary components for the test LPI

No.	Components	Scale
1	The efficiency of customs and border clearance, rated from „very low" (1) to „very high" (5) in survey question 10.	0.40
2	The quality of trade and transport infrastructure, rated from „very low" (1) to „very high" (5) in survey question 11.	0.42
3	The ease of arranging competitively priced shipments, rated from „very difficult" (1) to „very easy" (5) in survey question 12.	0.40
4	The competence and quality of logistics services, rated from „very low" (1) to „very high" (5) in survey question 13.	0.42
5	The ability to track and trace consignments, rated from „very low" (1) to „very high" (5) in survey question 14.	0.41
6	The frequency with which shipments reach consignees within scheduled or expected delivery times, rated from „hardly ever" (1) to „nearly always" (5) in survey question 15.	0.40

Source: own study based on Arvis et al., 2014, p. 51.

Comparative analysis of the European Union countries in 2018

As the LPI comprises six additional and more detailed indicators, it was decided to use multivariate comparative analysis to assess the logistics system. The variables are stimulants and are characterized by appropriate variability (the coefficient of variation is above 10%). The data used to assess the development of the logistics industry in the EU come from the resources of the World Bank and relate to 2018.

The Statistica program was used to verify the cluster analysis,i.e., to group the EU countries in terms of the studied variables. The economic distance was determined using the Euclidean metric, and the objects were combined based on Ward's method. Figure 2 shows the results of the dendrite analysis. When analyzing the dendrite (Figure 2), it should be noted that there are many small clusters at the lowest level of the binding distance. This means that countries show diversity at this level. At the binding distance above 2, three clusters of countries can be distinguished:

1. Germany, Sweden, Austria, the Netherlands, Belgium, Denmark, the United Kingdom, Finland, France, Italy, and Spain,
2. The Czech Republic, Portugal, Luxembourg, Poland, and Ireland,
3. Hungary, Slovenia, Estonia, Greece, Romania, Cyprus, Croatia, Lithuania, Bulgaria, Slovakia, Malta, and Latvia.

At a binding distance level above 4 – the first two groups came together. However, all countries showed similarities to each other at a binding distance of around 16.5.

The taxonomic measure of development was based on the development pattern method. Using this measure made it possible to organize the EU countries in 2018 by the development of the logistics system, operationalized by means of diagnostic variables (components) in terms of the LPI indicator. Table 4 presents the research results. The values of the development measure fluctuate between 0.05474 and 0.957037. The country which leads the ranking is Germany, while Malta and Latvia are at the bottom. Attention should be paid to the range (which is 0.902297) between the maximum and minimum value of the measure, indicating a large diversity of the examined objects.

The EU countries are highly diverse in terms of the LPI. It was also noted that countries can be grouped into those with a higher economic level (measured by GDP) ora lower level. Thus, it was decided to make a detailed review of the component features for three selected countries: Germany – the best, Poland – in the middle, and Latvia – the worst (see: Figs. 3–5). These countries are at different levels of logistics system development. Therefore, it is important that the weak points relate to other elements.

