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Contents

Contents

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Transboundary movements of plastic waste from EU countries

JEL Classification: *Q53; Q57; Q5*

Keywords: *Plastic waste; circular economy; sustainability*

Abstract

Research background: As environmental awareness is growing, EU countries still consume a lot of plastic. International trade in plastic waste has become a way of dealing with this problem, bringing an environmental and ethical challenge on the one hand (burdening less developed countries and intensifying environmental problems) and an economic on the other (inappropriate resource management). Transboundary movements of plastic waste should be based on the principles set out in the Basel Convention which entail minimizing and disposing all kind of waste in an environmentally sound manner, minimizing the amount of waste transported and treating it as close as possible to their place of origin. Unfortunately, European plastic waste is exported in large quantities, often to less developed countries and not processed in accordance with European standards.
Purpose of the article: This paper aims to determine the volume and directions of plastic waste exports from EU countries and trends in global and EU rules on transboundary plastic waste movements.
Methods: Statistical and intuitive. The considerations are based on literature on the subject-matter and secondary data, i.e. export data under the trade code 3915 (Waste, pairings and scrap of plastics) derived from the UN Comtrade and Eurostat Database and main legal basis for the international trade in plastic waste (the Basel Convention with its recent amendments) and its trends.
Findings & Value added: The export of plastic waste by EU countries to less developed countries is a huge problem, as many of them are among the largest exporters globally. Changes to the Basel Convention have not significantly affected the volume and destinations of EU plastic waste exports. They organize the categories of plastic waste but still leave an ample room for undesirable activities.

Although the EU's proposals are more restrictive, the most desirable solution is a complete ban on the export of plastic waste by EU countries.

Introduction

The rapid increase in the worldwide production and scale of applications of plastics since the 1950s has increased the amount of plastic waste, which has become a major environmental, industrial and political issue in recent years (Geyer *et al.*, 2017). Closing the loop is therefore an important part of reducing the negative human impact on the environment. However, post-consumer plastic waste does not have to be recycled only in the country of origin but can also be exported for this purpose. Transboundary movements of plastic waste from EU countries should be based on the principles set out in the Basel Convention (and transposed into the Waste Shipment Regulation) which entail minimizing and disposing all kind of waste in an environmentally sound manner, minimizing the amount of waste transported and treating and disposing it as close as possible to its place of origin. Unfortunately, European plastic waste is exported in large quantities, often to less developed countries and not processed in accordance with European standards (might even be dumped or burned in unregulated ways). International trade in plastic waste has become a way of dealing with Europe's growing plastic waste, bringing an environmental and ethical challenge on the one hand (burdening less developed countries and intensifying environmental problems) and an economic on the other (inappropriate resource management). This paper aims to identify trends in the volume and directions of plastic waste exports from EU countries (first part of the result section) and in the global and EU rules on transboundary plastic waste movements (second part). Statistical and intuitive methods are used in this work. The considerations are based on literature on the subject-matter and secondary data derived from the UN Comtrade Database and Eurostat.

Literature review

The issue of transboundary flows of plastic waste emerged in academic considerations in the late first decade of the 21st century. In the main, the plastic waste debate is linked to recycling issues. This is the result of the increasingly visible negative environmental impact of plastics - particularly in the marine environment (Schmidt *et al.* 2020) as recycling is considered one of the key ways to deal with plastic waste. The economic reason,

meanwhile, is the circular economy concept being implemented in many developed countries and new perception of waste as a resource/value to be retained (Lacy & Rutqvist, 2015). In this context, transboundary trade in plastic waste is also considered as a loss of valuable resources (Gregson & Crang 2015) but it is primarily perceived as significant source of exacerbating environmental problems (D'Amato *et al.* 2019). Many researchers aim to create a global plastic waste trade network, especially in the context of China's 2017 ban on plastic waste imports. This approach has been adopted by, among others, Zhao *et al.* (2021). Based on the bilateral trade volume of plastic waste from 1990 to 2019 they illustrated directions of the plastic waste import and export from major trading countries around the world. They have also shown a shift of the center of gravity from China to Southeast Asia. The literature also includes papers explaining these developments and trade patterns. Kellenberg (2012) stresses the importance of such socioeconomic variables as income, environmental regulations and the presence of organized crime (waste are flowing to countries with lower levels of environmental regulations because of lower cost of its managing). Mazzanti & Zoboli (2013) also point out other key factors of trade with plastic waste such as transportation costs, trade barriers (tariffs and legislation) and incentives for recycling. Numerous studies highlight poor waste management practices in low- and middle-income countries, i.e. weak management infrastructure and significant amounts of plastic waste ending up landfilled or dumped (Liang *et al.* 2021).

Research methodology

Statistical and intuitive methods are used in this work. The considerations are based, to a great extent, on literature on the subject-matter and secondary data under the trade code 3915 (Waste, pairings and scrap of plastics) derived from the UN Comtrade Database and Eurostat (the terms 'export' and 'import' are used for transboundary waste shipments both within the EU and to third countries, however the paper shows these two groups of countries separately). The second part of the result section is an analysis of the main legal basis for the international trade in plastic waste (the Basel Convention with its recent amendments) and its trends. The main hypothesis is that EU countries are still the leaders in exporting plastic waste. Changes to the Basel Convention have not significantly affected the volume and destinations of EU plastic waste exports. They organize the categories of plastic waste but still leave an ample room for undesirable activities. Although the

EU's proposals are more restrictive, the most desirable solution is a complete ban on the export of plastic waste by EU countries.

Results

1. Size and directions of plastic wastes transboundary movements from EU countries

Historically and to date, EU countries are the largest consumers of plastics and exporters of plastic waste. 65% of the world's exported plastic waste originates in the EU and is destined to both its intra-regional market and overseas countries, particularly Asian. Almost half of European post-consumer plastic waste collected for recycling is exported outside its country of origin (UN Comtrade, 2023). As a result, some countries are listed among the top recyclers but at the same time they export significant amounts of plastic waste (plastic waste officially exported for recycling purposes raises statistics on the circular economy). Between 2012 and 2017 the EU exported annually more than 2 million metric tons of plastic waste to non-EU countries, accounting for more than half of its total plastic waste export - extra and intra EU. Following China's ban on plastic waste imports in 2018, this figure began to fall, dropping to 1.6 in 2018 and to 1.1 in 2021. In 2021, plastic waste exports outside the EU accounted for a third of its total trade. The largest exporter of plastic waste in the EU in 2021 was Germany, followed by Netherlands, France, Belgium and Italy (figure 1). At the same time, these countries are among the largest exporters of plastic waste globally, which are in order: Germany (0.82 mln tons), Japan (0.62), US (0.63), Netherlands (0.62), France (0.34), Belgium (0.34) and Italy (0.21).

Until 2017, the largest importer of European plastic waste was China. Following this country's ban, Vietnam, Malaysia, Thailand and India became the early destinations to replace it. In the following years, exports have been redirected also to Indonesia and Turkey. These countries have become a major outlet for the EU, experiencing plastic waste import volumes 20 times higher than in 2017. In 2021, the largest non-EU importers of European plastic waste were: Turkey (36%), Malaysia (12%), Vietnam (11%), the UK (9%) and Indonesia (9%) (figure 2).

The world's and Europe's biggest exporter of plastic waste - Germany - in 2021 directed its exports mainly to Turkey and Malaysia, although the largest flows from this country were intra-EU (to the Netherlands and Poland). Other major producers and exporters of plastic waste also moved it

mainly to other European countrie. Netherlands traded mainly with Belgium, Germany and France while France – with Spain, Italy and Belgium (table 1).

Only seven countries are net importers of plastic waste: Denmark, Sweden, Portugal, Lithuania, Latvia, Luxembourg and Austria - they recycle more plastic waste than is domestically collected for this purpose. By contrast, the largest net exporters are Germany, Belgium, Spain, France, Slovenia, Netherlands and Italy. The Netherlands, Belgium and Italy are typical intermediaries - they import plastic waste from other countries and re-export it. Internal reasons for export include first of all the lack of capacity (maximum plastic recycling potential in the EU is about 60%), technology (the complexity of the separation process, which makes recycling difficult and expensive) or financial resources to treat the waste locally (depending on the price of plastic and the primary raw material, it may be more profitable to export waste than to process it, Circular Plastics Alliance, 2021).

2. Trends in global and EU rules on transboundary plastic waste movements

The most comprehensive global environmental treaty addressing transboundary shipments of waste is the Basel Convention (1989). Its primary objective is to restrict shipments of hazardous wastes to developing countries, but it also obliges Parties to manage and dispose all kind of waste in an environmentally sound manner, to minimize the amount of waste transported and to treat and dispose of wastes as close as possible to their place of generation. The obligations of the Basel Convention have been transposed into EU legislation by Regulation (EC) No 1013/2006 on shipments of waste (so called Waste Shipment Regulation, WSR). The WSR has also implemented the provisions of the OECD decision establishing a control system for waste shipments destined for recovery within the OECD area.

Transboundary movements of plastic waste is not separately regulated. By 2021, post-consumer plastic waste was classified as non-hazardous and could be exported to non-OECD countries only for recycling purposes (prohibited for incineration, energy recovery or landfilling)[1]. In 2019, amendments were adopted (in force from 2021) which imposed restrictions on plastic waste exports (Basel Convention, 2019). The Convention defines now three categories for plastic waste in international trade: hazardous

[1] Plastic waste could be classified as hazardous when they contain lead or halogenated organic compounds or are not ecotoxic but are defined as (or are considered to be) hazardous wastes by the domestic legislation of the Party of export, import or transit.

plastic waste (Annex VIII), plastic waste sorted by polymer, almost free from contamination and destined for recycling in an environmentally sound manner (Annex IX) and the other plastic waste (Annex II). Through this listing, plastic waste not covered by the Convention has been therefore reduced. On the other hand, new categories of plastic waste have come under the scope of the Convention and are now covered by the procedure for transboundary movements (Prior Informed Consent - PIC), provisions pertaining to waste minimization and to the environmentally sound management of waste. Although ESM (Environmental Management Systems) framework has been updated, the concepts of EMS recycling have not been clarified and they still create a lot of technical questions on which recycling processes are sound and what is required of parties to fulfil their obligations under the Convention e.g. they do not specify the manner or the extent to which the country of export must verify ESM abroad. Furthermore, since presumed non-hazardous waste is not subject to any control, there is a risk that other controlled wastes may be deliberately classified precisely as presumed non-hazardous. This may leave the way exported plastic waste is managed unchanged which means it will still not subject to any control in the destination country regarding its quality and actual management (exported plastic waste is only managed by the relevant customs authorities by collecting data on waste volume, country of origin and destination).

At the time of this briefing's publication, the EU is reviewing its control regime for the shipment of plastic waste which may even go further than Basel Convention. A lack of knowledge about what happens to exported plastic waste means that is preferable to handle it internally. On the other side, there is also a strong voice that there might not be enough capacity in the EU to deal with waste that is currently exported from the EU (Circular Plastics Alliance, 2021). In November 2021, the European Commission proposed new regulations (COM, 2021) under which it would be possible to export of non-hazardous waste only to those non-OECD countries that explicitly give their consent to receive EU waste and demonstrate their ability to treat this waste in an environmentally sound manner. Prior to exporting waste, exporters would have to make sure that the facilities they ship waste to have undergone an audit by an independent and accredited third party. Regarding the export of plastic waste to OECD countries, monitoring by the European Commission would be introduced (through the digitalization of procedures), with the possibility to suspend them in the event of concerns regarding possible environmental damage at destination. In December 2022, European Parliament Committee on the Environment, Public Health and Food Safety (ENVI) adopted the legislative report which is going to strengthen this proposal, notably on transparency, monitoring,

and scrutiny of waste management in third countries for the purpose of waste exports and which actually would put end to EU exports of non-hazardous plastic waste to non-OECD countries. The report awaits a vote and the adopted text will become Parliament's position for negotiations with the Council, which has still to agree on a general approach (as of 10 January 2023).

Conclusions

This paper aimed to identify trends in the volume and directions of UE countries export patterns of plastic waste. EU countries are still the leaders in exporting plastic waste: 65% of the world's export plastic waste originates in the EU and almost half of post-consumer plastic waste from Europe collected for recycling is exported outside of the source country (including intra-EU trade). The largest exporter of plastic waste in the EU in 2021 was Germany, followed by Netherlands, France, Belgium and Italy while the largest non-EU importers were: Turkey (36%), Malaysia (12%), Vietnam (11%), the UK (9%) and Indonesia (9%). Changes to the Basel Convention have not significantly affected the volume and destinations of EU plastic waste exports. They organize the categories of plastic waste but still leave an ample room for undesirable activities. Although the EU's proposals are more restrictive, the most desirable solution is a complete ban on the export of plastic waste by EU countries. Further research is therefore needed to justify this direction of change. It is also important to assess the performance of European recycling industries by identifying their weaknesses and strengths in order to respond to the challenges of plastic waste export restrictions in the near future.

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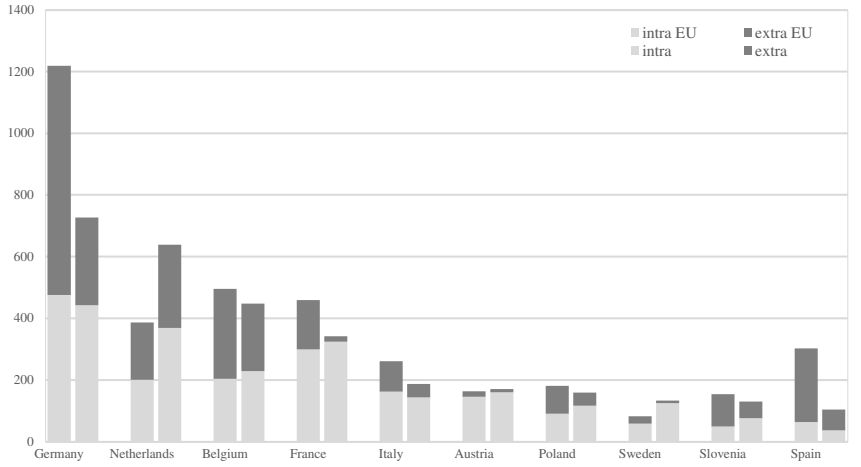
Annex

Table 1. Top EU plastic waste exporters and their main destination in 2021.

Top 5 EU exporters	5 main non-EU destination countries	5 main EU destination countries
Germany	Turkey (13%), Malaysia (6%), Switzerland (4%), Rep. of Korea (3%), Vietnam (1,6%)	Netherlands (24%), Poland (11%), Austria (6%), Belgium (4%), France (3%)
Netherlands	Indonesia (11%), Vietnam (10%), Malaysia (8%), UK (6%), Turkey (4%)	Belgium (18%), Germany (17%), France (5%), Italy (3%), Poland (3%)
France	Switzerland (3%), UK (2%), Turkey (0,3%), USA (0,2%), Canada (0,2%)	Spain (28%), Italy (20%), Belgium (14%), Germany (13%), Netherlands (11%)
Belgium	Turkey (13%), UK (5%), Indonesia (5%), Malaysia (5%), Vietnam (5%), India (1%)	Netherlands (35%), France (12%), Germany (8%), Italy (2%), Luxembourg (2%)
Italy	USA (8%), Turkey (6%), Switzerland (5%), Yemen (1%)	Austria (25%), Slovenia (13%), Germany (10%), Spain (6%), France (6%)

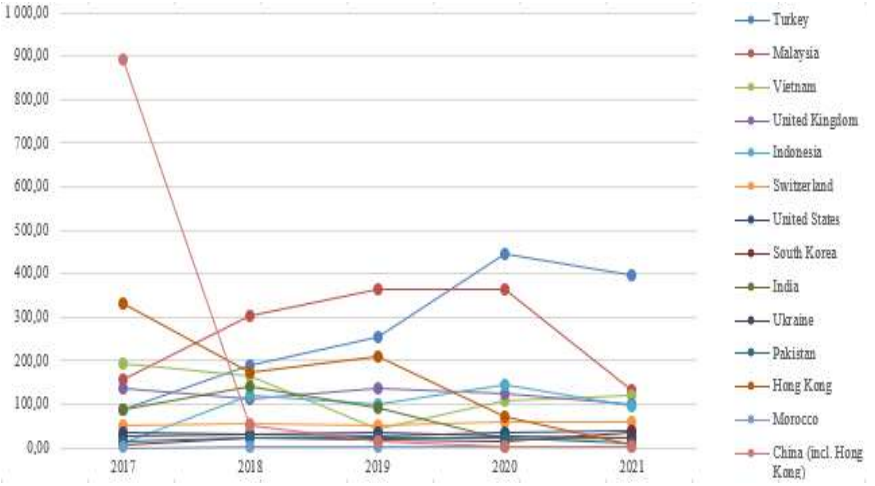
Source: own calculations based on Statista Database: https://www.statista.com/statistics/1269996/plastic-waste-export-destinations-european-union/ (15.01.2023)

Figure 1. Top 10 EU exporters of plastic waste in 2017 (first pillar) and in 2021, broken down by exports to the EU and non-EU countries (in 1000 metric tons)



Source: own calculations based on Eurostat Database: https://ec.europa.eu/eurostat/databrowser/view/ENV_WASTRDMP__custom_4740842/default/table?lang=en (11.01.2023).

Figure 2. Annual volumes of plastic waste exported outside the EU, 2017-2021, by main destination in 2021 (in 1000 metric tons)



Source: own calculations based on UN Comtrade Database (https://comtrade.un.org/data, 13.01.2023).