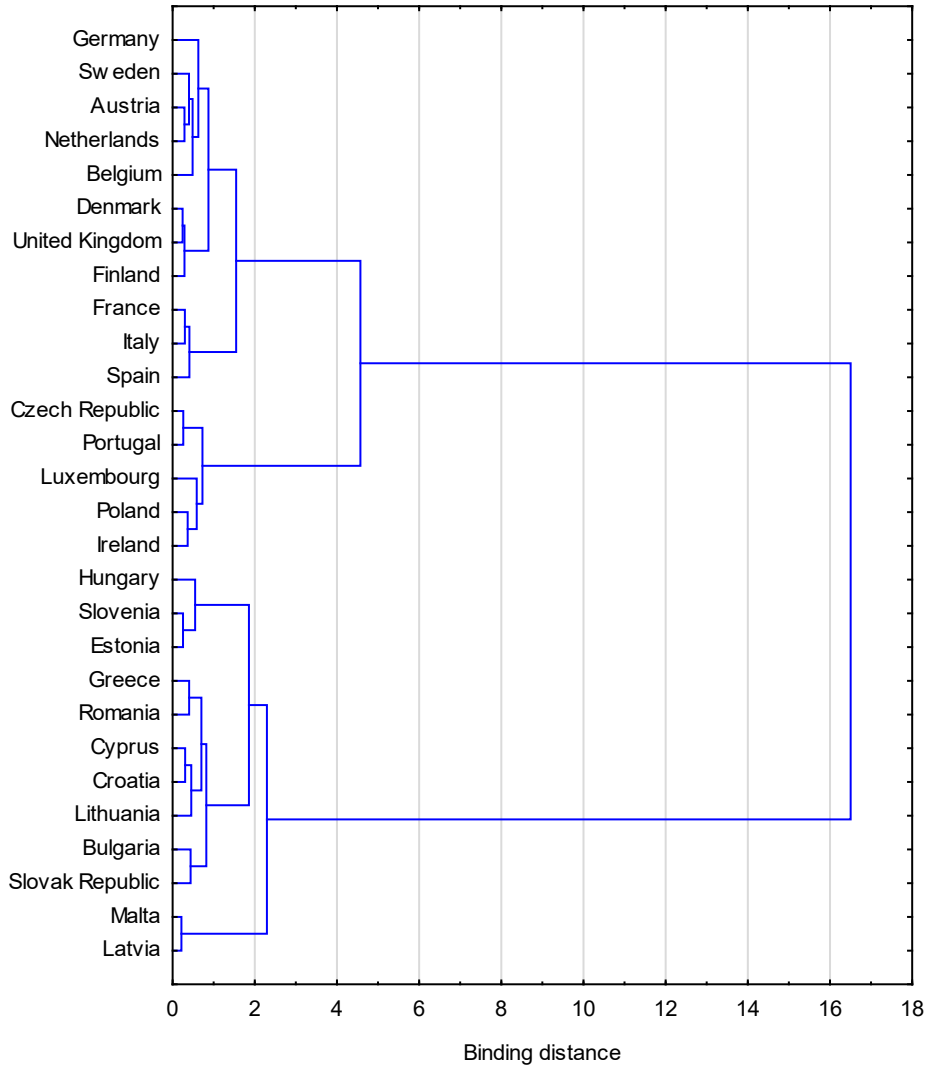

Figure 2. Dendrogram based on LPI variables in 2018
Source: own study based on data World Bank in Statistica.

Table 4. Classification of European Union countries according to the variables that describe the LPI in 2018

No.	Country	Measure		No.	Country	Measure
1	Germany	0.957037		15	Ireland	0.502444
2	Netherlands	0.848895		16	Poland	0.494660
3	Austria	0.847175		17	Hungary	0.440488
4	Sweden	0.841149		18	Slovenia	0.369924
5	Belgium	0.822111		19	Estonia	0.359954
6	United Kingdom	0.821833		20	Greece	0.295355
7	Denmark	0.804894		21	Cyprus	0.257857
8	Finland	0.793326		22	Croatia	0.239620
9	France	0.733708		23	Romania	0.230214
10	Spain	0.712661		24	Slovakia	0.190606
11	Italy	0.659762		25	Bulgaria	0.177388
12	Luxembourg	0.592456		26	Lithuania	0.172959
13	Czech Republic	0.589833		27	Malta	0.059594
14	Portugal	0.540143		28	Latvia	0.054740

Source: own study based on data World Bank.

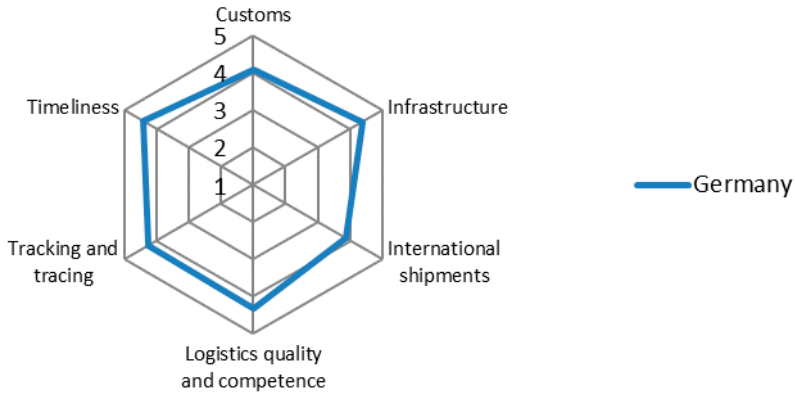

Figure 3. Values of the components of the LPI for Germany in 2018
Source: own study based on World Bank data.

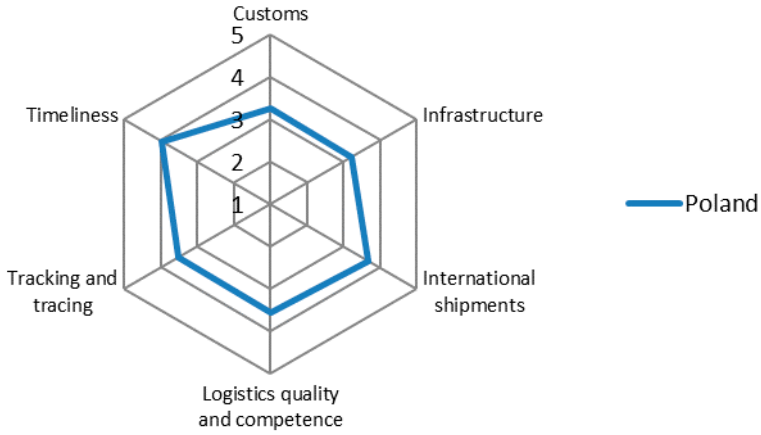

Figure 4. Values of the components of the LPI for Poland in 2018
Source: own study based on World Bank data.

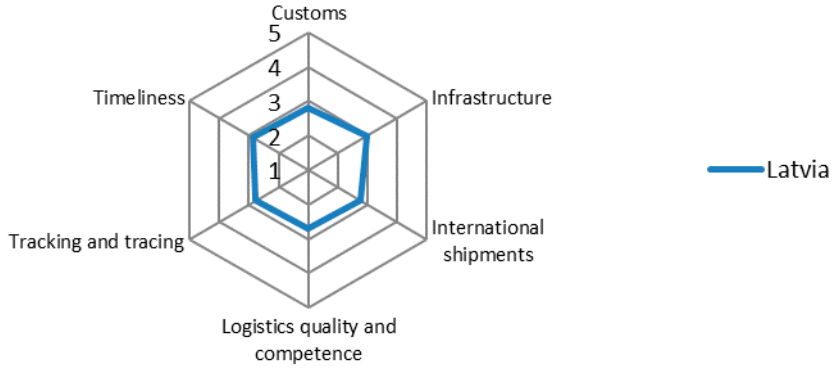

Figure 5. Values of the components of the LPI for Latvia in 2018
Source: own study based on World Bank data.