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Assessment of clusters business model efficiency in digital transformation conditions

JEL Classification: *C38; M20; M21*

Keywords: *Business model; cluster; digital transformation; digitalization.*

Abstract

Research background: Nowadays, traditional business models are becoming less and less efficient, so the transformation of models is inevitable, reflecting the aspirations of the European strategy, pandemic or geopolitical challenges.
Companies need to find ways to innovate with digital technology to create business strategies that add value to customers and improve performance.
This paper analyzed the improvement of cluster business models in order to achieve maximum efficiency in the conditions of digital transformation in Lithuania.
Purpose of the article: to identify the causes of business models efficiency in the context of digital transformation in Lithuanian clusters.
Methods: Comparative and systematic analysis of scientific literature. The following methods are planned to include literature analysis method, survey results.
Findings & Value added:
- 93 percent of cluster coordinators indicated that they plan to digitize their business processes within five years, only 7 percent clusters do not plan business digitization due to too small company and production volumes and the lack of additional need for companies that have already implemented digitalization to do it again;
- Digital technologies for the vast majority of clusters mean a competitive advantage in the sector in which the cluster organization operates.

- The sectors of the most popular digital technologies that will most affect cluster organizations are named: aircraft-based systems, artificial intelligence, continuous data exchange and collection, business management systems, automation and intelligent production, robotics.

Introduction

Nowadays, traditional business models are becoming less and less efficient, so the transformation of models is inevitable, reflecting the aspirations of the European strategy, pandemic or geopolitical challenges.

Companies need to find ways to innovate with digital technology to create business strategies that add value to customers and improve performance.

This paper analyzed the improvement of cluster business models in order to achieve maximum efficiency in the conditions of digital transformation in Lithuania.

Researchers (Hurth & Vrettos, 2021), Mascarenhas, 2011), various institutions (European Commission; Ministries of the Republic of Lithuania; OECD, universities), business representatives and the public are interested in business transformation issues at the national, European Union and international levels all over the world. Business is particularly affected by the political environment and the legal system applied by the governments of countries. Certain government decisions force businesses to transform, which is closely related to changes in their operations. This is not an easy task not only for a young, promising and fast-changing business, but also for representatives of old industries. All of them will be affected by the funding period of the European Union's 2021-2027 EU funds investment program for Lithuania, the implementation of which Lithuania, as a member of the European Union, has undertaken to ensure. The first two priorities of this program are: More advanced Lithuania and Greener Lithuania. The business will have to choose whether to fundamentally transform and be competitive, or not to make changes and lose business positions in the market over time.

Structures and types of business models were analyzed by Kinderis (2012); Kinder *et al.* (2013); Burinskiene *et al. (*2013); Storback *et al*. (2009); Baden-Fuller *et al*. (2010); Verstraete and Laffitte (2012); George and Bock (2011).

The concept of an innovative business model is associated with the creation of a new business or the transformation of an existing business, other-

wise known as "transformation". The analysis of the concepts of business models and their elements is systematized in Table 1.

Since clusters are networking between enterprise-based organizations, the very nature of clusters requires a different approach to cluster business models. Networking and clusters are a response to the global challenges of the external environment. The goals of the clusters are to improve core competencies and increase the quality of the economic situation by improving the environmental business climate (Masyuk *et al*., 2019).

The purpose of digitization in business is to create a significant competitive advantage that customers/consumers are willing to pay for (Innolytics, 2022). Business leaders must create a digital strategy and realize that it covers not just one area, but the entire business model (Kumar & Srivastava, 2019).

Research methods

The following methods were used for the research: literature analysis method, survey results.

Clusters in Lithuania tend to decrease: in 2016, 75 clusters were identified in Lithuania, in 2017 - 64 clusters, in 2019, 57 clusters were identified in Lithuania.

According to the last survey for 2020, 49 clusters were identified in Lithuania, but 28 (n = 28) cluster coordinators filled out the questionnaire. This is 57 percent of the study sample. The survey took place from June 15 to August 15, 2021.

Questionnaire for 2020 period, was made up of four main parts, but now we will discuss the second part of the questionnaire, which is designed to identify innovations in the business model of the cluster organization and the third part, which determines the possibilities of digitalization of business processes.

Limitations of the study. During the analysis, statistical data about 2020 the performance results of companies were not available either in the databases of the Statistics Department of the Republic of Lithuania or on the rekvizitai.lt portal due to the restrictions caused by the COVID-19 pandemic, so it was not possible to include the comparative 2020 results in the analysis of statistical data analysis. Another limitation: surveys were conducted during the holiday period (June-August), when there is less activity of respondents. The lack of motivation of the clusters to participate in the survey can also be identified as a limitation of the study.

Results

Digital transformation in cluster companies has recently become an important prerequisite for ensuring its concurrency. Digitization processes change not only the operational processes of individual business enterprises, but also international value creation chains in which many different entities participate. Self-assessment of the factors determining the speed and efficiency of digitization processes in order to make data-based decisions becomes a particularly relevant problem for companies at the moment of decision.

In this chapter, based on the 2016-2020 during the research conducted in Lithuania during the period, we will review how casters implement innovations in business models, how they are prepared for business changes and how to digitize their activities.

The innovative nature of clusters is confirmed in the course of this study, because companies participating in clusters are more inclined to implement innovations.

Comparing the results of the conducted survey (Figure 1) with the results of the literature analysis, it can be seen that the introduction of business model innovations in Lithuanian clusters focuses on experimentation, where 41 percent (N = 13) respondents indicated on the rating scale of 4-7 points that when applying innovations, they experimented with the implementation of a business model in a cluster organization (cluster or cluster companies), rather than conscious strategic planning. This instrument can be useful if the tasks and elements of value creation are constantly changing, but it is not suitable for mature sectors. Among the 7 business model innovation implementation instruments mentioned in the literature, the importance of teamwork (team formation) and the creation of a target budget for the implementation of innovations is emphasized. However, insufficient attention is paid to the instruments of strategy execution, program modeling and stimulation, project planning and control, and change management. This shows that the implementation of business model innovations in Lithuanian clusters is supported by individual instruments (mainly the financial budget 31% (N = 10) and the team responsible for implementation 28% (N = 9), i.e. funds are estimated and persons responsible for implementation are appointed), but does not rely on a set of instruments, i.e. there is a lack of a systematic approach that can help align projects with strategies, ensure flexibility of processes and predict expected results. Communication management is also not prioritized, which can lead to communication problems within the team and confusion about the roles and responsibilities of stakeholders.

The main goal of implementing innovations in the cluster organization was to create a response to market changes, the second place in terms of importance went to achieving a competitive advantage, and the third place to the discovery and implementation of the cluster strategy.

The ability of clusters to implement innovations is determined by the following reasons: cluster members can more adequately and quickly respond to customer needs due to a wider network of users than a single manufacturer; cluster members have access to the latest technologies in various areas of economic activity; both suppliers and consumers, as well as companies from other economic sectors, participate in the innovation implementation process; when companies cooperate, research and development costs decrease; cluster members experience intense

Digitization of business processes in value creation chains of clusters

Respondents' answers to the question "Does your cluster organization (cluster and cluster companies) plan to digitize business processes in the next 5 years?" were very significantly distributed (Figure 2). It can be seen that 93 percent of those surveyed plan to digitize their business processes in the future in the last five years. 7 percent of clusters that do not plan business digitalization indicated that the main reasons for not participating in the digitalization process are too small companies and production volumes, and companies that have already implemented digitalization do not have an additional need to perform business digitalization.

Another question aimed to assess the readiness of the cluster organization for digitization. The mean values revealed that the following statements scored above 4 points (Figure 3):

"Digital technologies are very important for the organization of the cluster" (mean value 5.21);

"The cluster organization is ready to address the challenges of digitization and take advantage of the opportunities" (4.82);

"The cluster organization is innovative and ready for digitization" (4.75);

"The cluster organization is in close cooperation with other organizations on issues of digital innovation" (4.71);

"The cluster organization responds quickly to the goals and opportunities posed by digitization" (4.64);

"The cluster itself will offer digitization solutions" (4.07).

During the survey, the cluster coordinators believe that digital technologies are an opportunity for the sector in which the cluster organization operates and that digital technologies will fundamentally transform the sector, but it is a challenge for the sector. The digital technologies that the clusters

say have the most impact on the sectors in which the cluster organizations operate (Figure 4).

Systems based on unmanned aircraft, artificial intelligence, consistent data exchange and collection, business management systems, automation and smart manufacturing, and robotics scored the most points. Respondents gave the least points to blockchain systems.

After conducting a literature analysis on the tools mentioned as being effective in implementing digital innovations in cluster organizations, during a descriptive empirical study cluster representatives were asked to indicate and rank the most important tools that, in their opinion, would work most effectively in implementing digital innovations in a cluster organization (Table 2 for the specified tools in order of importance).

The results of the conducted survey show that financial tools are considered the most significant tools for promoting the implementation of digital innovations in clusters: subsidies, fixed checks, cascading financing programs, tax benefits, borrowing guarantees. This means that Lithuanian clusters lack their own funds to implement digital transformations, so they are largely dependent on external financing. Although the most attention from the available financial tools is given to subsidies, the literature analysis shows the risk that the allocation of subsidies will finance larger projects and companies with the greatest potential. In the latter case, it would be more appropriate to choose cascading financing, loans with preferential interest, fixed checks. Attention to the creation of international networking is related to the need to expand the innovative ecosystems of clusters: in order to implement digital innovations faster and more successfully, it is necessary to promote cooperation and knowledge sharing in Lithuanian clusters between various local and foreign partners (small, medium-sized and large companies, institutions, universities, investors, entrepreneurs, etc.). The results of the survey also show that the problem of workforce qualification is encountered when implementing digital innovations in Lithuanian clusters. Based on the recommendations of the literature, workforce qualifications can be raised through joint training and education programs, specialized skills training programs needed in a certain sector, monitoring the progress and impact of acquired skills, forming professional interest groups and/or thematic committees. One-stop innovation centers would allow to coordinate the roles of various institutions in the process of digital transformations, unify legal requirements, accelerate the execution of business processes and functions through automated systems, and during pilot demonstrations, demonstrative installations and testing, it would be possible to link theoretical knowledge with technological breakthroughs, predict both industrial and commercial applicability of innovations.

In order to empirically examine the ways of accelerating digitalization of services, respondents were asked to rank the ways presented (Figure 5).

The respondents did not single out one most important method, so we can say that the complex application of methods would contribute to the acceleration of digitization in cluster organizations. However, the method with the most points - attracting financial resources for pilot projects and testing - shows that when implementing digital transformations in cluster organizations, one wants to minimize the risk of failure and maximize the benefits of digital transformations. Companies belonging to cluster organizations often lack financial resources to finance pilot projects and testing themselves, therefore attracting external funding for this purpose would help to make sure that digital transformations are compatible with existing business processes, that transformations are not characterized by a higher than acceptable level of errors, that technological systems are convenient to use both workers and consumers.

Conclusions

93 percent cluster coordinators indicated that they plan to digitize business processes in their activities within a five-year period, only 7 percent. clusters do not plan business digitization due to the small size of the company and production volumes and the lack of additional need for companies that have already implemented digitization to do it again.

It has been established that digital technologies are very important for Lithuanian clusters, and they are ready to address the challenges of digitization and take advantage of the opportunities. The cluster coordinators assessed themselves as organizations that are innovative and ready for digitization.

For the vast majority of clusters, digital technologies represent a competitive advantage in the sector in which the cluster organization operates.

The most popular digital technologies that will most affect the sector of cluster organizations are named: aircraft-based systems, artificial intelligence, consistent data exchange and collection, business management systems, automation and intelligent production, robotics.

The three most important tools for the implementation of digital innovations are singled out: financial instruments (subsidies) for the implementation of digital innovations; creation of international networking and workforce retraining, qualification raising and training of new competences.

The possibilities of applying complex methods to speed up digitization in cluster organizations: (1) community building and familiarization with digitization, encouragement to digitize, demonstration trainings; (2) market digitization roadmap development, curriculum development and training; (3) technology services: digital audit, consulting; (4) technology services: attracting financial resources for pilot projects, implementation, testing; (5) technology services: provision of technological infrastructure; (6) technological services: R&D projects, preparation for them, consulting and assistance; (7) business services: incubator, accelerator; (8) business services: attracting investments for technology development; (9) business services: training and consulting, project development; (10) to cooperate closely with clusters, together with digitization of sectors.

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Annex

Table 1. Concepts of business models (Kinderis 2012; Kinderis et. al., 2013; Burinskienė et. al., 2013; Storbacka et. al., 2009)

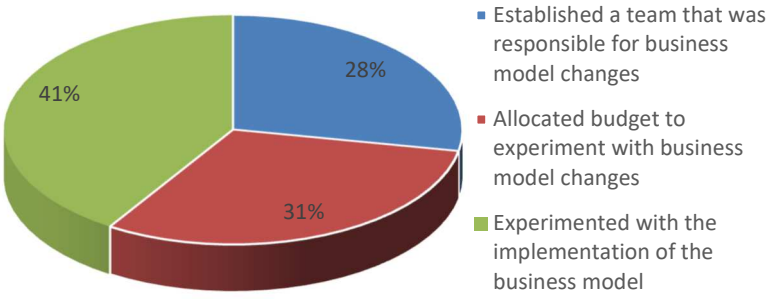
Author(s)	The concept of a business model	Elements of a business model
Chesbrough, 2007	The business model performs two important functions: creating value and obtaining value. Describes activities from the purchase of raw materials to the creation of a new service or product that meets the needs of consumers. Characterizes the management and development of the company	Resource management; pricing; development of activities
Johnson et. al., 2008	Value is created by 4 related elements: customer value proposition, profit logic, resources, and ongoing processes. Innovation is inseparable from the business model	Determination of customer value (including target customers, necessary to perform the work, offers); Innovation.
Storbacka ir Nenonen 2009	Configurations of interrelated capabilities that govern content, processes, and co-created dual-value interactions and management of exchanges	The content and interaction of the changes.
Baden-Fuller et. al., 2010	A method of operation in order to achieve the maximum benefit for the business from the produced a-services or products or the dimension of newly created value. It is a tool used to manage and model the company's activities.	Value determination, operational method; activity modeling tool.
Verstraete, Laffitte, 2011	A sequence of interrelated elements that create new value for the market served	Clients; employees; intermediaries; finance; technology, market
George, Bock 2011	The business model is perceived as a guarantor of the long-term survival of the company, a prerequisite and at the same time a consequence of entrepreneurship education. Business models create opportunities for the emergence of new business forms, identify market weaknesses.	Entrepreneur; resources; business forms; shareholders.

Table 2. Key tools for implementing digital innovation

No.	Tool	Given meaning
1.	Financial instruments for digital innovation: subsidies	5,9
2.	Creating international networking	5,8
3.	Retraining of the workforce, upskilling, training of new competences	5,6
4.	Financial instruments for digital innovation: fixed vouchers	5,5
5.	Building and promoting a healthy startup ecosystem	5,3
6.	Programs based on cascading funding	5,3
7.	R&D and innovation tax incentives	4,9
8.	One-stop innovation center	4,7
9.	Demos, demo installations and testing before purchasing the service	4,5
10.	Financial instruments for the deployment of digital innovation: guarantees	4,4

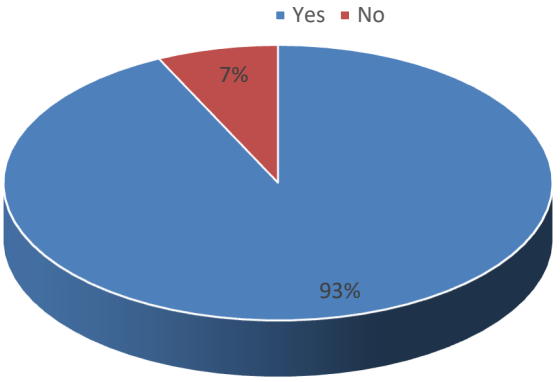
Source: Remeikiene, R. et al., (2023). Transformation of business models in clusters: digitalization, circular economy and the European green deal. (Forthcoming)

Figure 1. What instruments did you use in the cluster organization (cluster or cluster companies) to initiate and implement innovations? (%)



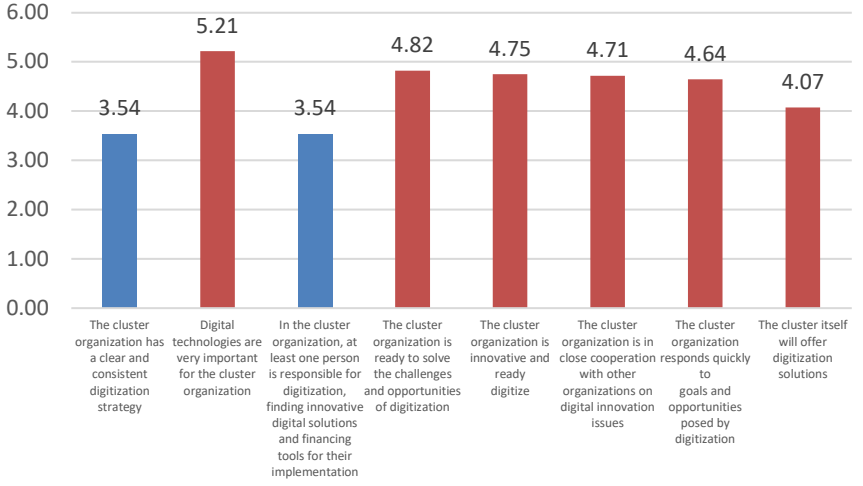
Source: Remeikiene, R. et al., (2023). Transformation of business models in clusters: digitalization, circular economy and the European green deal. (Forthcoming)

Figure 2. The intention of the cluster to digitize business processes in the last five years (%)



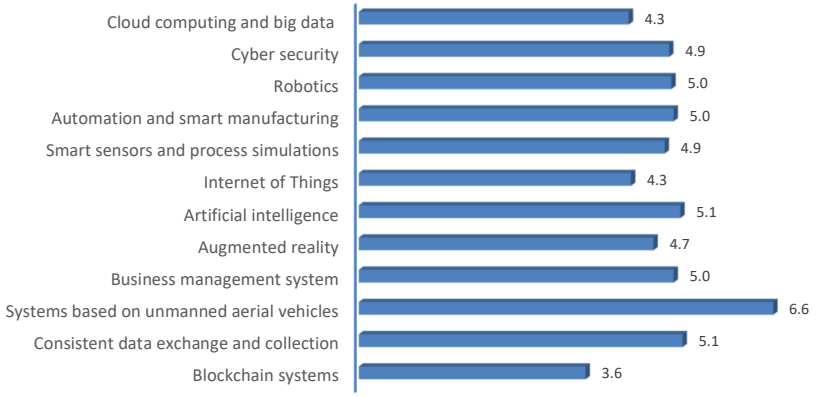
Source: Remeikiene, R. et al., (2023). Transformation of business models in clusters: digitalization, circular economy and the European green deal. (Forth-coming)

Figure 3. The readiness of the cluster organization for digitization, the values of the averages (mean values)



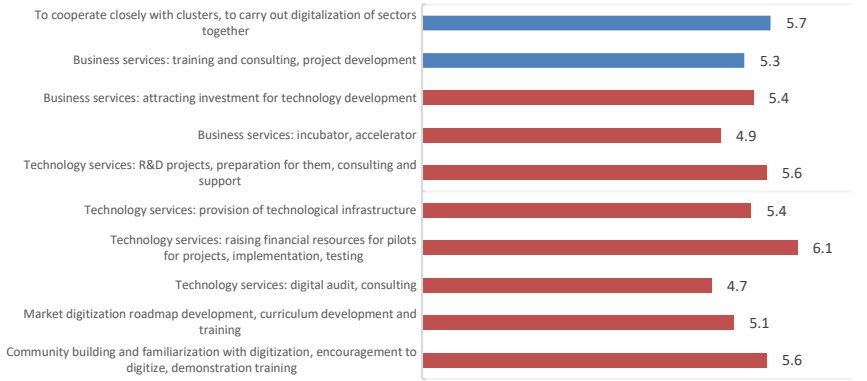
Source: Remeikiene, R. et al., (2023). Transformation of business models in clusters: digitalization, circular economy and the European green deal. (Forthcoming).

Figure 4. Digital technologies affecting the sector where the cluster operates (mean values)



Source: Remeikiene, R. et al., (2023). Transformation of business models in clusters: digitalization, circular economy and the European green deal. (Forthcoming)

Figure 5. What services would accelerate digitalization in a cluster organization? (%)



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Impact of the dual circulation strategy on China's international competitiveness

JEL Classification: *F14; F63; O11*

Keywords: *Dual Circulation Strategy; China; international trade competitiveness; Revealed Comparative Advantages*

Abstract

Research background: With the passage of time and the changes taking place both within China itself and, above all, in the world economy, it seems highly probable that further opportunities for the development in the current model of development of the Chinese economy are inevitably coming to an end and that China is in real danger of gradual economic stagnation, which is undesirable for both socio-economic and political reasons. This fact has been realised by the Chinese authorities, the best evidence of which was the proposal of a new strategy, known as Dual Circulation Strategy in the 14th Five-Year Plan. This justifies the need to undertake economic research on the possible impact of the implementation of this strategy on various spheres of Chinese economy, including its international competitiveness in international trade.
Purpose of the article: The primary aim of the article is to present the basic assumptions of China's Dual Circulation Strategy and to answer the question of whether, and to what extent, the implementation of this strategy can affect the international competitiveness of the Chinese economy.
Methods: In order to assess the international competitiveness of the Chinese economy, an in-depth analysis of the evolution of China's Revealed Comparative Advantages (RCAs) in international trade from 2010 to 2021 was carried out using the traditional and commonly applied original analysis method of Balassa's Revealed Comparative Advantages (RCAs).
Findings & Value added: Implementation of Dual Circulation Strategy may contribute not only to maintaining China's comparative advantages in international trade in manufacturing goods, mainly in the category of medium-high and, to some

extent, high-tech goods, but, more importantly, it may increase the international competitiveness of the Chinese economy in trade in high-tech goods. However, this will not be a simple or rapid process, as it will be conditioned by a number of challenges of both an internal (domestic) and external (international) nature.

Introduction

Thanks to the economic reforms initiated by Deng Xiaoping which consisted in the gradual opening up of the Chinese economy to foreign countries and reaping real comparative advantages from this process, together with China's increasing participation in the international division of labour, China has experienced tremendous economic growth and development over recent decades. It has even become a world leader in this respect. A watershed moment from this point of view was China's accession to the World Trade Organisation in December 2001. From that moment on, it was possible to speak of the development and international competitiveness of China's economy being based on an export-oriented model. With the passage of time and the changes taking place both within China itself and, above all, in the international environment (in the world economy), it seems highly probable that further opportunities for the development in the current model of development of the Chinese economy are inevitably coming to an end and that China is in real danger of gradual economic stagnation, which is undesirable for both socio-economic and political reasons. This fact has been realised by the Chinese authorities, the best evidence of which was the proposal of a new strategy, known as Dual Circulation Strategy (DCS) in the 14th Five-Year Plan. This justifies the need to undertake economic research on the possible impact of the implementation of this strategy on various spheres of Chinese economy, including its international competitiveness in international trade. This will be the subject of this paper.

The primary aim of the paper is to present the basic assumptions of China's Dual Circulation Strategy and to answer the question of whether, and to what extent, the implementation of this strategy can affect the international competitiveness of the Chinese economy.

The thesis of this paper is that the implementation of DCS may contribute not only to maintaining China's comparative advantages in international trade in manufacturing goods, mainly in the category of medium-high and, to some extent, high-tech goods, but, more importantly, it may increase the international competitiveness of the Chinese economy in trade in high-tech goods. However, this will not be a simple or rapid process, as it will be

conditioned by a number of challenges of both an internal (domestic) and external (international) nature.

In order to assess the international competitiveness of the Chinese economy, an in-depth analysis of the evolution of China's Revealed Comparative Advantages (RCAs) in international trade from 2010 to 2021 was carried out using the traditional and commonly applied original analysis method of Balassa's Revealed Comparative Advantages (RCAs). All the necessary data used in this study came from the United Nations Commodity Trade Statistics Database.

Research method

The competitiveness of economies in international trade can be measured in various ways. A review of the measures applied to do that was made by Startiene and Remeikiene (2014). As highlighted by Costinot *et al.* (2012), the measurement of comparative advantages in international trade is a key issue from the point of view not only of the positioning of a given economy in the international division of labour, but also, and perhaps most importantly, from the point of view of a country's trade policy. Hence, this article uses the method of analysing revealed comparative advantages (RCAs) introduced by Balassa (1965, 1989), specifically the Balassa's index (the RCA index) in the following formula:

$$RCA_{ij}^{K} = \frac{x_{ij}^{K} / X_{j}^{K}}{x_{i}^{j} / X^{j}} \tag{1}$$

where:
RCA_{ij}^{K} – the index of revealed comparative advantages (RCAs) of country K for commodity group i in relation to country or group of countries j
x_{ij}^{K}– exports of commodity group i from country K to country or group of countries j
X_{j}^{K} – total exports from country K to country or group of countries j
x_{i}^{j}– exports of commodity group i from country or group of countries j
X^{j} – total exports from country or group of countries j

A revealed comparative advantage in the exports of a given commodity group i can only be said to exist if its share in the total exports of a country is greater than the share of the given commodity group i in total exports from country or group of countries j, and therefore if $RCA_{ij}^{K} > 1$. If, on the other hand, $0 < RCA_{ij}^{K} < 1$, then there is no revealed comparative advantage.

Basic premises of Dual Circulation Strategy

The key objectives of Dual Circulation Strategy boil down to: (1) reduction of external demand as an engine of economic growth by increasing domestic consumption; (2) strengthening of China's position as a global manufacturing powerhouse for high-value-added products; (3) achievement of a higher self-sufficiency in key areas by fostering innovation; (4) ensuring access to key inputs by diversifying supply chains and targeting investment to specific sectors (Lin, 2021).

The cornerstone of DCS is the assumption of the existence (coexistence) of two basic circuits, i.e.: internal (domestic) circulation and external (international) circulation (Cooper, 2021). Thus, there are two interrelated systems of production and flow of goods and services (internal and external). In the huge, by virtue of the country's size and level of development, and increasingly absorptive internal market (the internal circuit), the strategy aims to: (1) stimulate consumption and (2) promote and support domestic investment (including through the reinvestment of profits earned by Chinese transnational corporations) to drive China's further economic and social growth and development. The task of the external circuit, on the other hand, is to supply raw materials and components for domestic production and to enable the acquisition of technology and capital for the best possible functioning of the internal market. In this regard, the Dual Circulation Strategy entails: (1) further active development of cooperation with foreign partners under the Belt & Road Initiative, (2) further development and expansion of China's Free Trade Zones (FTZs) to continue greater, albeit controlled and gradual, liberalization of access to the Chinese market for foreign companies, (3) maintaining the attractiveness of Chinese economy for FDIs, creating a strong financial centre of not only regional but also global importance, and pursuing an exchange rate policy conducive to improving the international competitiveness of Chinese economy, (4) actively working for China's greater involvement in global governance in order to seek to increase its leadership role not only in Asia but also in the world.

In China's Dual Circulation Strategy, the emphasis is very clearly distributed, it is the domestic circulation system that is the primary and leading system, constituting the main engine of China's development in the near future, while the external circulation system is to be only an auxiliary system, supporting the development of the former. Thus, and this should be clearly emphasized, the treatment of domestic circulation as the main element of China's development strategy in question is by no means tantamount to closing the door to the outside world and pursuing an isolationist policy. Rather, the aim of the approach is to realize more dynamic sustainable development by unleashing the potential of domestic demand to effectively connect domestic and international markets and make the best use of these two markets as well as of the domestic and foreign resources. In turn, consistent stimulation of the growth of domestic consumption and domestic investment, taking advantage of the external environment on Chinese terms, is to ensure a steady rise in internal (domestic) circulation, ensuring that China's economic growth and development is much more autonomous than before in relation to the global economy in general. This is to be a pro-growth residual model of China's development in today's highly volatile and unpredictable international environment (Javed *et al.*, 2023; EIU, 2020).

China's competitiveness in international trade

The competitiveness of the Chinese economy varies strongly within individual commodity groups, which is indicative of China's clear specialization in international trade. Over the entire analysed period of 2010-2021, China had revealed comparative advantages in international trade in only 3 out of 9 total commodity groups according to the Standard International Trade Classification (SITC) Classification Rev. 1, i.e. in *Manufactured goods classified chiefly by material* (Group 6), in *Machinery and transport equipment* (Group 7) and in *Miscellaneous manufactured articles* (Group 8).

An in-depth analysis of the value of the RCA index during the period under review shows that China is by far the most internationally competitive in the trade of Group 8 goods, i.e. *Miscellaneous manufactured articles* (Table 1). The most competitive Chinese goods in this group include: *Prefabricated buildings; sanitary plumbing, heating and lighting fixtures and fittings, n.e.s.* (Subgroup 81), *Furniture and parts thereof; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings* (Subgroup 82), *Travel goods, handbags and similar containers* (Subgroup 83),

Articles of apparel and clothing accessories (Subgroup 84) and *Footwear* (Subgroup 85). For each of these commodity subgroups, the values of the RCA index, although fluctuating over the analysed period, remained high (RCA > 2) (Table 2).

The second most competitive commodity group, in which China has the largest, relatively stable, revealed comparative advantages, is Group 7, i.e. *Machinery and transport equipment*. Here, in turn, the most competitive in international trade are Chinese goods in the following subgroups: *Office machines and automatic data-processing machines* (Subgroup 75), as well as *Telecommunications and sound-recording and reproducing apparatus and equipment* (Subgroup 76). China also has strong comparative advantages in trade in goods from Subgroup 74 and Subgroup 77 (Table 2).

And the third and final commodity group, in which over the entire analysed period of 2010-2021 China had relatively comparative advantages (RCA > 1), albeit the smallest compared to the commodity groups previously mentioned, is Group 6, i.e. *Manufactured goods classified chiefly by material*. The highest international competitiveness within this group is traditionally enjoyed by *Textile yarn, fabrics, made-up articles, n.e.s., and related products* (Subgroup 65) and *Manufactures of metals, n.e.s.* (Subgroup 69). In addition to it, China continued to have revealed comparative advantages in trade in goods from subgroups 62, 63, 66 (Table 2).

Interestingly, in addition to those mentioned above, China had revealed comparative advantages in foreign trade in only one more case during the period under review, namely in trade in goods from Subgroup 52 (*Inorganic chemicals*). And in 2021, for the first time, it also appeared to be competitive in trade in goods from Subgroup 51 (*Organic chemicals*).

Influence of Dual Circulation Strategy on China's international trade competitiveness

There is no doubt that the international competitiveness of the Chinese economy, as well as China's further economic and social growth and development, will depend on both internal (domestic) and external (international) economic circulation. For even if, in accordance with the Dual Circulation Strategy, the internal economic circuit will ultimately play an increasingly important role, it is difficult to imagine, especially in today's globalized world economy, that China would be willing and able to afford at the same time to consciously significantly marginalize the importance of economic relations with the external environment. For in practice, even

with the different distribution of importance, the two circuits must be treated as strictly complementary to each other.

China's competitive success under the aegis of DCS will undoubtedly depend on the modernization of its industrial structure, i.e., in particular, the shift from labour-intensive industries to capital-intensive industries (including both physical and human capital), as well as the amount of capital accumulation (largely domestic) required for these changes (Yifu &Wang, 2022). As Ju, Lin and Wang (2015) point out, with the indicated desirable modernization of the industrial structure, the Chinese economy will be more competitive internationally, thanks to its ability to increase the production of capital-intensive goods, which will also offer the possibility of higher returns on capital, thus allowing the level of domestic savings to rise, which in turn will further boost domestic demand and stimulate further industrial modernization, as well as overall economic and social growth and development. Moreover, the primary goal of DCS, self-sufficiency, also has important sectoral implications in Chinese industry. And the presumed creation of China's new industrial powerhouse 4.0 is ultimately expected to reduce dependence on the rest of the world and allow the elimination of existing bottlenecks mainly related to shortages of natural resources or cutting-edge technology (Garcia-Herrero, 2021).

In the context of the above, a crucial role will be played by China's industrial policy (Wang *et al.*, 2019). In order for it to be effective in terms of efforts to stimulate the overall competitiveness and development of the Chinese economy, it should first address: (1) new high-tech industries, to strengthen this potential and build China's new competitive advantages in the international market around it, (2) industries in which China has traditionally held latent comparative advantages for years, to maintain its international competitive position in this area, (3) industries in which goods are produced for the domestic market, in line with the realization of the idea of anti-import substitution, thereby reducing the importance of external circulation in importing goods from abroad. In addition, tougher reforms are needed in areas such as the financial services sector, the labour and land markets, and the domestic property system to reduce market distortions and strengthen domestic growth potential and competitiveness. Reforms are also needed in the income distribution system to reduce inequality, promote regional integration and enable more people to benefit from development (Kakwani *et al.*, 2019; Wang, 2019).

From the point of view of the translation of the implementation of DCS into international competitiveness, it is also worth noting the actions already initiated by the Chinese authorities to protect its domestic natural resources, especially metals, including lithium, cobalt and rare earth metals,

which are crucial from the point of view of new technologies. A good example of this is the elimination of the export tax rebate on iron ore (Garcia-Herrero, 2021).

External circulation and China's economic relations with the international environment are and will continue to be, as it seems, particularly important, especially for Chinese industries catching up on the technological gap with the world leaders (US, EU). This is because, as a rule, the fastest way to catch up on this gap is through trade cooperation, the purchase of modern machinery and equipment, the creation of joint ventures with high-tech foreign companies, as well as investment in research and development to assimilate these advanced technologies from abroad into the country. Nevertheless, in all likelihood, it can be assumed that the existing international technology exchanges may be disrupted over time for protectionist reasons based on geopolitical considerations. For some time now, China's relations with the US have been strained (both politically and economically) (Xing, 2020). The United States is increasing its pressure to restrict microprocessor and semiconductor exports to China and access to other highly advanced technologies. It is noteworthy that China's semiconductor imports have been larger than its oil imports for a decade now, and are *actually* the number one item in China's import basket (Garcia-Herrero, 2021), which is the best indication of the very clear bottleneck of the Chinese economy.

In this situation, China, seeking not only to maintain but also to improve the competitiveness of its own economy, should treat these products and related technologies as strategic and effectively encourage and support domestic enterprises to conduct their own R&D projects to enable the development of their own technology to replace imports of, for example, the aforementioned microprocessors (or other high-tech goods with high added value). Thus, China's strategic approach to geopolitical challenges will be forced to increase domestic circulation, especially in those areas where international circulation may be restricted for geopolitical reasons. This will have a direct impact on the formation of China's international competitiveness, ultimately clearly improving it, in particular in industries that are important in the era of the modern digital economy.

Conclusions

According to the basic premises of DCS, there are two economic circuits, i.e. internal (domestic) and external (international) one. However, it is the domestic circulation system that is to be the primary and leading one, con-

stituting the main engine of development and competitiveness of the Chinese economy in the near future. The external circulation system, on the other hand, is to serve only as an auxiliary system, supporting the development of the former. This does not mean that exports or, more broadly, economic cooperation with foreign countries are not and will not be important for China. However, their importance will diminish in favour of the domestic economic circuit, which is expected to ensure China's greater resilience in the face of ongoing changes and shocks in the global economy.

In connection with DCS, the production capacity of the domestic industrial base is to be increased by leapfrogging the broader technology sector. China's target is to achieve a 70 percent share of domestic production in technology sectors by 2025, as well as to reduce its own economy's dependence on external supply chains and make China a leading player in the semiconductor market. This is an extremely ambitious task, and even if it is not achieved in its entirety, the direction of change undoubtedly creates an opportunity not only for the further development of the Chinese economy domestically, but also internationally, something Beijing is very keen on. In the case of the latter, the competitiveness of the Chinese economy in international trade in goods is expected to improve significantly, especially in high-tech goods. This is all the more important in the realities of today's global economy, where, as a result of changes taking place in the structure of world demand, goods created in industries that make intensive use of modern production factors and are characterized by high innovation and technological sophistication are becoming increasingly important.