In the case of Germany, which is at the forefront of the classification in terms of logistics efficiency, the weaker elements are customs and international shipments. In Poland, the weakest links in the logistics system are customs and infrastructure. Meanwhile, in Latvia, timeliness and infrastructure wererated slightly higher than the other components, although all elements were verified at a fairly low level, on average, around 2. On this basis, it may be concluded which elements should be improved in the overall logistics efficiency structure.

The World Bank study largely reflects logistics efficiency, considering the breakdown of countries according to their income. On the one hand, this is the correct ap-

proach; however, income alone does not make it possible to show the diversity of services or the level of technical and organizational advancement in the TSL (transport, shipping and logistics) sector. The LPI report assumes that it is income that influences a country's logistic potential and performance. However, the research results indicate that countries with a similar income but with different geographic conditions, for example, are characterized by a different LPI value. Knowing the barriers of the TSL market, its specificity, dependencies, economic factors, and structures of the supply chains, one should be careful in drawing hasty conclusions in the future for individual regions.

Conclusions

The development of logistics systems is a vital element of an efficient supply chain and the processes that takeplace within it. In-depth quantitative and qualitative analyses provide information on the functioning of the above-mentioned points. Efficient flows in the logistics system are important from the economic point of view. This article presented several different types of quantitative measures thatcharacterize logistics systems. Using indicators, it is possible to describe, evaluate, and compare systems that operateon a microeconomic (i.e., enterprises) and macroeconomic (general – for example, countries) scale. The methods of assessing logistics systems presented in the article constitute only some of those available in the literature on this subject.

The study presented interesting results. First of all, a number of indicators that describethe processes in the logistics system are shown. In addition, the facilities (EU countries) were compared in terms of the development of logistics systems. They show diversity in terms of the development of the logistics system in 2018. Consequently, it may be pointed out that countries can compete with each other in this respect, as a highly developed logistics system brings economic and social benefits.

The use of multivariate comparative analysis methods for research enables interesting conclusions. Cluster analysis made it possible to group countries in terms of diagnostic features that characterize the logistics system. Meanwhile, the taxonomic measure of development made it possible to classify the countries in terms of the development of the logistics system, from the best developed to the worst.

The conclusions of the research are:

- it is possible to distinguish EU countries that are definitely leaders in terms of the development of the logistics system (from the point of view of efficiency measured by the LPI) in the analyzed period: Germany, the Netherlands, and Austria; meanwhile, countries with the lowest rank include Lithuania, Malta, and Latvia,
- countries with a higher level of gross domestic product per capita are higher in the ranking of the taxonomic measure of development and form groups in the cluster analysis; the same regularity applies to countries with a lower level of gross domestic product per capita,

- a poorly developed logistics system is characteristic of countries located in the eastern and south-eastern part of Europe, while a higher level is generally found in countries located in the western and north-western part of Europe,
- based on a detailed analysis of the components of the LPI, it is possible to identify the strengths and weaknesses of each of the surveyed countries, which may allow detailed conclusions to be drawn in the context of improving the logistics situation.

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Wybarane wskaźniki poziomu rozwoju logistycznego – przegląd i analiza porównawcza w krajach UE

Branża logistyczna współcześnie rozwija się bardzo dynamicznie. Sprawne przepływy towarów, osób i informacji są bardzo istotnym ogniwem każdego łańcucha dostaw i całego systemu logistycznego. Aby systemy mogły funkcjonować efektywnie, należy je odpowiednio oceniać, porównywać, jak i analizować. W tym celu istnieje wiele różnorodnych wskaźników, zarówno prostych i złożonych. Celem niniejszego artykułu jest dokonanie przeglądu tychże wskaźników, a także przeprowadzenie analizy porównawczej dla wybranego wskaźnika mierzącego poziom rozwoju systemu logistycznego (LPI – Logistics Performance Index). Podmiotem badania są kraje Unii Europejskiej. Do analiz wykorzystano metody wielowymiarowej analizy porównawczej.