In order for this ambitious plan to succeed, however, certain actions are necessary on the part of both state authorities and the industrial sector in China. Indeed, a number of recommendations for necessary actions can be made in this regard, which primarily include: (1) modernization of the industrial structure, i.e. in particular, moving away from labour-intensive industries to capital-intensive industries that primarily produce high value-added and high-tech goods; (2) reforming the financial services sector, the labour and land market, and the national property system, with the aim of reducing market distortions and strengthening the country's growth potential and competitiveness; (3) the promotion and development of research and development, especially in the generation and implementation of high-tech manufacturing; (4) the Chinese authorities' efforts to acquire new, while protecting existing, domestic natural resources, especially metals, including rare earths, which are key to the new technologies on which the development of the Chinese economy's competitive potential is to be based.

The main limitations of ongoing research on the impact of DCS include, first and foremost, its relatively short implementation period, as well as limited access to reliable, comprehensive data from Chinese sources. However, this does not mean that such research should not be conducted. On the contrary, they are extremely important both for China, but also for the entire global economy, of which China is an extremely important component. In the future, it is worthwhile to conduct in-depth research on the sectoral competitiveness of the Chinese economy in the context of the implementation of the dual circulation strategy.

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Annex

Table 1. China's RCA index values in groups of goods (according to SITC Rev. 1) in selected years of the 2010-2021 period

Commodity		2010	2015	2020	2021
Code	**Name**				
0	Food and live animals	0.457588	0.398579	0.355108	0.332746
1	Beverages and tobacco	0.154818	0.174688	0.113348	0.104337
2	Crude materials, inedible, except fuels	0.180407	0.176266	0.14431	0.14313
3	Mineral fuels, lubricants and related materials	0.130782	0.11804	0.15766	0.117879
4	Animal and vegetable oils, fats and waxes	0.045648	0.05752	0.098447	0.110973
5	Chemicals and related products, n.e.s.	0.507529	0.520062	0.524588	0.631473
6	Manufactured goods classified chiefly by material	1.219484	1.360626	1.385841	1.275958
7	Machinery and transport equipment	1.410948	1.278764	1.3063	1.353903
8	Miscellaneous manufactured articles	2.135457	2.031759	1.838516	1.895166
9	Commodities and transactions not classified elsewhere in the SITC	0.020655	0.018632	0.189482	0.252246

Source: own calculations based on the UN COMTRADE (2023) data.

Table 2. Subgroups of goods with China's RCA index > 1 (according to SITC Rev. 4) in selected years of the 2010-2021 period

Commodity		2010	2015	2020	2021
Code	**Name**				
52	Inorganic chemicals	1.239066	1.030719	0.989432	1.131919
62	Rubber manufactures, n.e.s.	1.090566	1.068519	1.004904	1.032352
63	Cork and wood manufactures (excluding furniture)	1.512772	1.520903	1.272202	1.220891
65	Textile yarn, fabrics, made-up articles, n.e.s., and related products	2.755518	2.597255	3.097849	2.628753
66	Non-metallic mineral manufactures, n.e.s.	1.058966	1.196557	1.225431	1.122622
69	Manufactures of metals, n.e.s.	1.630228	1.700941	1.78139	1.839306

Table 2. Continued

Commodity		2010	2015	2020	2021
Code	**Name**				
74	General industrial machinery and equipment, n.e.s., and machine parts, n.e.s.	1.124758	1.134182	1.247692	1.308588
75	Office machines and automatic data-processing machines	3.294163	2.595297	2.445145	2.384935
76	Telecommunications and sound-recording and reproducing apparatus and equipment	2.712448	2.669279	2.457588	2.400597
77	Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including nonelectrical counterparts, n.e.s., of electrical household-type equipment)	1.423444	1.424669	1.399476	1.438931
81	Prefabricated buildings; sanitary plumbing, heating and lighting fixtures and fittings, n.e.s.	2.554065	3.605279	3.602766	3.551068
82	Furniture and parts thereof; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings	2.7769	2.57113	2.401288	2.385918
83	Travel goods, handbags and similar containers	4.10984	3.295527	2.314773	2.412606
84	Articles of apparel and clothing accessories	3.293468	2.674006	2.229748	2.213014
85	Footwear	3.526911	2.946539	2.103575	2.287616
87	Professional, scientific and controlling instruments and apparatus, n.e.s.	1.142055	1.071118	0.982343	1.004694
89	Miscellaneous manufactured articles, n.e.s.	1.607851	1.696995	1.808475	1.914428

Source: own calculations based on the UN COMTRADE (2023) data.

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Study of social benefits to the unemployed recipients in the general context of unemployment and social support: the case of Lithuania

JEL Classification: *J24; J64*

Keywords: *unemployed; recipients of social benefits; social support policy in Lithuania*

Abstract

Research background: The number of social benefits to the recipients registered as unemployed at the Employment Service in 2017-2020 decreased from 26.4 thousand to 8.3 thousand. 2020 appeared to be exceptional, since after one-time and temporary benefits had been paid, the income of families increased and therefore, a large part of them lost the right to social benefits. The article uses statistical data of the pre-pandemic year 2019. The average annual number of registered vacancies in 2019 was only 8.5 thousand. Thus, 1.5 unemployed people who received social benefits or 17 of all the registered unemployed people had to apply for one job. The unemployed, registered to receive social benefits, accounted for 1.5 % of the labor force (in 2019, the labor force was 1447.4 thousand), therefore, there is a growing need to investigate the reasons for the inactivity of unemployed recipients of social benefits in the labor market and to provide employers and the Employment Service of the Republic of Lithuania with measures to eliminate these reasons.
Purpose of the article: to investigate the reasons for the unemployment of the unemployed recipients of social benefits and to offer the most effective means of employment of the unemployed recipients of social benefits in the labor market.
Methods: Analysis of scientific literature, survey of the unemployed on social assistance, analysis of statistical data.

Findings & Value added: The unemployed recipients of social benefits constitute an insignificant part of the total labor force (1.5%) and a small part of all registered unemployed (14.5%), so their role in the labor market is small. The number of the registered unemployed receiving social benefits is more significant not for the labor market, but for the social support system. The survey research revealed the reasons for the unemployment of the recipients receiving social benefits. The most significant of them are that there are no jobs in the residential area, and to work elsewhere one faces transport problems; health problems, inadequate qualifications, insufficient salary to live on, debts due to which a large part of the future salary is deducted by bailiffs and/or age discrimination in the labor market. Each of these reasons was cited by more than 30% respondents.

Introduction

Relevance of the topic. The number of registered unemployed receiving social benefits is more significant not for the labor market, but for the social support system. In 2019, they accounted for 47.1 percent of adult recipients of social benefits. Other recipients of social benefits are either adolescent, or unable to work due to health problems, family obligations or other important reasons. They are not required to register with the Employment Service when claiming for social benefits. Out of 44.7 thousand , 12,000 adult recipients of social benefits (26.8%) received employment-related income. They are, of course, not registered as unemployed.

Hall&Kudlyak (2022), Šileika et. al. (2004) studied the reasons why the unemployed are reluctant to find work, however, there is a lack of research into why a target group such as benefit recipients remain long-term unemployed. In this way, the article aims to investigate the reasons for the lack of motivation of social benefit recipients to find employment in the Lithuanian labor market.

Purpose of the article: to investigate the reasons for the unemployment of the unemployed recipients of social benefits and to offer the most effective means of employment of the unemployed recipients of social benefits in the labor market.

Methods: Analysis of scientific literature, survey of the unemployed on social assistance, analysis of statistical data.

Research methods

Statistical data analysis

Primary data on social benefit recipients are available on the SPISS platform of the Ministry of Social Security and Labor of the Republic of Lithuania. However, SPISS does not record which benefit recipients are unemployed. Such data are collected by the Employment Service, but are not made public. The Ministry of Social Security and Labor has a database "Monitoring the effectiveness of social support in Lithuanian municipalities (Ministry of Social Security and Labor, 2022). It contains some data about the target group. Below we provide basic administrative statistics on registered unemployed people receiving social benefits.

The number of social benefit recipients registered as unemployed at the Employment Service in 2017-2020 decreased from 26.4 thousand up to 8.3 thousand. However, 2020 was a special year because one-time and temporary benefits were paid, which increased the income of families and, thereby, a large number of them lost the right to social benefits. Therefore, in the following analysis, we will use the statistics of the ones before the pandemic, 2019. This is the last year for which the data is reliable.

The research target group in 2019 amounted to 21.05 thousand persons who received social benefits and were registered as unemployed at the Employment Service. In total, the average annual number of unemployed people registered with the Employment Service was 144.9 thousand. Thus, only 14.5 percent of the registered unemployed received social allowances. Together, they accounted for 31.7 percent of all social benefit recipients; in 2019 there were 66.3 thousand of such.

Average annual number of registered vacancies in 2019 was only 8.5 thousand. Thus, 1.5 unemployed people who received social benefits or 17 of all registered unemployed people had to apply for one job. The registered unemployed people receiving social benefits accounted for 1.5 percent of the workforce (in 2019, the workforce was 1447.4 thousand).

Data and methodology

The main source of original data is a survey of social benefit recipients registered as unemployed at the employment service. According to the rules for granting social benefits in Lithuania, working persons can receive social benefits if their income per family member is lower than the State Supported Income (SSI) and if they are registered as unemployed at the Employment Agency (EA). 499 respondents were interviewed in May, 2022. That

figure is 2.4% of all recipients of social benefits registered as unemployed in 2019.

The selection of respondents was not carried out according to strict requirements of representativeness. The main problem in researching welfare recipients is their accessibility. A representative selection would require a list of them with basic demographic and economic-social characteristics and contact details. Many such data are available to social security administration agencies, but they do not have the right to share them due to the requirements of personal data protection laws. Thus, the respondents were reached through non-governmental organizations that provide various support and information to the poor. Candidates for respondents were selected according to two criteria. *First,* they are recipients of social assistance. *Second,* they are registered with the EA as unemployed. Nonetheless, to check the reliability of the survey data, some questions were included in the questionnaire, the answers to which could be checked using administrative data.

Hypothesis (1): the unemployed have unreasonable expectations about wages.

Results

Survey of unemployed social benefit recipients

The study revealed the reasons for the unemployment of benefit recipients. The most significant of them are that there are no jobs in the residential area, thus going elsewhere causes a transportation problem, health problems, inadequate qualifications, insufficient living wage, debts, due to which a large part of the future salary would be deducted by the bailiffs, and/or age discrimination in the labor market. Each of these reasons was cited by more than 30 percent of respondents (see Table 1).

The examination of the most important reason in more detail why social benefit recipients do not work reveals that there are no jobs in the area of residence and transportation is a problem to go elsewhere. This was indicated by more than half of the respondents.

Correlation analysis (Kendall's tau_b; Spearman's rho) showed that the relationship between the place of residence and the place where there is no work and the transportation problem is encountered elsewhere is statistically significant (p = 0.000) and the strength is medium (rtau_b =.586 **; r Spearman's rho = .619**). The model created during the regression analysis (y = 400.302+0.364 x +0.487y) explains 36-49 percent. dependent variable

(there is no work in the residential area, traveling elsewhere is a problem). The independent variables are the place of residence, the period during which social benefits are received and the duration of unemployment.

Compared to big cities, unemployed people living in cities and receiving social benefits 6 times, and those living in villages - 48 times indicated that there is no work in their area, and that going elsewhere is a transport problem. It is not surprising that the responses of respondents in metropolitan areas differ significantly from those in rural areas, since cities have a greater supply of jobs.

The hypothesis that the unemployed have unreasonable expectations about wages, i.e. the higher the salary they want, the less often they look for work or do not seek employment/do not look for work is not confirmed. A statistically significant relationship was not found between those who do not work for more than 12 months, as well as between those who receive social benefits for the same period and those who want a higher salary (700 EUR and more). There was also no statistically significant relationship between those who did not look for a job in the last four weeks and those who want a higher salary (700 EUR and more).

We investigated the relationship between the duration of taro unemployment and the amount of wages expected by the unemployed. We distinguished two limits of desired salaries - about the minimum salary (600 euros) and about the average salary (900 euros). Among those who do not work for less than a year, they would statistically significantly more often want a higher salary in their hands (i.e. from 600 eur +). Among those who have not worked for more than a year, more respondents would settle for a lower salary (i.e. from 0 - 600 euros). A similar trend is observed when comparing the duration of unemployment with the desire to receive an even higher salary. Those with a shorter unemployment experience would more often want a higher than average salary (i.e. higher than 901 eur +). At a time when the long-term unemployed are less likely to settle for a lower salary, i.e. in the salary range 0 - 901 euros. Thus, the expectation of a higher salary (perhaps unjustified) is not the reason for longer unemployment. In contrast, those who have been unemployed for longer are likely to lose hope of earning more and tend to settle for a more modest salary. Evidently, 20 percent of respondents say that it is not worth it to work, because the social benefit will decrease if you work.

A higher proportion of respondents (more than those who say that it is not worth working because benefits will decrease and less than those who think that living benefits are enough) mention bailiffs as a reason why it is not worth working. Debts (for communal services, communication services, fines for traveling without a ticket on public transport, etc.) are seen as an

obstacle to receiving an official salary, as a large part of it is collected by bailiffs for debts, late fees and expensive services of the bailiffs themselves. Almost a third of the respondents indicated that this is the reason why it is not worth working for them. Thus, due to poverty, individuals end up among debtors, and then they are also excluded from the labor market.

Conclusions

The data presented in the statistical analysis show that unemployed social benefit recipients in Lithuania constitute an insignificant part of the total workforce (1.5%) and a small part of all registered unemployed (14.5%). Therefore, their role in the labor market is small. In addition, registered jobs alone would not be enough for them, not to mention the fact that the total number of registered unemployed applicants is several times larger. It is true that both the number of registered unemployed and the number of registered jobs depend on the motivation to register.

The survey found that one of the most important unemployment problems was the availability of work. Comparing respondents from villages or single farms with respondents from big cities, respondents living in villages or single farms are 48 more likely to experience the problem of lack of transportation and jobs. Comparing respondents living in cities and districts with respondents living in big cities, respondents living in cities and districts are 6 times more likely to experience the problem of lack of transportation and jobs. The results revealed that those who have not worked for more than a year would like a lower salary (net) than those who have not worked for up to a year. Most would agree to work for a salary of 500-1000 euros (net). Most of the respondents' answers fell into the range of 700-900 eur (net). In third place according to frequency, 500-700 eur (net). Hence, the longer one is unemployed, the less motivation to find a job for the desired salary and the more willing to work for a lower salary.

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Annex

Table 1. For what reason are you not working?

For what reason are you not working?	Proc.
There is no work in the area where I live, transportation is a problem to go elsewhere	56
I have health problems, although there is no disability	42
I cannot find a job according to my acquired specialty/profession	40
There is no work for a decent living wage	35
It doesn't pay for me to work, because the bailiffs will deduct a large part of my earnings	31
They don't hire me because of my age	30
There is no work, not even for minimum wage	27
Work is offered only in shifts	24
It is not worth it for me to work because social benefits will be greatly reduced	20
Social benefits/allowances are sufficient for living	19
I have an addiction (to alcohol, drugs, etc.)	19
I take care of the child	16
I am looking after an elderly/disabled relative	8
I am disabled (disability level determined)	8
I don't want to work	7

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Ordoliberalism: A third way?

JEL Classification: *B25; B59; F60; Q50; P18*

Keywords: *ordoliberalism; neoliberalism; economic order.*

Abstract

Research background: To a limited extent, modern researchers are interested in ordoliberalism, as a theory of the socio-economic system, which is confirmed by the results of the bibliometric analysis. In conducted studies, the assumptions of ordoliberalism are used partially, for example, for research on: the role of the state in the economy, the antitrust law, the theoretical assumptions of the SME, the determinants of German economic policy after World War II.
Purpose of the article: The aim of this article is to present the possibilities offered by the ordoliberal theory that predispose it to determine a socio-economic order which makes it possible to tackle the dysfunctions and crises that afflict today's economy.
Methods: The research methodology involves a critical analysis of the works of the most essential representatives of ordoliberal thought, particularly Walter Eucken and others, from the perspective of the above mentioned purpose of the study. This requires examining German-Polish and English-language publications of the authors included in the mainstream ordoliberalism.
Findings & Value added: As a result of the conducted analysis, the hypothesis about the existence of the elements of ordoliberal theory that allow it to respond to

the challenges of the modern world, including economic, social, environmental and climate crises and pandemic threats has been confirmed. Research of this kind implies a return of thinking in terms of economic order, and thus contributes to the theory of economics.

Introduction

In recent years, the world has been grappling with the adverse consequences of an array of worsening global problems such as population explosion, income inequality and environmental pollution. On the one hand, the past few years have seen a steady increase in production and income, and on the other, there has been a rise in income and economic inequality (OECD, 2022), resulting in further polarisation – with all its negative effects – in today's world (OECD, 2017). At the same time, the world has also been facing an increasing population and strain on the natural environment (United Nations, 2022). With the current population level, the consumption rate now stands at 1.7 planets and is estimated to reach 3 planets in 2050 (Kłos, 2014, p. 74).

In the face of growing injustice in the modern world, coupled with demographic and environmental issues, the research question that emerges is what remedial steps can be taken. The available socio-economic doctrines have never been confronted with such a coincidence of problems as that affecting the world today, and the extent to which they are capable of solving these problems is limited. The type of neoliberalism represented by the Chicago School of Economics, which was the predominant socio-economic view from the mid-1970s until at least the global financial crisis of 2007–2008, has largely compromised itself, and while Keynesian economics did save the world at the end of the first decade of the twenty-first century from an even deeper economic collapse, this was not the "*free lunch*" so harshly criticised by neoliberal economists. The cost was high, and the use of a vast stream of money to stimulate the economy (with low interest rates and budget deficits) corrupted the manner in which economic policies are pursued in the long run.

In view of the above, the ordoliberal theory seems to be the only theory that provides a normative framework capable of addressing the contemporary problems and offers an opportunity to establish a socio-economic system based on responsibility and freedom. Obviously, it is not possible to propose short-term solutions to today's problems on the basis of that theory, but in a longer term, it can provide a valuable set of guidelines for the development of a fair order.