Słowa kluczowe: system logistyczny, wskaźniki logistyczne, Logistics Performance Index, wielowymiarowa analiza porównawcza

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National Business Cultures as a System-forming Factor of the "Lublin Triangle"[1]

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Abstract

Considering the evolution of the scientific knowledge on the topic the authors define "national business cultures" as a complex interdisciplinary basic phenomenon of modern comparative studies and international entrepreneurship. Using the accepted in the world comparative studies methodology – indicative parameters of national business cultures and considering the authors' corresponding empirical developments a systematic comparative analysis of the national business cultures of the founding countries of the new cooperation platform in Central and Eastern Europe – the "Lublin Triangle" (Poland, Lithuania, Ukraine) – is carried out. The close similarity and wide complementarity of the national business cultures of these countries are revealed. This is largely predetermined not only by their common, centuries-old history, but also

1 The article was prepared as a part of a joint Polish-Ukrainian project "National business cultures of Poland and Ukraine: improving the scientific and practical foundations of cooperation in European and world markets" with grant support from the National Agency for Scientific Exchanges of Poland (NAWA – Narodowa Agencja Wymiany Akademickiej) and the Ministry of Education and Science of Ukraine.

by a number of other institutional and economic factors, as well as natural conditions. The priority sectors and spheres of integration of the three countries are determined both at the interstate level and at the level of the interaction of their business structures. Implementing this approach will ensure an increase in the competitive positions of Poland, Lithuania, and Ukraine and, as a result, the Lublin Triangle as a whole, in the system of the modern international division of labor. Based on the similarity and complementarity of the national business cultures, a group of other countries of Central and Eastern Europe (Latvia, Estonia, Slovakia, Romania, and Bulgaria) was selected. Under certain conditions, they could also become members of the Lublin Triangle, which would further strengthen and develop the European Union.

Keywords: national business cultures, comparative analysis, Lublin Triangle, Central and Eastern Europe, Poland, Lithuania, Ukraine, entrepreneurship, international integration, European Union

JEL: F23, O57

Introduction

At the beginning of the 21st century, serious economic, social, and political problems emerged in the development of the global economy. Unfortunately, they worsened significantly at the end of the 2010s and the beginning of the 2020s. Many countries have not been able to overcome the recession after the global financial crisis of 2008–2009, and on a broader, institutional level, anti-globalization manifestations have increased significantly. The content of such problems is predetermined by several other aggravating phenomena, processes, and trends. The main ones are the following.

There are open contradictions in some countries' approaches to and assessments of the forms and mechanisms for implementing the European Union's (EU) common economic policy. This is perhaps best exemplified in the long and very painful Brexit, with the United Kingdom leaving the EU. As a result of war and general instability in the MENA region, the huge influx of migrants became a catalyst for centrifugal tendencies in several EU countries. In parallel with this, and in some cases even before that, military conflicts took place in Transnistria (Moldova), Abkhazia and South Ossetia (Georgia), and Donbas (Ukraine). As a result, long-term contradictions have formed between the major players of modern world politics, and those are unclear and have a delayed nature of their manifestations.

In early 2020, the COVID–2019 pandemic began to spread rapidly, against the background of the insufficiently effective regulatory policy of both the World Health Organization and the most developed countries of the world in general. The inability of OPEC and the OPEC+ Treaty to achieve its main objective, i.e., to regulate the oil market by means of production, was clearly manifested, which led to a drop in oil prices and aggravated the wave of the new economic decline. This mirrored what had already happened in the global gas market. In total, COVID–19 and the collapse of prices

in the world energy markets had consequently led to uncontrollable tendencies in other commodity markets, in the world financial and stock markets; and in general – in the system of international economics and politics.

The combination of such negative economic, institutional, and natural manifestations is nothing more than a systemic social crisis. Along with this, there are grounds to assume that such tendencies will intensify further (at least in the medium-term perspective) due to the predicted additional negative political, scientific, technical, and environmental factors.

Against this background, the problematics of substantiation of the formation of new alliances and associations of states as a complementary foundation of modern society has got significantly actualized. At the same time, we are not talking about diminishing the activities of effectively functioning international integration associations.

Therefore, the establishment in June 2020 of a new platform for cooperation in Central and Eastern Europe between Poland, Lithuania, and Ukraine – the "Lublin Triangle" – is quite logical. It is a throwback to the Union of Lublin of 1569, which founded the federal state of the Kingdom of Poland and the Grand Duchy of Lithuania (which at that time included a major part of modern Ukraine), better known as the Polish-Lithuanian Commonwealth. For more than two centuries, up to the partitions of the Commonwealth in 1772–1795, it was one of the mightiest powers in Europe.

Such new associations can logically be built only on the basis of stable, mutually beneficial processes, at least within their framework. However, the formation of such processes is possible only if they rely on a set of common, fundamental economic, institutional, and natural foundations inherent in their states. Contemporary interdisciplinary studies indicate that one of these few basic foundations is represented in such a complex phenomenon of the theory and practice of economic comparative studies and international entrepreneurship as national business cultures.

The experience of the interwar period allows us to re-evaluate a number of common characteristics inherent in Poland, Lithuania, and Ukraine:

- they have deep institutional (historical and psychological) roots;
- in terms of their spatial location they are identified by subregional (primarily intra-continental) nature;
- they have common borders and an advantageous geographical location.

Thus, a complex scientific and practical problem arises in understanding the content of the national business cultures when assessing this interdisciplinary phenomenon as a stimulating (or constraining) factor in terms of cooperation between these countries within the framework of the newly created Lublin Triangle.

Review of the literature on the research topic

The foundations of scientific knowledge of the theory of national business cultures were laid by the well-known Dutch scientists and practitioner managers Geert Hofstede (1984) and Fons Trompenaars (Hampden-Turner and Trompenaars 2011). Significantly, most of their research was practically oriented towards improving managerial practices. Founded in 1980 and 1985, respectively, by Hofstede, the Institute for Research on Intercultural Cooperation and Hofstede Insights were the world's first research centers on this issue (not counting the Foreign Service Institute, created in the United States in 1947 under the patronage of the State Department for the training and reprofiling of high-level diplomats and businessmen). Based on the synthesis of Hofstede's and Trompenaars' approaches, they substantiated the indicative parameters of national business cultures, including "Power distance," "Individualism," "Masculinity," "Uncertainty avoidance," "Long-term orientation," and "Indulgence." (Hofstede Insights n.d., *National culture*).

These indicative parameters are used to analyze and assess the national business cultures of individual countries or groups of countries. Today, Hofstede Insights is the most authoritative organization in its field, conducting public research of national business cultures. They use the techniques proposed by Hofstede and Trompenaars, i.e., an assessment of the extreme values of the indicative parameters from their lowest to the highest, with a quantitative expression for each country (from 0 to 100 points).

In the history of world comparative studies, notable proponents of the managerial direction of investigating national business cultures include Minkov (Minkov and Hofstede 2014), Erdman (2017), and Rozkwitalska (2018).

In the 1980s, in the development of issues of national business cultures, in addition to managerial aspects, a new direction emerged, communication. It represents an analysis of aspects of the communicative behavior and interaction of people from different countries (and/or carriers of different cultures). This direction is associated with the famous scientist and practitioner from England, Richard Lewis (2019). Notable followers of Lewis include Deutscher (2010) and Katan (2014).

In the 1990s and 2000s marketing aspects of national business cultures studies drew up the prevailing topicality. This concept involved not only the widely understood problematics of international business itself, but also the synthesis of the theory and practice of history, sociology and cultural studies and even some aspects of psychoanalysis. The most reasoned marketing approach in the study of national business cultures was presented by Clotaire Rapaille (2019), followed by Cohen (2005) and de Mooij (2015).

In general, in the most advanced countries of the world at the beginning of the 21st century, the intensity of the development of issues of national business cultures decreased. Along with this, the issue became of greater importance in the ex-socialist countries, which had been really implementing the European integration policy.

Within the complex conception in Poland and Ukraine these aspects (in the context of implementing management practices) developed most (Glinkowska-Krauze, Kaczmarek, and Chebotarov 2020), and in Lithuania – in the context of considering business behavior and business values of the Lithuanians (Rutkovska, Smetona, and Smetonienė 2017).

In order to determine possible profiles of future managers, issues of national business cultures are raised in joint Polish-Ukrainian developments (Glinkowska and Chebotarov 2018; 2019). The first comparative studies of the national business cultures of the countries of Central and Eastern Europe appeared on the example of Germany, France, Poland, Hungary, and Ukraine (Glinkowska-Krauze, Chebotarov, and Chebotarov 2020). Recently, the first comparative study of the national business cultures of Poland, Lithuania, Belarus, and Ukraine was carried out.

The creation of the Lublin Triangle confirms the need for comparative studies of the national business cultures of Poland, Lithuania, and Ukraine. However, it also raises a number of complex questions about substantiating specific areas and forms of cooperation between the countries, as well as the comprehensive development of the Lublin Triangle.

The purpose of the article is to conduct a comparative, interdisciplinary analysis of the national business cultures of Poland, Lithuania, and Ukraine in the context of strengthening the scientific and practical argumentation for the creation and expansion of the Lublin Triangle format by involving other countries of Central and Eastern Europe.

Methodology, methods, and empirical base of the research

In this study, the methods of the unity of analysis and synthesis (when studying the parameters of the national business cultures of Poland, Lithuania, and Ukraine), the unity of the logical and the historical (in the context of taking into account the institutional prerequisites for creating the Lublin Triangle), and the grouping method and comparative analysis (when identifying a group of countries of Central and Eastern Europe, which, based on the similarity of their national business cultures, can also become participants in the Lublin Triangle).

In addition to the developments of Hofstede Insights, the empirical foundations of this study of national business cultures consist of detailed questionnaires for business representatives and government authorities. It was also based on interviews with expert analysts conducted by the authors in the context of a joint project entitled "National business cultures of Poland and Ukraine: improving the scientific and practical foundations of cooperation in European and world markets" with grant support from NAWA (Narodowa Agencja Wymiany Akademickiej – National Agency for Scientific Exchanges of Poland) and the Ministry of Education and Science of Ukraine.

The main material of the article

The interdisciplinary nature of national business cultures is due to the wide range of factors that shape them. These factors are structured and co-ordered, and form two groups. The first group (economic, institutional, international, and psychological) is determinative. The second group (demographic, communicative, scientific-technical, and natural-geographical) acts as a derivative or co-ordered in relation to the first group.

There is no system-based categorical denomination of the definition of "national business cultures". Therefore, our theoretical-methodological and scientific-practical developments serve as a basis for our definition of this denominative category.

National business cultures are a system of intrinsic values, properties, and behavioral canons of entrepreneurship; basic provisions and norms of business, as well as traditions and ethics of doing business, which are evolutionarily formed and reproduced in time and space, and in the combination specific to a particular country (or group of countries close in parameters).

The chosen characteristics of the main parameters of national business cultures are based on assimilation of achievements of science and practice by the world comparative economic studies, and are as follows.