In the last few years, there has been a resurgence of academic interest in ordoliberalism, which suggests that researchers are looking to this concept for guidance on how to determine policy frameworks which correspond to the problems faced by modern economies and societies. Unfortunately, for a relatively long time before this resurgence, the ordoliberal theory was mainly the object of interest of historians of economic thought, and any research conducted in that field was limited to German-speaking countries. Moreover, the existing research on the ordoliberal theory can be described as fragmentary, and the principles of that theory have only been analysed in a piecemeal manner.

The aim of this article is to present the possibilities offered by the ordoliberal theory that make it suitable for determining a socio-economic order capable of tackling the dysfunctions and crises that afflict today's economy. The first part of the article discusses the breadth and depth of the existing research on ordoliberalism, including its fragmentary nature. Next, a note on the methodology of the study is provided, followed by a description of the normative framework of the socio-economic order proposed by the ordoliberal theory, which can be relevant to the development of an order that proves fair in the long run. Finally, the discussion is summarised in the final conclusions.

Research background

A time series analysis based on bibliometric research showing the number of publications on ordoliberalism in selected academic databases suggests that on the one hand, studies on ordoliberalism to date have been limited in scope, but on the other, there has been a resurgence of interest in the subject. In the WoS database, there are 249 publications available for the 1971–2023 period, that contain the word "ordoliberalism" in the title, abstract or keywords[1]. In terms of the amount of research on ordoliberalism being disseminated, two landmark shifts in researchers' activity can be identified. The first spike coincides with the global financial and economic crisis of 2009–2014, and the second, even sharper increase can be seen in 2017–2019/2022, that is, during the prelude, as it were, to the current global pandemic and the subsequent global socio-economic crisis.

The growing interest in ordoliberalism within academic circles has also been reflected in the public debate, with many quotes in the press pointing to ordoliberalism as the theoretical foundation of the economic policy pur-

[1] *State of research: 20/03/2023.*

sued by Germany during the euro area sovereign debt crisis (The Economist, 2017). The link between Germany's policy and ordoliberalism appears to be the country's apparent aversion to expansive monetary and fiscal policy action (such as establishing multiple recovery mechanisms for indebted countries and banks) combined with its insistence on decisive cost-cutting measures.

The observed resurgence of interest in ordoliberalism suggests that researchers are looking to this concept for guidance on how to determine policy frameworks which correspond to the problems faced by modern economies and societies. At the same time, however, the new research has brought to light certain problems which the ordoliberal theory needs to address.

As has been the case with other economic theories created several decades ago, one of the main issues with the ordoliberal theory is the fact that its assumptions and core principles must be adapted to the rapidly changing socio-economic circumstances and to the realities of today's institutional environment. Developed in its theoretical dimension by Walter Eucken in the 1930s and 1940s and applied by Ludwig Erhard in West Germany's post-war policies, ordoliberalism is an established doctrine that has to be modified and adjusted to account for, among other things, the challenges that come with integration processes, the need to respect human rights and dignity, the state of the environment and the exhaustion of non-renewable resources, and matters of public health.

Another problem faced by the ordoliberal theory is the relatively limited adoption of the concept of socio-economic order that is essential to ordoliberalism. Unfortunately, while the notion of "order" is highly relevant to German-speaking economists, it has not been widely disseminated among those rooted in the economic tradition of English-speaking countries. This observation is supported, for instance, by the results of bibliometric studies, which clearly indicate that while the term "ordoliberalism" is used in research papers worldwide, with 249 publications in WoS, only 60 of these publications refer to "ordoliberalism" and "order" at the same time.

In addition to the above, the ordoliberal theory is yet to become the subject of detailed and recurring quantitative empirical research. So far, attempts to quantify the actual implementation of the principles of this theory have been limited to studies on the Social Market Economy and described in a handful of papers (Helfer, 2015; Van Suntum *et al*., 2012; Davidescu, 2017). This scarcity of quantitative research on the ordoliberal theory may stem from the fact that ordoliberals themselves are rather sceptical about the mathematisation of economics due to their strong philosophical and normative orientation. Furthermore, proponents of ordoliberalism are quick

to point out the disconnect between formal neoclassical models (defined for idealised economic models) and the current economic policy issues that involve real institutions and actors.

Another important issue with the existing studies on the ordoliberal theory is their fragmentary nature and narrow focus on one selected aspect. In the most popular publications on ordoliberalism indexed in the WoS database, the authors have used selected principles and assumptions of that theory to analyse such issues as the role of the state in the contemporary world, the EU antitrust law, Germany's stance on debt restructuring in Southern Europe, or the theoretical foundations of the Social Market Economy. In line with Eucken's theory of competitive order, however, attempts to analyse the socio-economic order solely in terms of one of its indicators should be considered flawed.

The problem with existing research on ordoliberalism is its focus on the ordoliberal economic policy, which in economic reality translates to the fragmentation of its goals and of the regulatory instruments being used. Today's economic policies do not respond in the manner prescribed by the ordoliberal theory (order policy), that is, in a manner oriented at the development of a competitive order; instead, they mainly operate discretionally and, in a growing number of cases, only *ex post* (the discretionary process policy). In fact, one can observe the return of various – sometimes more or less disguised – directive forms of governance in certain branches of the economy, especially in international trade.

In the 1940s and 1950s, ordoliberal thinkers defined themselves as representatives of the "Third Way" between laissez-faire capitalism and Marxist central planning and economic governance. In the current situation of the world, however, this "Third Way" should be defined differently. The Marxist concept of a command economy has finally discredited itself, and serious objections have been raised against the neoliberalism of the Chicago School of Economics, although it still has some influential.The past few years have also seen a revival of Keynesianism, which has been used to save economies from various kinds of crises. With this revival also comes the wider adoption of the idea of "industrial policy," that is, attempts by public authorities to address specific and specialised issues that affect particular industries or regions. In view of the above, ordoliberalism can and should establish itself as the "Third Way" between the extremely selfish neoliberalism that still lives on and the newly revived Keynesianism with its interventionist industrial policies.

Research methods

The research methodology involves a critical analysis of the works of the most essential representatives of ordoliberal thought, particularly Walter Eucken and others, from the perspective of the above-mentioned purpose of the study. This requires examining German-, Polish- and English-language publications by authors recognised as representatives of mainstream ordoliberalism.

Results

The search for a socio-economic doctrine that would be capable of solving the problems of the modern world has often been limited to taking advantage of the policy instruments proposed by J. M. Keynes or by the neoclassical school of thought. In fact, these two concepts of economic policy tend to re-emerge in succession as the cornerstones of the electoral programmes of governing political parties. Unfortunately, however, neither of these doctrines alone can support an order that is founded on justice, freedom and responsibility – the very values that the modern world so badly needs. As a result, one may look to ordoliberalism as the theory that provides a set of normative frameworks which constitute a socio-economic order that combines the strengths of the Keynesian and neoliberal views while reducing the risk of their deficiencies coming into play.

The leading representatives of ordoliberalism, including Eucken, were clearly opposed to the main tenets of Keynes's theory. Therefore, as they formulated the principles of the ordoliberal competitive order, one of their goals was to create the right conditions for a balanced state budget, a stable currency and flexible prices that can effectively curb unemployment. Thus, the concept of ordoliberal order can prevent the negative consequences of Keynesian economics that can be observed today, including excessive public sector debt and increasing inflationary pressure. Furthermore, in contrast to Keynesianism, ordoliberalism offers the long-term perspective that is needed in the modern world. With regard to the time horizon of the economic order policy, a leading representative of ordoliberalism, Eucken, stated that "if this policy is not sufficiently stable, then the market-driven competitive order cannot take full advantage of its ability to function." (2004, p. 288). The author emphasised that the time horizon of the economic order policy determines the institutional structure of the supply and demand sides of the economy and that any instability of this policy triggers the tendency to create industrial clusters and corporate groups. A similar

long-term approach is also evident in the ideas of Ludwig Erhard, whose concept of the "formed society" was meant to be implemented over many decades.

A point of convergence between the ordoliberal theory of competitive order and Keynesian economics is the benefits – also recognised by Eucken – of fiscal stimulation of the economy in times of crisis. For instance, the literature dealing with the subject takes note of Eucken's support for Lautenbach's plan of 1931, which was a stimulus package designed to reduce the adverse effects of the Great Crisis in Germany. The relationship between Eucken's and Keynes's full employment policies has also been emphasised (Feld & *et al.,* 2021). This means that the implementation of the ordoliberal theory of competitive order – which coincides in some respects with Keynes's theory – may potentially produce effects similar to those for which the world so readily employs Keynesian policy instruments.

The ordoliberal theory of order also responds to the deficiencies of classical liberalism, which – by relying on the assumption that the socio-economic order (including the rules of the market) develops spontaneously in a bottom-up manner and that the role of the state is therefore limited to "not getting in the way" – has unfortunately led to the emergence of many of the problems that afflict the modern world. By permitting the markets to operate without a set of rules established and respected by all actors in the economic process, the liberal approach has produced growing income and material disparities with very significant externalities. This seems to validate the ordoliberal view that markets need explicit rules established by the state, which – by holding the appropriate powers – can enforce compliance with these rules and thus prevent the negative consequences of laissez-faire and free market ideas.

Ordoliberalism also makes it possible to resolve other problems inherent in neoclassical economics, namely the "institutional neutrality" and the fact that research is conducted on the basis of abstract models of general equilibrium – disconnected from the actual conditions in which the economic process takes place. According to Eucken, an economics that disregards the real-world economic order deserves to be called "stratospheric economics," soaring in the clouds of abstraction (Eucken, 2005, p. 28). This is why ordoliberals distinguish two levels of the socio-economic system for research purposes: the institutional level, also referred to as the economic constitution (*Wirtschaftsverfassung*), which is composed of the formal rules of the game, and the process level, which is the economic game itself. Within the ordoliberal theory of competitive order, there is a feedback between the two levels, which means that the analysis of the course of the

economic process is set within the cultural and social context of that process. This, in turn, increases the predictive capability and applicability of that analysis.

Both Eucken and representatives of liberal economic thought have placed the issue of free competition in the centre of attention. According to Eucken, the main advantages of an economic order based on the competition mechanism include a guarantee of the correctness of the economic calculation and a balance between the spheres of freedom and regulation, which – at the same time – ensures individual freedom and reduces the possibility of limiting the freedom of other individuals by creating powerful economic formations (Eucken, 2004). Eucken maintained that free competition occurs when both tenderers and clients compete with one another and, on this basis, develop their economic plans. Prices are not imposed as part of a market strategy but come from the market, and the only way to coordinate business is through freedom of exchange and contract. Free market competition is characterised by the absence of collusive cartels blocking buyers and suppliers (Eucken, 2004, pp. 247–250), who should have the same market power. Thus, a freely operating competition mechanism allows entities to participate in the unrestricted economic process, which may come from both state institutions and private entities. This approach makes it possible to perceive competition not only as a model that guarantees the greatest effectiveness at the level of the entire economy but also as a process that enables the protection of the freedom of participants in the economic process as the basic value of a society, which is an extremely important benefit in the context of the problems of the modern world.

Conclusions

The breadth and depth of the many problems faced by the modern world are the products of a crisis, among other things, in economics as a science. This is particularly true not only of the mainstream neoclassical economic theory, which has dominated the thinking of most economists for many decades, but also of Keynesian economics, since neither of these theories alone is capable of resolving and preventing the accumulation of global problems. A possible solution comes from the ordoliberal theory of competitive order, which combines the strengths of the liberal and Keynesian approaches while avoiding their pitfalls. Despite certain issues with the existing research on the ordoliberal theory (as previously discussed), this

theoretical approach has been steadily gaining acceptance in the past few years.

The problems of the modern world mentioned in this paper should serve as a motivation to depart from the quantitative perception of the role of the state and to choose a third way between classical liberalism and socialism. According to the ordoliberal theory, competition is the most important thing, but it has to take place within a framework of rules that ensure equal access to the market for all actors participating in the economic process. Responsibility for establishing and enforcing the rules of the ordoliberal competitive order rests with the strong state, whose primary focus is not so much the scope of regulations being implemented as it is the nature and contents of such regulations. Therefore, ordoliberalism carries a very important lesson: liberalism does not necessarily have to involve minimising the role of the state in the economy.

A major advantage of the ordoliberal theory is its long-term research perspective. In contrast to Keynes's claims that the state can only counteract a short-term economic imbalance, Eucken proposes an economic policy that does not focus on the current market process and instead aims to establish stable rules that foster the coordinating function of the markets.

Another aspect of the ordoliberal theory that needs to be highlighted is its methodological holism. The ordoliberal way of looking at the socio-economic system – not only in terms of the current course of the economic process but also, and above all, in terms of the environment in which this process is taking place – eliminates the problems inherent in neoclassical economics with its reliance on abstract models extracted from that environment. As a result, conclusions formulated on the basis of the ordoliberal theory take into consideration the context of the ongoing economic process and, by also taking into account the institutional environment, make it possible to design a socio-economic order that corresponds to the common interests of the citizens.

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The United Kingdom and European Union macroeconomic stability after Brexit

JEL Classification: *E02; E66; F15*

Keywords: *Macroeconomics Stabilization Pentagon, macroeconomic stabilization, Brexit*

Abstract

Research background: The United Kingdom has been triggered Article 50 of the Lisbon Treaty on 29th March 2017 and formally has been begun Britain's exit from EU. The Withdrawal Agreement entered into force on 1 February 2020. The very announcement of Brexit aroused many concerns and uncertainty. The Withdrawal has taken place in an orderly manner, the UK and the EU remain in close partnership with new agreements. Such a significant institutional change also may affect economy and indirectly macroeconomic stability.
Purpose of the article: This research aims to identify and assess the changes in macroeconomic stability in United Kingdom compare to European Union.
Methods: The method used in the study is a comparative analysis that employs a macroeconomic stabilization pentagon model (MSP). The macroeconomic stabilization pentagon is based on the GDP growth rate, the unemployment rate, the inflation rate, the budget balance and the current account balance. Time range of research is 2015-2021. The MSP indicators for United Kingdom and UE-27 are compared.
Findings & Value added: In the period 2015-2018, i.e. during the uncertainty as to the results of the Withdrawal Agreement negotiation, the MSP index fluctuates slightly, which we interpret as very small changes in macroeconomic stability. The UK's macroeconomic stability has fallen dramatically in 2020, the first year out of the EU. It is worth emphasizing that the UK's macroeconomic stability was lower than UE-27one throughout the period studied.
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Introduction

In a referendum on the 23rd of June 2016, the British people voted to leave the European Union. The withdraw process turned out to be more complicated than the voting people thought. Prolonged negotiations on the withdraw agreement caused a lot of uncertainty among the stakeholders. Britain would be carving out an unprecedented path. No nation state has ever held a referendum and then left the EU. While the process of economic integration is quite well researched, the theory of disintegration does not actually exist. Such a significant institutional change like disintegration also may affect economy and indirectly macroeconomic stability. The EU and trade agreements have been very successful in reducing trade costs and boosting trade between its members. This is a source an economic success and welfare increase. Therefore it could be expected that disintegration will hinder economic activity and result in a decline in prosperity. Dahindra et al. (2023) has examined the trade and welfare impacts of Brexit, which reduces the UK's deep trade commitments with European Union -its largest trading partner but opens up new avenues for deep trade agreements with economies outside the EU. They concluded that in every scenario analysis the UK economy experiences a welfare loss. The prolonged uncertainty about Brexit has affected economic conditions thus far (Makrychoriti & Spyrou, 2022). The United Kingdom withdrew from the European Union on 31 January 2020, a transitional period ended on 31 December 2020. Ultimately, the UK ceased to be a member of the EU at the beginning of 2021. The Brexit agreement has been implemented, causing a rise in barriers to trade, investment, and migration with the UK's largest economic partner (De Lyon & Dhingra, 2021). Great Britain has ceased to be a member of the Single Market, which means that it has left the regulatory union. Veterinary, sanitary, technical, etc. certificates became necessary for many goods. Obtaining them required additional time and entailed higher costs. There have also been changes in the UK. Great Britain in the settlement of VAT, excise duty and many others. This may have prompted some companies to reorient their sales and purchases on the EU market. Institutions are responsible for ordering and coordinating otherwise chaotic and unpredictable reality even if this happens only in actors' minds through the creation of expectations or maybe even stereotypes (Czech, 2014, pp. 310-312). According to the British statistical office ONS, an important factor hindering the exchange of goods in January was also introduced in the UK. In the first month of trading under the new legal conditions, there were huge perturbations at the borders. In Calais, the main port through which cars move from the continent to the UK. In the UK, there were huge queues of lorries that

were stopped because of missing or incorrect documents. Some transport companies suspended their services because they were unable to cope with the additional administrative, logistical, regulatory, etc. requirements and the cost of very long downtimes (Kawecka-Wyrzykowska & Ambroziak, 2021, pp.55-82). It is a significant institutional change, like the economy transition or integration, so the similar scientific methods can be used to assess macroeconomic stability.

This research aims to identify and assess the changes in macroeconomic stability in United Kingdom compare to EU-27.

The study period covers the years 2015-2021, that is, the period from the year before the Brexit vote to the UK's first year outside the European Union. The British withdrawal has coincided in time with the pandemic crisis, which affected all European countries. Therefore, EU-27 countries were used as a comparative group, strongly affected by the covid-19 pandemic, but to a lesser extent by Brexit.

Research methods

The research hypothesis was formulated: Macroeconomic stability has decreased to a greater extent in the UK than in the EU-27.

Macroeconomic stabilization means the existence of a permanent economic balance (internal and external), both in real and monetary terms. R. Mundell and A.W. Phillips put forward a method of analysis of the economy, the so called magic quadrangle, presenting the achievements in each year in terms of one of the four objectives of economic policy: rapid growth, full employment, low inflation and external balance. From the magic quadrangle method is derived the concept of the macroeconomic stabilization pentagon (Żuchowska, 2013, pp. 49).