The "Power distance" parameter allows us to characterize the distancing of middle and lower-level managers from making significant managerial decisions. "Individualism" measures the cultivation and dissemination of an individualistic approach to establishing and managing a business. "Masculinity" measures society's preference for success in business, assertiveness, and materialism. In countries with a high level of "Masculinity", power competition in organizations is usually resolved through struggle and conflict, rather than through mutual concessions based on the interests of the parties. "Uncertainty avoidance" measures the degree to which societies, and by extension, managers are uncomfortable with and deal with uncertainty and ambiguity. "Long-term orientation" shows whether managers concentrate their actions on the short- or long-term perspective. "Indulgence" in comparative economic studies is understood as valuing the gratification of natural desires, egoism, and profit-making in entrepreneurship, and the penetration of these "values" into all other spheres of society (Hofstede Insights n.d., *National culture*).

Chart 1 illustrates the characteristics of the national business cultures of the selected countries by the parameters "Power distance", "Individualism" and "Masculinity" with their respective quantitative estimates.

According to the "Power distance" parameter, the national business cultures of the Lublin Triangle countries are characterized by great variation. Lithuania has the smallest distance between the power of middle and lower managers and the management hierarchy (42 points); according to this indicator, Lithuania does not differ much from the most developed countries in the world. Poland (68 points) occupies a middle position, which generally corresponds to the developed countries of Europe. The highest distance from power is characteristic of the business environment of Ukraine (92 points).

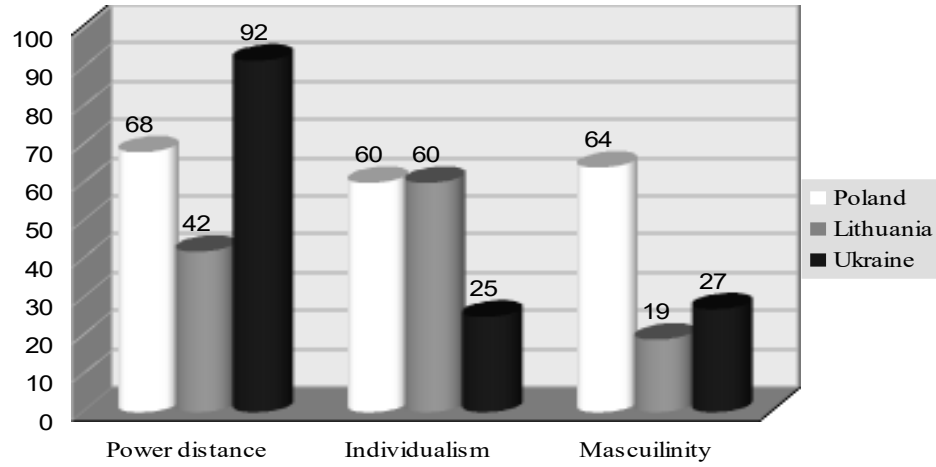

Chart 1. Comparative characteristics of the national business cultures of the Lublin Triangle in terms of "Power distance," "Individualism," and "Masculinity"
Source: Hofstede Insights n.d., *Country comparison: Lithuania, Poland, Ukraine*.

The "Individualism" parameter is exactly the same in Poland and Lithuania (60 points each). Such a score is quite typical for Western countries. According to Hofstede Insights, Ukraine (25 points) is a classic country of the collectivist approach, which is typical for the countries of the East. However, according to the authors' empirical research, Ukraine's indicator on this parameter is much higher and slightly different from that of Poland, occupying approximately the middle position between the countries of the West and the East.

In general, the "Masculinity" parameter reflects quite similar characteristics of the national business cultures of Lithuania and Ukraine (19 and 27 points, respectively). Poland, with a score of 64 points, is a representative of the more Western properties of pragmatism in establishing and doing business.

Chart 2 similarly illustrates the characteristics and assessments of the national business cultures of the Lublin Triangle on the other three parameters adopted in modern economic comparative studies.

The scores on the "Uncertainty avoidance" parameter represent not just similarity, but great closeness of national business cultures of Poland and Ukraine (93 and 95 points, respectively), although Lithuania differs from them in this regard (65 points).

Regarding "Long-term orientation", the national business cultures of Lithuania and Ukraine are close (82 and 86 points, respectively). Poland, on the other hand, is a country with a pronounced short-term business orientation (38 points).

According to the "Indulgence" parameter, the national business cultures of Lithuania and Ukraine are also very close (16 and 14 points, respectively); Poland is also considerably close (29 points).

A generalized comparative analysis of the national business cultures of the countries of the Lublin Triangle shows that they are, indeed, quite close to each other. In five

of the six parameters, the national business cultures of these countries are similar in pairs (or even, as with "Individualism" in Poland and Lithuania, identical).