In Poland, the concept of macroeconomic stabilisation pentagon, supplemented by an additional criterion (state budget), was developed in 1990 at the Foreign Trade Research Institute (Instytut Koniunktur i Cen Handlu Zagranicznego), and in subsequent years was used in the analysis by Kołodko (1993). This model is useful in the assessment of the degree of economic policy coordination in achieving the objective of macroeconomic equilibrium (Moździerz, 2019, pp.295-315). The macroeconomic stabilisation pentagon model is mostly used to assess the transition economy. However, the disintegration, like Brexit, is a significant institutional change, that affects various areas of the economy, too. Therefore, the use of this method seems reasonable.

The model of the macroeconomic stabilisation pentagon includes five basic macroeconomic indicators:

1. economic growth rate (GDP), a synthetic expression of the level of economic development of the country;
2. unemployment rate (UNE), measured as the ratio of the labour force able to work to the number of employees;
3. inflation rate (INF), regarded as an indicator of internal balance and measured by the consumer price index;
4. state budget balance (GOV), measured in relation to the GDP;
5. current account balance (CAB), measured in relation to the GDP.

The pentagon vertices are calibrated in such a way that the better the development of the analysed indicators, the further away they move from the centre. The scales adopted for each variable are increasing or decreasing, depending on which direction of change is considered positive for the economy (for example, decreasing for the rates of unemployment and inflation, and increasing for the rate of GDP). The macroeconomic stabilisation pentagon has five triangles (Żuchowska, 2013, pp. 50–52):

a – d the real sphere triangle, bounded by the GDP changes and unemployment rates;

b – the stagflation triangle, i.e. of unemployment and inflation;

c – the budget and inflation triangle, the shape of which depends on the inflation dynamics and the state budget balance;

d – the financial equilibrium triangle, determined by the sizes of the state budget balance and the current account state;

e – the external sector triangle, resulting from the formation of the current account balance and the GDP growth.

$$MSP = a + b + c + d + e =$$
$$[GDP \cdot UNE + UNE \cdot INF + INF \cdot GOV + GOV \cdot CAB + CAB \cdot GDP] \cdot k\,,$$

where:

$k = ½\, sin\, 72^{\circ} = 0{,}4755$;

GDP — economic growth rate;

UNE — unemployment rate;

INF — inflation rate;

GOV — state budget balance;

CAB — current account balance.

MSP1 = a + b + c, determines the formation of the inner sphere, and MSP2 = d + e, represents the sphere dependent on external factors (Żuchowska, 2013, p.52). This model characterises selected macroeconomic

values only at a given moment. By using this set of indicators, the macroeconomic stability of individual countries can be compared with each other. According to the model, one can talk about destabilisation in the case of the decline in the MSP indicator, and about progressive stabilisation – in the case of its growth.

The calculation of MSP indicators, as well as MSP1 and MSP2, required the arbitrary determination of the maximum and minimum values of the analysed macroeconomic variables. They were used to determine the vertices of the pentagon and the scale for each variable. On their basis, the areas of the partial triangles were estimated (assuming that the maximum value of such a field is 0.2, and the area of the pentagon MSP 1) (see Żuchowska, 2013, p.53). It follows that the calculated indicators are relative, they show which of the surveyed countries are more and which are less stable.

Studying the macroeconomic effects of Britain's withdrawal from the European Union faces a serious problem, namely the occurrence of a pandemic crisis at the same time. Due this coincidence, it is difficult to judge to what extent the Covid-19 pandemic is responsible for the macroeconomic imbalance, and to what extent Brexit is responsible. The lockdown policies implemented by most governments in response to the spread of the Covid-19 epidemic in the spring of 2020 result negative macroeconomic and welfare effects (Auray & Eyquem, 2020, pp.). However, the pandemic crisis affected all European countries. Therefore, EU-27 countries were used as a comparative group. Comparative analysis of the main macroeconomic indicators is the basis for assessing the current state of a given economy in relation to other countries (Roszko-Wójtowicz & Grzelak, 2020, pp. 657-688). As the covid-19 pandemic affected all the countries surveyed, this decline in macroeconomic stability could be a result of the UK leaving the EU.

The source of data is Eurostat Database. Time range of research is 2015-2021. Year 2022 remains out of scope. This is an intentional exclusion, in 2022 the increase in the prices of raw materials and energy caused by the war strongly disturbs macroeconomic stability, and the intention of the research was to examine the impact of Brexit.

Results

The MSP indicator remained almost at the same level throughout the negotiation period (table 1 and table 2). This indicator even slightly increased for Great Britain from 0.521 in 2015, 0.523 in 2016, 0.555 in 2017, 0.560

in 2018, to 0.602 in 2019. Similar for EU-27, the MSP increases form 0.637 in 2015 to 0.696 in 2019. Uncertainty about the UK's future relationship with the EU has not been reflected in the deterioration of macroeconomic stability. However, in 2019 the macroeconomic stability in UK was at lower level than EU-27 (see figure 1). As we see at figure 1, UK has significant worse current account balance than UE-27, but lower rate of unemployment in 2019. In 2020 the MSP indicator decreased rapidly, to 0.285 for United Kingdom and to 0.422 for EU-27. United Kingdom remained macroeconomically less stable than the rest of EU, but in the year of withdrawal the instability increased dramatically (see figure 2). As is shown on figure 2, there is a decrease in GDP growth, increase state budget deficit and got worse current account balance in 2020, both in UK and EU-27. Of course, partially this instability occurs due pandemic crisis, but in UK the decrease is much more deeper than the rest of EU.

The MSP1 indicator, which, determines the formation of the inner sphere (the real sphere triangle, bounded by the GDP changes and unemployment rates; the stagflation triangle, i.e. of unemployment and inflation; and the budget and inflation triangle, the shape of which depends on the inflation dynamics and the state budget balance) remained stable until 2019 (see table 1 and table 2). The inner sphere was more stable in UK than in EU-27 till 2019. Later, the deterioration in stability was greater in the United Kingdom.

The MSP2 indicator, which determines the formation of the sphere dependent on external factors remains lower for UK compare to UE-27 (see table 1 and table 2). Great Britain experienced much more macroeconomic instability in the spheres the financial equilibrium triangle, determined by the sizes of the state budget balance and the current account state; and the external sector triangle, resulting from the formation of the current account balance and the GDP growth. As with previous indicators, we also see a significant decline in stability in 2020, much stronger for the UK.

Comparing Figure 2 to Figure 3, we find that macroeconomic stability has improved in 2021. However, in the UK it remains at a lower level than in the compared group of EU-27 countries.

It is optimistic that in 2021 the MSP, MSP1, MSP2 indicators for all the countries surveyed increased, which should be interpreted as an increase in macroeconomic stability. However, a detailed analysis of the data from Table 1 shows the decline of stability in the area b-the stagflation triangle in both cases in 2021. In addition, we see no improvement and even a slight increase in instability the shape of which depends on the inflation dynamics and the state budget balance for UK in 2021.

Conclusions

The Brexit is a significant institutional change. Even without the common currency Great Britain was a part of Single European Market, ensuring the free movement of capital, labour, services and goods without tariff and non-tariff barriers**.** The prolonged wait for the future agreement between the UK and the EU resulted in high economic uncertainty. But the long period of negotiations did not destroy macroeconomic stability. The macroeconomic stabilization pentagon (MSP) indicator remained stable almost at the same level during period 2015-2019.

It should be noted, however, that throughout the period under review, the macroeconomic stability of the United Kingdom remained at a noticeably lower level than the comparable stability of the group of EU-27 countries.

We observe a massive increase in macroeconomic instability in 2020. This is the year of the United Kingdom's exit from the European Union, but at the same time the Covid-19 pandemic crisis beginning. This is the most serious limitation of this research, despite the use of comparative analysis, we cannot be sure to what extent factors other than Brexit caused a decline in macroeconomic stability. Given the timing of the UK's departure from the EU and the outbreak of the COVID-19 pandemic, it is not possible to fully isolate their individual economic effects from one another. Comparative analysis of the main macroeconomic indicators is the basis for assessing the current state of a given economy in relation to other countries (Roszko-Wójtowicz & Grzelak, 2020, pp. 657-688). The Covid-19 pandemic affected all the countries surveyed, this was a symmetrical shock. However, the investigated indicators not change symmetrical. The MSP indicator decreased much more for Great Britain than for the rest of the EU-27 countries. We interpret this excess decrease compared to the control group as a result of Brexit. Next year the macroeconomic stability increase in both case, but in UK remain at lower level than in European Union**.**

The research hypothesis, Macroeconomic stability has declined more in the UK than in the EU-27, has been confirmed. As the COVID-19 pandemic affected all the countries surveyed, this decline in macroeconomic stability could be a result of the UK leaving the EU.

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Annex

Table 1. United Kingdom sub-indices and the MSP index

	2015	2016	2017	2018	2019	2020	2021
Area a	0.137	0.142	0.145	0.151	0.154	0.017	0.122
Area b	0.145	0.144	0.136	0.140	0.148	0.146	0.136
Area c	0.133	0.138	0.131	0.134	0.138	0.075	0.099
Area d	0.045	0.044	0.064	0.060	0.072	0.036	0.064
Area e	0.061	0.056	0.079	0.075	0.091	0.010	0.089
MSP1	0.415	0.424	0.412	0.425	0.439	0.239	0.357
MSP2	0.106	0.100	0.143	0.135	0.163	0.046	0.153
MSP	0.521	0.523	0.555	0.560	0.602	0.285	0.510

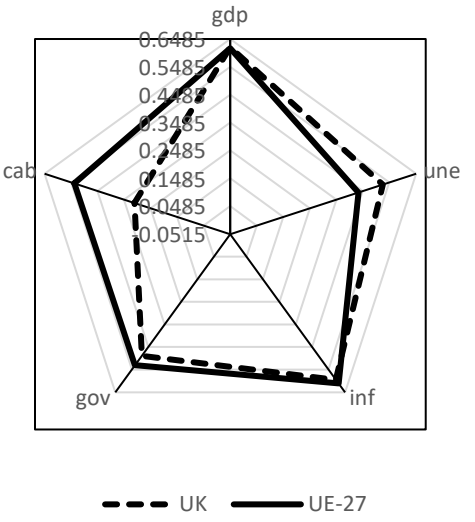
Source: own calculations based on Eurostat database.

Table 2. UE-27 sub-indices and the MSP index

	2015	2016	2017	2018	2019	2020	2021
Area a	0.093	0.103	0.109	0.120	0.126	0.034	0.110
Area b	0.099	0.108	0.110	0.116	0.125	0.127	0.113
Area c	0.152	0.156	0.149	0.149	0.154	0.120	0.118
Area d	0.132	0.139	0.140	0.140	0.135	0.098	0.113
Area e	0.161	0.167	0.159	0.161	0.157	0.043	0.140
MSP1	0.344	0.366	0.368	0.385	0.405	0.282	0.341
MSP2	0.293	0.306	0.299	0.301	0.292	0.141	0.253
MSP	0.637	0.672	0.666	0.685	0.696	0.422	0.595

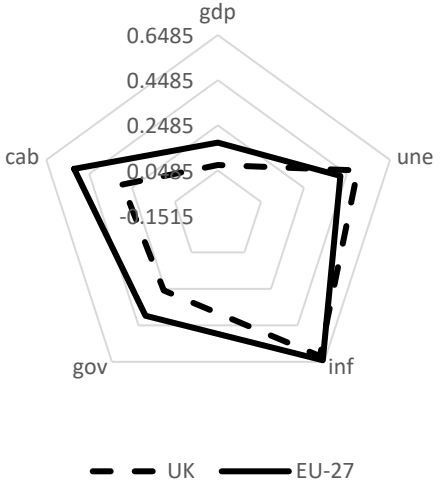
Source: own calculations based on Eurostat database

Figure 1. Macroeconomic Stabilization Pentagon in 2019



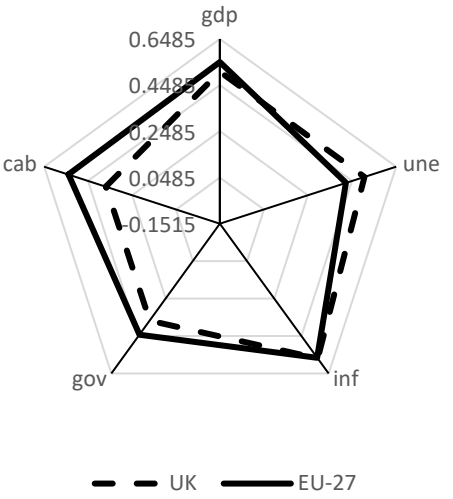
Source: own calculations based on Eurostat.

Figure 2. Macroeconomic Stabilization Pentagon in 2020



Source: own calculations based on Eurostat.

Figure 3. Macroeconomic Stabilization Pentagon in 2021



Source: own calculations based on Eurostat.

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Exploring the correlation between regional variability in the level and quality of education and population income inequality

JEL Classification: *D31, I21, I24, I25*

Keywords: *education level; income level; income inequality; poverty risk; EU countries; variability; regression analysis*

Abstract

Research background: In some countries, far more commonly than in other regions, the youth are considerably more successful in completing higher education, and adults are eager to raise their competencies even after having finished education. In other regions, the opposite is true, with relatively more young people leaving education early, not working or receiving any training. Are the causes of those disparities in the level and quality of education (EL) attributable to population income inequality (IL)? Or is it perhaps that low levels of education contribute to income inequality and increased risk of poverty among populations?
Purpose of the article: The article sought to investigate whether a correlation exists between the level and quality of education (EL) and population income inequality (IL), as well as assess the scale of the variation and trends in this regard, as of before and during the economic crisis.
Methods: To assess the issue in question, 16 variables and 27 objects/countries of the European Union were used. The research period covered the years 2012-2021. In order to examine the variability and the trends at play, the coefficients of variation V_s and R were calculated. Multivariate analysis of the data was carried out, followed by an exploration of the links between the level and quality of education (EL) and population income inequality (IL) via the method of correlation and multiple regression.
Findings & Value added: The study has confirmed the existence of a significant correlation between regional variability in the level and quality of education (EL) and population income inequality (IL). The marginalization of certain social groups has intensified even more during the current economic crisis. Substantial

correlations persist between countries with high population incomes and the percentage of tertiary education holders and adults furthering their education. In parallel, as the percentage of young people not in education or employment decreases, countries' GDP and income levels rise, while income inequality and poverty risk decrease. Knowledge of the aforementioned interdependencies is vital for the implementation of education policy as one of the biggest levers reducing educational disparities and thus income inequality in the population.

Introduction

The urgency of studying inequality has been evidenced by the international institutions' expressed concerns regarding the persistence and growth of inequity, which is considered a major challenge of our time, with increasing talk of inequality worsening as an effect of pandemic shock (Davidescu et al., 2022).

The connection between income inequality and the level and quality of education lies at the heart of current academic and policy debates on social and economic development. Research on the impact of the level and quality of education on income and income inequality as well as economic development has been undertaken by many academics (Ansari, 2016; Banzragch et al., 2019; Dao, 2020). The literature emphasizes the fact that education and skills have become increasingly vital determinants of life outcomes (Vandeplas, 2021), whereas economic development as well as prosperity and social cohesion can be achieved through well-designed and well-targeted investments in education (Algan et al., 2021). Education is both a determinant of prosperity and a core sustainable development resource. The expectations regarding the redistributive role of the state, as well as the individual efforts to harmoniously integrate all the economic, social and environmental problems affecting each and every one of us, are largely dependent upon education (Biasutti & Frate, 2017; Bijl et al., 2010). The factor differentiating the level of both education as well as income is residency (Beltrán Tapia & Martinez-Galarraga, 2018).

The causes of income inequality can be many, and it is difficult to determine conclusively whether income inequality is the trigger of low levels of education, or whether it is the level of education that affects inequality. Taking the above into account, therefore, several paper objectives were set. In order to implement these objectives, a number of international source databases were used. Multivariate analysis, correlation analysis and multiple regression were applied on a sample of 16 independent and dependent variables collected for 27 EU member countries. The first study objective

was to (i) assess the pre-crisis and present magnitude of changes and inequalities be in the level of education (EL) and the level of income inequality (IL) among EU countries, and (ii) analyze the interdependencies between the variables characterizing the issues under study. The realization of the paper objective was to allow verification of a hypothesis assuming that EU countries continue to diverge significantly in terms of the level and quality of education, and the disparities have intensified even more during the crisis, substantially affecting population income levels, income inequality and the risk of poverty.

Research methods

The source of the empirical data entailed the information collected by the European Statistical Office (*Eurostat*, 2023). Twenty-seven countries (objects) of the European Union were analyzed. The research period covered the years 2012-2021.

The specific data sources comprised:

- The Statistical Office of the European Union,
- European Union statistics on Income and Living Conditions (EU-SILC),
- European System of National and Regional Accounts (ESA 2010),
- European Union Labour Force Survey (EU-LFS).

In order to achieve the paper objectives, a selection of variables describing EL and IL in EU countries was made. Consequently, a numerical database consisting of sixteen indicators was created:

1. Indicators characterizing the EL level and quality of education (independent variables):
   - X_{01} (ELET) - Early leavers from education and training 18-24 ages [%],
   - X_{02} (TEA(25-34) - Tertiary educational attainment (ISCED level 5-8) of people aged 25-34 [%],
   - X_{03} (NEET) - Young people neither in employment nor in education and training (NEET rate) 15-24 ages [%],
   - X_{04} (APL) - Adult participation in learning 25-64 ages [%],
   - X_{05} (PLBDS) - Share of individuals having at least basic digital skills 16-74 ages [%],
   - X_{06} (STE) - Students in tertiary education - as % of 20-24 years old in the population,
   - X_{07} (PEAL(0-2) - Population by educational attainment level (less than primary, primary and lower secondary education - levels 0-2 ISCED 2011) [%],

X_{08} (PEAL(3-4) - Population by educational attainment level (upper secondary and post-secondary non-tertiary educations - levels 3-4 ISCED 2011) [%],

X_{09} (PEAL(5-8) - Population by educational attainment level (tertiary education - levels 5-8 ISCED 2011) [%].