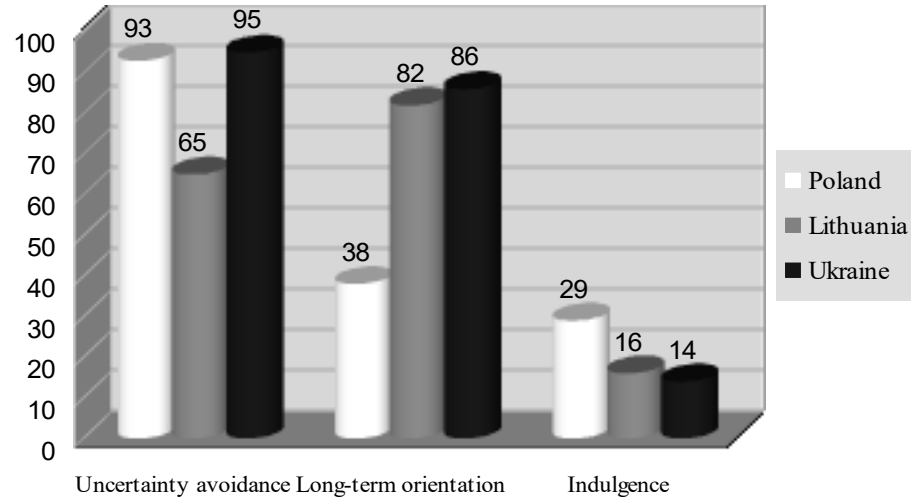

Chart 2. Comparative characteristics of the national business cultures of the Lublin Triangle in terms of "Uncertainty avoidance", "Long-term orientation," and "Indulgence"
Source: Hofstede Insights n.d., *Country comparison: Lithuania, Poland, Ukraine*.

At the same time, an objective analysis shows that the national business cultures of Lithuania and Ukraine, paradoxically at first glance, are more similar. This follows from the similarity of these countries' business cultures in terms of "Masculinity" (19 and 27 points, respectively), "Long-term orientation" (82 and 86 points), and "Indulgence" (16 and 14 points).

Based on the structure and current trends of national economic complexes of Poland, Lithuania, and Ukraine in the sectoral dimension, the most effective cooperation of these countries will be in the agri-food sphere (agriculture and, especially, in the processing and food industries), industrial construction (primarily in the implementation of large infrastructure projects related to automotive and rail transport logistics, and modernizing ports and terminals), energy (including nuclear), oil refining, IT, and in almost all segments of the service sector.

In addition to the sectoral dimension special attention should be paid to interregional cooperation. A more systematic establishment of Euroregions and cross-border clusters will be appropriate here. Cooperation when creating free economic zones can be very productive, which is confirmed by the analysis of the activities of the Lodz free economic zone. The cooperation of the countries of the Lublin Triangle in creating Euroregions and free economic zones could be effective, and with a focus on real support from the European Union.

Within such cooperation in the sectoral and territorial dimensions between these countries' business structures (both bilaterally and trilaterally) based on the similarity and complementarity of national business cultures, it would be appropriate to focus on their domestic markets. At the same time, it makes sense to consider accelerating the transition from simple export-import operations between business entities to more advanced forms of integrated cooperation (Glinkowska 2018). This is based on studying the theoretical, methodological, and applied practical aspects of national business cultures.

With institutional and organizational-methodological support and the implementation of a direct economic, regulatory policy by those states, cooperation between Poland, Lithuania, and Ukraine could act as a powerful integration center for several other Central and Eastern European countries (which also have close and complementary national business cultures with the countries of the Lublin Triangle). These countries could include Latvia, Estonia, Slovakia, Romania, and Bulgaria, as confirmed by the parameters of their national business cultures (Table 1).

The main conclusions of the comparative analysis of the national business cultures of this group of countries, based on the Hofstede Insights' developments, given in Table 1 can be summarized as follows.

For the selected eight countries, almost all parameters of national business cultures are characterized by high similarity and complementarity.

Table 1. Parameters of national business cultures of Poland, Lithuania, Ukraine, Latvia, Estonia, Slovakia, Romania, and Bulgaria

Parameter / Country	Power distance	Individualism	Masculinity	Uncertainty avoidance	Long-term orientation	Indulgence
Poland	68	60	64	93	38	29
Lithuania	42	60	19	65	82	16
Ukraine	92	25	27	95	86	14
Latvia	44	70	9	63	69	13
Estonia	40	60	30	60	82	16
Slovakia	100	52	100	51	77	28
Romania	90	30	42	90	52	20
Bulgaria	70	30	40	85	69	16

Source: based upon data from: Hofstede Insights n.d., *Country comparison: Lithuania, Poland, Slovakia, Ukraine* and Hofstede Insights n.d., *Country comparison: Bulgaria, Estonia, Latvia, Romania*.

According to the "Power distance" parameter, Ukraine (92 points), Romania (90 points), and Slovakia (100 points), as well as Lithuania (42 points), Latvia (44 points), and Estonia are close to each other (40 points). In addition, Poland (68 points) and Romania (70 points) have similar national business culture properties.

Regarding "Individualism", three countries (Poland, Lithuania, and Estonia) score 60 points. This subgroup of countries is, on the one hand, close to Slovakia (52 points), and on the other, Latvia (70 points). Bulgaria and Romania are identical in this respect (30 points each), quite close to Ukraine (25 points).

According to the "Masculinity" parameter, Romania and Bulgaria are very close (42 and 40 points, respectively), as are Lithuania (19 points), Ukraine (27), and Estonia (30). Latvia (with 9 points) logically "gravitates" towards Lithuania.

Within the "Uncertainty avoidance" parameter, Poland (93 points), Ukraine (95), Romania (90), and Bulgaria (85) are very close. Meanwhile, Lithuania, Latvia, and Estonia (65, 63, and 60 points, respectively) are close to Slovakia (51).