2. Indicators characterizing the IL population income inequality (dependent variables):

Y_{01} (GDP EURO) - Real GDP per capita in euro,

Y_{02} (GDP PPS) - Purchasing power adjusted GDP per capita in PPS,

Y_{03} (AGDIH PPS) - Adjusted gross disposable income of households per capita in PPS,

Y_{04} (MENI_EURO) - Mean equivalised net income per capita in euro,

Y_{05} (IID) - Inequality of income distribution [-],

Y_{06} (GINI) - Gini coefficient of equivalised disposable income (0-100) [%],

Y_{07} (RPR) - At-risk-of-poverty rate [%].

The descriptive and graphical analysis of the study results employs European Union Member State abbreviations accordant with ISO 3166 Alpha-2 codes developed by the International Organization for Standardization: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE).

The selection of X and Y variables was based on the expert method, which entailed discussions with independent experts on the validity of the choice of variables. The decision on the target indicators was contingent on the availability of complete and up-to-date data on all EU member states, as well as on the experts' positive assessment of the variable selection.

The variables were subjected to detailed statistical analysis (Table 1 and Table 2). Coefficients of variation V_s, measures of dispersion R, asymmetry A and kurtosis K were calculated, among others. The coefficient of variation V_s and measure of dispersion R were employed to assess the heterogeneity of the countries under examination.

The coefficients of variation V_s calculated for all variables over the entire 2012-2021 research period exceed the adopted threshold of 10%, therefore, the objects/countries are characterized by variation sufficient enough to carry out further analysis thereon. Verification of the hypothesis on the normality of the variables' distribution was also undertaken, via the Shapiro-Wilk test. Variables for which the Shapiro-Wilk test reached statis-

tical significance ($p<0.05$) exhibit distributions deviating from the Gauss curve, hence they were eliminated from certain analyses, e.g., variable X and Y interdependence testing via multiple regression. These variables are X_{03}, X_{04}, X_{06}, X_{07}, Y_{01}, Y_{02}. The variables were also assessed for their impact on the phenomena analyzed, and divided into stimulants (X_{02}, X_{04}, X_{05}, X_{06}, X_{09} and Y_{01}, Y_{02}, Y_{03}, Y_{04}) as well as destimulants (X_{01}, X_{03}, X_{07}, X_{08} and Y_{05}, Y_{06}, Y_{07}). Given the fact that data on some objects/countries, or pertaining to particular years under study, were missing (n.d.), variable Y_{03} was eliminated from some analyses (Table 1 and Table 2).

An additional calculation was made of the correlation coefficients r_{xy} for the independent variables X (r_{xx}), followed by the dependent variables Y(r_{yy}), in order to verify and eliminate those carrying the same information on the phenomenon under consideration (Murawska et al., 2020). Ultimately, the following variables were adopted as the most valid upon the detailed statistical analysis and reduction:

1. X_{01} i X_{02}, to assess the level of education (EL)
2. Y_{04} i Y_{05}, to assess income inequality (IL).

The r_{xy} coefficients of correlation between the independent variables X and the dependent variables Y were calculated as well, with the aim of exploring the interdependencies among the characteristics of the objects (countries) examined in terms of the indicators describing the phenomena under study. In the next step, multiple regression analysis was performed.

Results

On the negative side, Europe's significant gaps in educational attainment and basic skills persist (Vandeplas, 2021). As mentioned earlier, EU-27 countries are significantly divergent in terms of the indicators characterizing both the level and quality of education (EL) as well as population income inequality (IL) (Figure 1). The greatest variability can be noted in the percentage of 25-64 y/o adults is post-education education (X_{04}), as well as in variables Y_{01} and Y_{04}, which indicates very large country-to-country gaps in economic development and population income.

Alarmingly, ever since the crisis began in 2020, an increase in the country-to-country variation (V_s) has followed for almost all variables describing both EL and IL. Only for variable X_{04} (percentage of adults in post-education) the differential decreased in 2021. Likewise, the gap also narrowed slightly for only two indicators describing IL, namely Y_{01} (real GDP per capita in Euros) and Y_{03} (adjusted gross disposable income of households per capita in PPS). Particularly during economic crises, it is essential

to monitor the country-to-country disparity changes in both education and income inequality. As highlighted by Algan et al. (Algan et al., 2021), better educated, both quantitatively and qualitatively, European countries recover faster from economic crises and show greater economic resilience.

The analysis of the r_{xy} relationship between the independent variables X and dependent variables Y has yielded interesting results, leading to some thought-provoking conclusions. Indeed, the variation in the values of the variables representing income in EU-27 countries, i.e., Y_{01}, Y_{02} i Y_{03}, is influenced by nearly all independent variables, namely significant positive stimulants X_{02}, X_{04}, X_{05}, X_{09}, as well as significant negative destimulants $X_{03,}$ and, curiously enough, X_{06} and X_{08}. There is no significant effect of variable X_{01} and X_{07}. As such, it can be concluded that a higher percentage of tertiary education holders, both those under 35 as well as under 65 years of age, individuals in post-education training and digitally skilled persons, at a lower proportion of young people who are not working nor in education and, interestingly, falling number of students and/or individuals holding secondary education qualification, contribute significantly to a country's higher GDP and population income (Table 3).

The correlation results showed that the percentage of 18-24 y/o early education leavers in a given EU-27 country displayed no interdependence with income (Y_{01}, Y_{02}, Y_{03}) yet, alarmingly, a significant positive effect on the dependent variables Y_{05} and Y_{06}, characterizing income inequality, occurs. Significant positive effect on variables Y_{05}, Y_{06} and Y_{07} is exerted by X_{03}, whereas negative by variable X_{05}. Based on the above results, it can therefore be inferred that income inequality and the risk of poverty in the EU-27 increase with an upward trend in the percentage of young early education/training leavers as well as those not in employment, education or training. Poverty risk and income inequality, in contrast, are significantly lower in countries characterized by a higher percentage of persons with minimum basic digital skills (Table 3).

The multiple regression analysis indicated significant positive correlational links between the five independent variables X and the factored in dependent variables Y_{04} and Y_{05}. The high values of the correlation coefficient r evidence the existence of the dependence. This means that the income level and the scale of IL inequality (equality) are significantly affected by the level and quality of education in the country. It is worth noting that the coefficients of determination at R^2=0.62 and R^2=0.43 were indicative of an approximately 60 percent effect of independent variables X on Y_{04} (income level variation), and an approximately 40 percent effect on Y_{05} ((income distribution inequality variation). This implies the existence of

other determinants responsible for the remaining variability in the level of income and income inequality (Table 4).

Conclusions

The present study confirmed the significant interdependencies between regional variability in the level and quality of education (EL) and population income inequality (IL). The variation among EU countries in this regard is considerable, and the marginalization of the outliers has intensified even more during the current economic crisis. Significant positive correlations exist between EU countries with high population incomes, and the percentage of tertiary education holders and adults furthering their education. Concomitantly, as the percentage of young early education leavers, not in education or employment (the so-called NEETs) decreases, GDP and income levels rise significantly, while income inequality and the risk of poverty decline. With knowledge of the above interdependencies and the relevance of education policy as one of the biggest levers reducing income disparities, it is advisable to seek educational equalization and promote equal access to education in all countries.

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Annex

Table 1. Statistical characteristics of variables describing EL in the EU-27 countries (data for 2021)

Variable	S/D	$\bar{x}_j$	x_{min}	x_{max}	V_s	R	A	K	SW-W
X_{01}	D	8.2	2.4 (HR)	15.3 (RO)	41.3	12.9	0.1	-0.6	0.98 (ND)
X_{02}	S	44.5	23.3 (RO)	62.6 (LU)	22.2	39.3	-0.1	-0.3	0.98 (ND)
X_{03}	D	10.0	5.1 (SE)	19.8 (IT)	34.8	14.7	1.2	1.8	0.90
X_{04}	S	12.6	1.8 (BG)	34.7 (SE)	66.0	32.9	1.1	0.9	0.90
X_{05}	S	56.3	27.8 (RO)	79.2 (FI)	21.5	51.4	-0.3	0.5	0.97 (ND)
X_{06}	S	34.1	8.5 (LU)	45.1 (GR)	22.2	36.6	-1.6	4.0	0.89
X_{07}	D	21.6	10.9 (LT)	40.3 (PT)	37.9	29.4	1.1	0.7	0.87
X_{08}	D	46.3	25.6 (ES)	64.5 (CZ)	22.7	38.9	0.0	-0.8	0.97 (ND)
X_{09}	S	32.1	16.4 (RO)	45.2 (IE)	24.0	28.8	-0.3	-0.6	0.97 (ND)

Key: *S* – stimulant, *D* – destimulant, $\bar{x}_j$ – average value UE (27), x_{min} – minimum value for the country, x_{max}- maximum value for the country, V_s – coefficient of variation in %, *R* – range (max-min), *A*– asymmetry, *K*– kurtosis, SW-W- Shapiro-Wilk test result, ND – normal distribution

Source: own elaboration based on (*Eurostat*, 2023).

Table 2. Statistical characteristics of variables describing IL EU-27 countries (data for 2021)

Variable	S/D	$\bar{x}_j$	x_{min}	x_{max}	V_s	R	A	K	SW-W
Y_{01}	S	28,182	6,950 (BG)	84,490 (LU)	65.1	77,540	1.6	2.7	0.85
Y_{02}	S	33,796	18,600 (BG)	87,100 (LU)	44.1	68,500	2.4	6.5	0.74
Y_{03}	S	22,757	n.d.	36,319 (LU)	23.1	20,403	0.7	0.2	0.94 (ND)
Y_{04}	S	19,593	5,446 (RO)	48,220 (LU)	55.0	42,774	0.7	0.1	0.92 (ND)
Y_{05}	D	4.8	3.0 (SK)	7.5 (BG)	25.6	4.4	0.7	-0.4	0.94 (ND)
Y_{06}	D	29.4	20.9 (SK)	39.7 (BG)	14.7	18.8	0.3	0.0	0.98 (ND)
Y_{07}	D	16.3	8.6 (CZ)	23.4 (LV)	24.8	14.8	0.1	-1.0	0.96 (ND)

Key: as in Table 1.
Source: own elaboration based on (*Eurostat*, 2023).

Table 3. Correlations r_{xy} between independent variables X characterizing EL and dependent variables Y characterizing IL (data for EU(27) in 2021)

Variable	*The correlation coefficients marked by an asterisk are significant with p < .05000; N=27 (missing data was deleted on a case-to-case basis)								
	X_{01}	X_{02}	X_{03}	X_{04}	X_{05}	X_{06}	X_{07}	X_{08}	X_{09}
Y_{01}	-0.11	0.62*	-0.43*	0.55*	0.60*	-0.42*	0.13	-0.56*	0.63*
Y_{02}	-0.10	0.60*	-0.36	0.42*	0.49*	-0.51*	0.05	-0.48*	0.60*
Y_{04}	-0.01	0.58*	-0.47*	0.63*	0.64*	-0.38*	0.20	-0.61*	0.62*
Y_{05}	0.42*	-0.30	0.59*	-0.39*	-0.57*	0.05	0.33	-0.02	-0.32
Y_{06}	0.39*	-0.18	0.51*	-0.34	-0.50*	0.01	0.33	-0.12	-0.19
Y_{07}	0.31	-0.18	0.55*	-0.28	-0.46*	-0.02	0.31	-0.09	-0.20

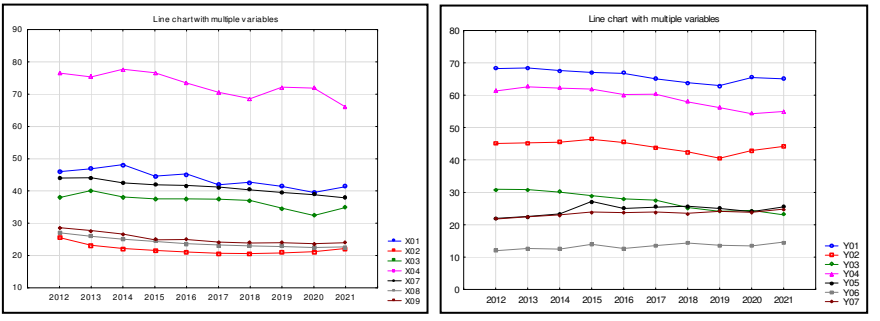
Source: own elaboration based on (*Eurostat*, 2023).

Table 4. Summary of dependent variable Y_{04} and Y_{05} multiple regression with independent variable X_{01}, X_{02}, X_{05}, X_{08}, X_{09} (data for EU-27 countries in 2021)

Statistics	Y_{04}	Y_{05}
Multiple r	0.787	0.655
Multiple R^2	0.619	0.429
Corrected R^2	0.528	0.292
F(5,21)	6.819	3.149
p	0.001	0.028
SEE	0.687	0.841

Key: r - linear correlation coefficient; R^2 - coefficient of determination; F - F statistics; p - critical significance level; SEE - The standard error of the estimation.

Figure 1. 2012-2021 levels of and changes in the variation of EU-country-describing variables X and Y (27 cases, based on the coefficient of variation V_s - raw data)



Source: own elaboration based on (*Eurostat*, 2023).

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Opportunities and threats of economic stabilization policies during the COVID-19 pandemic: An empirical study of the European Union

JEL Classification: *C10; E62; F44*

Keywords: *Economic Shocks; economic stabilization policy; COVID-19; European Union*

Abstract

Research background: Although the Covid 19 pandemic has imposed unprecedented economic shocks all over the world, but the economical dysfunction imposed by the Covid-19 pandemic on workers and firms were less than anticipation in European Union. One of the vital reasons behind it was the immediate economic stabilization policy measures adopted by the EU to handle the economic shocks through a good support to the business and workers with short-time work schemes as well as firms with substantial liquidity support. Yet the Euro economic stabilization policy measures fail to reach out the long-term economic growth and stability during or post-pandemic period.
Purpose of the article: Considering that economic growth and stability are closely related, the opportunities and threats of the economic stabilization policies and their effectiveness in the EU will not only contribute on the empirical research gap related to the revision of economic stabilization policies adopted during this period but also provide further recommendations to adopt more effective policy measures in future.
Methods: In this study, we will first review the recent literature on economic stabilization policies and its effectiveness in the EU during the COVID-19 pandemic with statistical analysis. Secondly, we will cross examine and compare the performance of economic stabilization policies 2020- 2024 (pre, during and post pan-

demic period in a smaller extent), to get a clear footprint based on its effectiveness measuring indicators such as GDP, HICP, Unemployment, Unit labor costs, Compensation per employee, Labor productivity, General government budget balance, Structural budget balance , fiscal stance, Current account balance by using the correlation co-efficient test.

Findings & Value added: The findings indicate the necessity of revision and reformation of Economic Stabilization Policies through a cross-examination of their effectiveness and cyclicality in Euro area in response to the covid-19 pandemic, such as explicit mandates, consideration of time and situation, motivation to come up, establishment of effective control measures, long-term predetermined alignment among the member states of the European Union, and so on.

Introduction

During this covid-19 pandemic, all the euro area was compelled to concentrate on different economic stabilization policy measures to stimulate teh national economy like fiscal and monetary policy reformation, different liquidity support measures etc. The Economic Stabilization Policy mainly contributes on achieving the macroeconomic goals like reduced unemployment balanced budgets, price stability and dealing with inflation, deficits, recession and so on (Czeczeli Vivien et al., 2020). To keep the economical wheel activated, and balanced among the euro area, they emphasize on structural develpment of economical reformation and increase the rate of public investment at national level that may prove beneficial to provide support to the other badly hampered European economies.

Common Equity Tier 1 (CET1) ratio has reflected the financial soundness of the EU banking sector. Everything was financially fit and fine. It has risen from 9% by 2009 and reached nearly 15% in the fourth quarter of 2019. But suddenly, the COVID-19 pandemic has created an unprecedented economic contraction in 2020, which results in the fall of EU real GDP by 6.1%, exceeding the result of the global financial crisis 2008 (Menguy, 2022).

European Commission had initiated different country-specified recommendations for designing the economic stabilization policy measures in response to the covid-19 pandemic, even from the 2020 European Semester. During the same year the EC have started to accumulate and allot recovery fund for the investments and structural reforms in future. But still economic stabilization policies adopted during that time need cross examination and, in some extent, revision like inclusion of some explicit mandates, maintaining alignment among one another etc.

Research methods

This research mainly focus on the opportunities and threats of the economic srtabilization policies during the covid-19 pandemic. At first in this paper we tried to represent the critical analysis of the opportunities and threats of the economic srtabilization policy measures through different literatures and afterwards, those policy response is tried to be examined through these indicators (GDP, HICP, Unemployment, Unit labor costs, Compensation per employee, Labor productivity, General government budget balance, Structural budget balance, fiscal stance, Current account balance). These indicators are chosen based on the long term data availability and scope to represent their fluctuations before, during and after the pandemic. These data were extracted from the database of EUROSTAT (2023) and EUROPEAN CENTRAL BANK (2023).

This study is limited on economic stabilization policies adopted during the covid-19 pandemic and their on ground effectiveness accross the Euro area. The real GDP here represnted as independent variable while analysing the on ground effectiveness of economic stabilization policy measuring indicators. The time series represented in this study is from 2020 to 2024 due to the shortage of time and paper length.

Here mainly the relationship between the two variables is represented by utilizing the formula of Pearson correlation coefficient:
The formula for the Pearson correlation coefficient, r, is:

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})2 \sum(y - \bar{y})2}}$$

where x and y are the sample means average (array1) and average (array2).

Results

Stability and Growth Pact's general escape clause by ECOFIN Council fixed the fiscal adjustment scale according to the design, perfection, time and target but COVID-19 pandemic has brought drastic changes and heterogeneity in fiscal policy. As evidence, the euro area budget deficit had reached to 8.5% of GDP in 2020 from 0.6% of GDP in 2019 (European Commission Economic Forecast, Spring 2020) (Eurostat 2023).