Regarding the "Long-term orientation" parameter, Lithuania and Estonia are identical (82 points each), as are Latvia and Bulgaria (69 points each). Ukraine (86) and Slovakia (77) are very close to the first subgroup.

Finally, according to the "Indulgence" parameter, three countries are identical: Lithuania, Estonia, and Bulgaria (16 points each). Ukraine and Latvia are very close to them (14 and 13 points, respectively), as is Romania (20 points). The other two countries, which are also practically identical in this respect (Poland and Slovakia – 29 and 28 points, respectively), do not differ much from Romania (20 points).

From the data in Table 1, the following generalizations can be made. The selected group of eight countries of Central and Eastern Europe is characterized by very close similarities in four of the six parameters used in such comparative studies, four ("Individualism", "Uncertainty avoidance", "Long-term orientation" and "Indulgence"). Such similarities are inherent in seven to eight countries. For the other two parameters ("Power distance" and "Masculinity"), the similarity is slightly less significant.

Therefore, the spread of integration ties between Poland, Lithuania, and Ukraine, both at the interstate level and between business entities, in priority areas of activity and deepening organizational and economic excellence of such cooperation, could impact (example and impulse) the formation of similar cooperation within the markets of the expanded group of Central and Eastern European countries.

Conclusions from the presented study

National business cultures represent one of the fundamental components of not only entrepreneurial activity, but also the economic organization of modern society as a whole. This component is interdisciplinary in nature. At the same time, it can act as both a stimulating or constraining factor for the development of business, and international integration, in particular.

For the Lublin Triangle, national business cultures are a potentially powerful factor in multilateral cooperation both at the interstate level of the founding countries, Poland, Lithuania, and Ukraine, and at the level of their business structures. This is very much predetermined by the mutual centuries-old history of the Kingdom of Poland and the Grand Duchy of Lithuania. Its origins, in our opinion, were laid not only by the Union of Lublin in 1569, but also by the Union of Krevo of 1385.

Cooperation between the countries of the Lublin Triangle meets the spirit of the EU, and it could become a significant additional factor to ensure the economic and political sustainability of its eastern frontier.

Based on the similarity of national business cultures, other countries of Central and Eastern Europe – Latvia, Estonia, Slovakia, Romania, and Bulgaria – are very close to the founding countries of the Lublin Triangle. Thus, the successful cooperation of Poland, Lithuania, and Ukraine within the framework of the Lublin Triangle can become an important component of integration cooperation between the countries of Central and Eastern Europe and the European Union as a whole.

Areas for further development include understanding the broad institutional basis (prerequisites) of cooperation between Poland, Lithuania, and Ukraine, and substantiating the specific economic mechanisms, in particular, in the development of investment projects in the selected priority industry sectors and areas of cooperation between the countries of the Lublin Triangle. This could become the basis for expanding the Lublin Triangle format and ensuring its highly competitive position in the modern system of the international division of labor.

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Narodowe kultury biznesowe jako czynnik systemotwórczy „Trójkąta Lubelskiego"

Opierając się na rozważaniu ewolucji kształtowania się wiedzy naukowej w historii rozwoju badanego problemu, autorka określiła definicję „narodowych kultur biznesu" jako złożonego, interdyscyplinarnego, podstawowego zjawiska współczesnych studiów porównawczych i przedsiębiorczości międzynarodowej jest podawany. W oparciu o ogólnie przyjętą na świecie metodologię badań porównawczych: indykatywne parametry narodowych kultur biznesowych oraz z uwzględnieniem odpowiadających im szczegółowych opracowań empirycznych przeprowadzonych przez autorów w ramach realizacji wspólnego polsko-ukraińskiego ministerialnego projektu, systematyczne przeprowadzana jest analiza narodowych kultur biznesowych krajów założycielskich nowej platformy współpracy w Europie Środkowo-Wschodniej – „Trójkąt Lubelski" (Polska, Litwa i Ukraina). Ujawniono cechy bliskiego podobieństwa i dużej komplementarności narodowych kultur biznesowych tych krajów. W dużej mierze determinuje to nie tylko ich wspólna wielowiekowa historia, ale także szereg innych uwarunkowań instytucjonalnych, a także naturalnych i ekonomicznych. Priorytetowe sektory i sfery integracji Polski, Litwy i Ukrainy są określane zarówno na poziomie międzypaństwowym, jak i na poziomie interakcji ich struktur biznesowych. Realizacja tego podejścia zapewni wzrost pozycji konkurencyjnej Polski, Litwy i Ukrainy, a tym samym całego „Trójkąta Lubelskiego" w systemie współczesnego międzynarodowego podziału pracy. Na podstawie podobieństwa i komplementarności narodowych kultur biznesowych wybrano grupę innych krajów Europy Środkowo-Wschodniej (Łotwę, Estonię, Słowację, Rumunię i Bułgarię), które pod pewnymi warunkami mogą również zostać członkami Trójkąta, co w naturalny sposób doprowadzi do dalszego wzmocnienia i rozwoju Unii Europejskiej.

Słowa kluczowe: narodowe kultury biznesowe, analiza porównawcza, „Trójkąt Lubelski", Europa Środkowo-Wschodnia, Polska, Litwa, Ukraina, przedsiębiorczość, integracja międzynarodowa, Unia Europejska

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