According to the European Commission Economic Forecast, Spring 2020, The european union had declared discretionary fiscal measures as

3.25% of total GDP, market loaans and liquidity support as 20% of total GDP, along with many other initiatives like Pandemic Emergency Purchase Programme (PEPP) that 12% of GDP, near around €1.35 trillion to ensure the medium term price stabilization while purchasing extra asset in a flexible way. This PEPP mainly works as a transmission of monetary policiy while TLTRO III programme emphasize on protection of credit supply. Not only with the market function, but also the EU had focused on the temporary support with a view to mitigating unemployment on emergency purposes and introduced the SURE programme, unlock short term employment schemes at national level with €540 billion of funding. The Recovery and Resilience Facility (RRF) €312.5 billion of grants and up to €360 billion of loans worst affected economy among the european member states without increasing national deficits or debt, motivate member states to improve the growth-friendliness in terms of their fiscal policies, and develop medium term fiscal strategies (Kose et al., 2023).

Although Commission is quite flexible regarding the economic shock management during the pandemic period and suggested to sustain and recover the economy and once it is accomplished then move towards attaining medium-term fiscal sustainability and that is currently suggested to deactivate of 2023 along with country specific considerations (Haroutunian, Hauptmeier, and Leiner-Killinger 2020).

Fiscal policy should maintain its competence with the situation, there should neither be any premature withdrawal of fiscal support nor should blindly dependent on public finances (Mileusnic, 2022). In the event of large economic shocks, the ability to steer the fiscal stance in the euro area has lack of effective policy measures in good time as well as coomplete depndency at national level in the absence of any central controlthat make the situation complex (Haroutunian et al., 2020).

On the other hand, Monetary policy responses through low interest rates facilitate the public expenditure that help to avoid a low-growth with high-debt trap during the pendemic period. Basically it imposes three challenges for the ECB. They are as follows-

a. Stabilization of financial markets;
b. Protection of credit supply;
c. Dealing with the negative impact on the projected inflation path generated from the pandemic.

Monetary policy response initiatives to cover the first two challenges. In general, the market stabilization with PEPP programmes, liquidity support with the TLTRO programme have accompanied the effective monetary policy response during the Covid-19 pandemic that is dealing with the negative impact on the projected inflation path generated from the pandemic.

Monetary policy response is very crucial to cope up with low inflation, higher interest rates, low investment and consumption recovery. Keeping these issues in concern, monetary policy strategy, 2021 codified the requirements of the economy being in the vicinity of the lower bound to symmetric two per cent inflation target. But when the control of the market stabilization by central bank is absent, it is difficult to maintain the consistency of asset prices and control the financial flows through the cross-border. On the other hand, monetary policies should not be the reason for wage-price spiral.

Alongside it will be harder to keep the fiscal policy at the right track than dealing with the rate of inflation. It mainly will represent the two challenges forward:

a. Control of inflation and
b. Maintainance of fiscal support.

Advanced European economies are expected to face 4% of GDP as fiscal deficits by 2022 that is larger than the global financial crisis 2008. In this situation, central banks will not be eligible enough to co-operate since they have already done their jobs basing on their capabilities. Specifically, monetary policy approaches should be maintained in such a way that it should not become a tool of persistent inflation (Kammer, 2021).

Now, the economic shocks imposed by the covid-19 period has initiated the EU to adopt different fiscal afigurend monetary policies to balance the economic stabilization policy effectiveness measuring variables. For example, reduction of working hours, substantial liquidity support to the firms, job retention schemes and so on. Most of the EU member states have launched programs for preserving access to both bank loans and public loans those all are large scale in nature but unfortunately failed to attain same levels of recovery and growth.

In terms of real GDP, values of almost every aspect, beginning with private consumption, government consumption, gross fixed capital formations, exports, and imports, have begun to regain according to Figure 1, following the EUROSTAT report on 2023, but after the outbreak of the Russia-Ukraine war, the scenario has begun to deteriate again.

Similarly, following the global economy's encounter with the covid-19 pandemic, the European Union implemented various economic stabilization policies to boost the economic shock. Figure 2 represents that the HICP (Harmonized Index of Consumer Prices) has yet to achieve stability. This is also the result of two subsequent events, the covid-19 pandemic and the Russia-Ukraine conflict.

When other macroeconomic indicators are considered, Figure 3 illustrates much better position where the employment rate is growing compared to the time period of 2020-2022 while the unemployment rate is declining slowly.However, in terms of unit labor expense, it dropped to -0.2 from 4.6 in 2021. it has since begun to expand slowly. From 2020 to 2021, compensation per employee, labor productivity, and budgetary stance (adjusted for NGEU grants) have all improved. The general government budget and structural budget balance are constantly increasing, whereas the current account balance (percentage of GDP) began to improve from 2020 to 2021 but then fell back to 1.7 in 2022.It may also be the redult of Russian aggretion on Ukraine starting from 2022.

Following the Table 1, when the real GDP are growing, HICP inflation, fiscal stance, labor productivity, compensation per employee, unemployment, and employment rate are all rising, representing the positive correlation while on the other hand, current account balance, structural budget balance, general government budget balance, and unit labor cost are all falling owing to the negative correlation with real GDP.All of these above mentioned variables are very important while determining the success or failure of any economic stabilization policy measures.

A proper and stable economy is very crucial not only interms of government financing but also attracts more international capital flow (Gomez-Gonzalez et al., 2022). Additionally, control mechanism and imposition of sanction through either fines or incentives can motivate the EU member states to work more promply to attain the proper economic stabilization during the post-covid period. It is recommended to have the option for an effective countercyclical measures for the better maintainance along with pre-cyclical fiscal policies (Šreiberytė, 2020).

Conclusions

In concluding remark, econimic stabilization policies adopted by the EC partially has started to effect the national economies in the positive way but in the long run although some variables are responding very slow.

Although some variables are responding are quickly while some other are slow. Russian invasion on Ukraine plays here a crucial part in the economic stailization in the EU after the covid-19 pandemic. Finally, fiscal and monetary policy response in the Euro area can be addressed as a partial success story but need to be very careful on their efforts to provide economic support for maintaining agreement considering the time and situation to respond more quickly with long term effectiveness.

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Annex

Table 1. Determination of the correlation coefficient between the real GDP and economic stabilizationn policy effeciveness measuring indicators (European Central Bank, 2023)

Independent variable	Dependent variable	Correlation co-efficient
Real GDP	HICP Inflation	0.329676
	Current account balance	-0.04827
	Fiscal stance	0.586633
	Structural budget balance	-0.90041
	General government budget balance	-0.94513
	Labor productivity	0.982284
	Compensation per employee	0.986869
	Unit labor cost	-0.95361
	Unemployment	0.990259
	Employment	0.684371

Figure 1. Evaluation of real GDP (2020-2024) (European Central Bank, 2023)

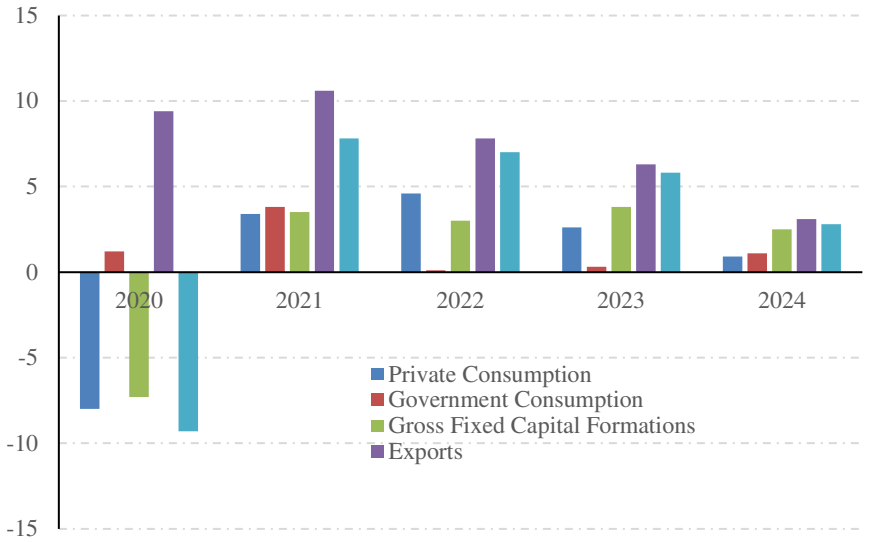


Figure 2. Estimation of HICP inflation (2020-2024) (European Central Bank, 2023)

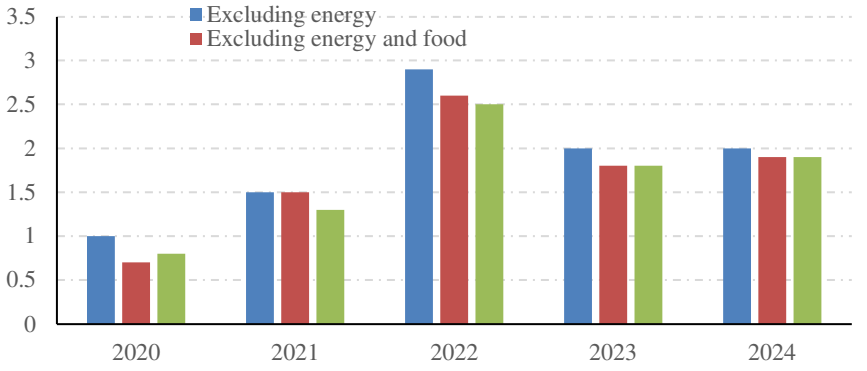
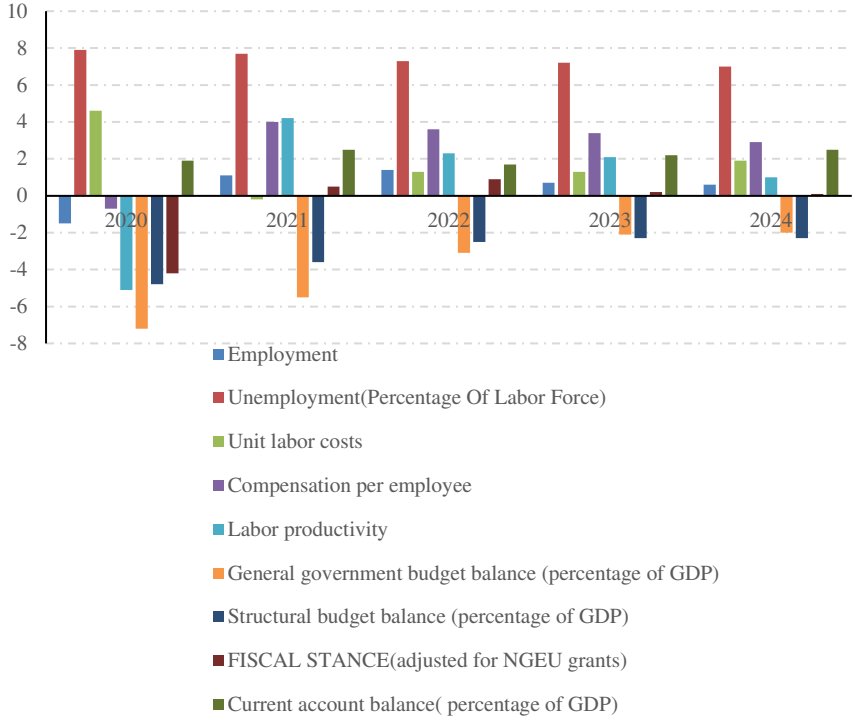


Figure 3. Evaluation of economic stabilization policy effectiveness measuring indicators during 2020-2024 (European Central Bank, 2023)



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Poland's position in trade in food products against the background other new member states of the European Union

JEL Classification: *F14; L66; Q17*

Keywords: *foreign trade; food; Poland; new EU Member States*

Abstract

Research background: The enlargement of the European Union (EU), which means the accession of ten countries (including Poland) in 2004, two in 2007 and one in 2013, has significantly changed the terms of trade both within the EU and with non-member countries. EU membership also fundamentally changed the economic conditions for food producers from the new Member States (NMS) and gave a new, very strong impulse to trade in food products.
Purpose of the article: The aim of the research presented in the article is to assess whether the new trade conditions resulting from the accession to the EU had a significant impact on the level and dynamics of trade turnover of the food sector in Poland and other new Member States.
Methods: The article analyzes the basic trade streams (exports, imports and turnover balance) of foreign trade in food products of all NMS against the background of the results achieved in the EU. This analysis made it possible to assess the impact of EU accession on the development of food trade in this group of countries and to indicate the countries that play the largest role in this trade. The analyses covers the years 2004–2021. The data source was the WITS-Comtrade trade database.
Findings & Value added: The analysis showed that the impact of integration with the EU on trade in food products of the new Member States was varied. The highest and fastest growing surplus in food trade was achieved by Poland, followed by

Hungary, Bulgaria and Lithuania. There was a deficit in food trade in the Czech Republic, Slovakia and Romania. All the countries listed above were significant exporters of food products to the world market, but Poland held the dominant position among them (with the share of NMS in exports of approx. 40%). The next stage of the research presented in this article should be an indicator assessment of competitiveness of the Polish food sector against the background of other NMS.

Introduction and literature review

Enlargement of the European Union, which meant the accession of ten countries (apart from Poland, also: Cyprus, the Czech Republic, Estonia, Lithuania, Latvia, Malta, Slovakia, Slovenia and Hungary) in 2004, another two countries (Bulgaria and Romania) in 2007 and one country (Croatia) in 2013, gave a new shape to the trade and economic relations of the new Member States (NMS, EU-13) and other countries. This involved the need to adapt to the EU rules and a thorough change in the existing rules of trade with all partners. The most important changes concerned the inclusion of the NMS into the EU's single internal market and the adoption of all the rules and instruments of the EU's common commercial policy towards third countries (Molendowski & Polan, 2020). As a result, NMSs were covered by the common customs tariff, which in practice meant that with the accession to the EU, the issues of regulating bilateral trade were replaced by trade policy implemented by institutions and member states at the EU level.

Trade within the European Union has been covered by the rules of the European single market (ESM), which is governed by four freedoms, i.e. free movement of goods, capital, people and provision of services. The free movement of goods means a ban on import and export duties and charges having equivalent effect, a ban on quantitative restrictions (quotas) on imports and exports and measures having equivalent effect, a ban on discriminatory and protectionist taxation, and an order to reorganize state monopolies of a commercial nature. Restrictions on the free movement of goods are allowed only in special cases provided for in the Treaty on the Functioning of the European Union (TFEU) (Consolidated…, 2012).

Membership in the EU has also significantly changed the terms of trade with non-EU countries. As of the date of membership, the EU-13 countries lost the possibility to pursue an independent trade policy and had to terminate all trade agreements, including those on preferential trade. For NMS trade with third countries, the existence of a customs union within the EU, since the early 1970s, was of great significance. The consequence was the adoption by the countries of the common customs tariff, EU solutions in the

field of non-tariff measures, including anti-dumping, compensatory and anti-excessive import proceedings, as well as the transfer of competence to the EU level in the scope of concluding multilateral and bilateral agreements with trade partners that are not members of EU (Wróbel, 2011).

Membership in the EU fundamentally changed the economic conditions for the operation of food producers from the new Member States and gave a new, very strong impetus to trade in food products. The elimination of all restrictions in mutual food trade with both old (EU-15) and new Member States meant that food products produced in the NMS could be exported to the markets of other Member States without restrictions. At the same time, products from the EU-15 countries could freely compete on the markets of the EU-13 countries with their own products. The condition for their mutual introduction was compliance with EU sanitary, veterinary, phytosanitary, animal welfare and environmental protection standards. This required the Member States to fully harmonize regulations and create an effective system for control (Ambroziak & Szczepaniak, 2016).

When it comes to food products, the question whether the inevitable loss of a part of their own market will be compensated by increased sales on the markets of other EU countries has become the basic problem of individual NMS. From a formal point of view, the fulfillment by producers of the above-mentioned EU quality standard was a sufficient condition for placing the products on the markets of EU Member States. However, the actual use of the possibility of increasing food exports to the EU market depended on the fact that NMS producers had competitive advantages over producers from other EU countries.

The aim of the study is to assess whether the new trade conditions resulting from the accession to the European Union had a significant impact on the level and dynamics of trade turnover in the food sector in Poland and other new EU Member States.

Research methods

The study contains an analysis of basic trade streams (exports, imports and turnover balance) in the field of trade in food products of individual new member states against the background of foreign food trade of the entire group of EU-13 countries and the EU in general. Efforts were made to identify countries that are the most important exporters and net exporters of food products among this group of countries. The analysis is complemented by the assessment of Poland's position against the background of other NMS, made on the basis of two indicators concerning export relations, i.e.

the value of exports per capita and the percentage relation of exports to gross domestic product (GDP) in individual countries.

The analysis used statistical data from the WITS-Comtrade trade database, expressed in USD. The term "food products" is understood as chapters 01–24 of the HS (Harmonized Commodity Description and Coding System). The research covered the years 2004–2021.

Results and discussion

After the enlargement of the European Union, a dynamic development of foreign trade in food products took place in all new Member States (Table 1). In the years 2004–2021, the value of exports of NMS food products increased five and a half times, from USD 19.4 to USD 108.2 billion. The increase in imports was slightly slower, the value of which increased fourfold in the period, from USD 22.8 to USD 95.1 billion. The faster growth dynamics of exports than imports made this group of countries a net exporter of food starting from 2010. In 2021, the positive trade balance in the EU-13 amounted to USD 13.1 billion and was approx. USD 16.5 billion higher than in 2004. Among NMSs, only Poland, Hungary, Bulgaria, Lithuania and Latvia were net exporters of food products, but it was the value of the balance generated by Poland that was decisive.

This is because Poland was one of those new Member States which maintained a high dynamics of exports growth all the time, much higher than the growth dynamics of imports. This resulted in Poland's position as the largest food exporter among the EU-13 countries (with a share of 40% in 2021) and a significant improvement in the trade balance from approx. USD 1.0 billion in 2004 to USD 14.1 billion USD in 2021 (Table 1, Figure 1). The situation was slightly different in Hungary, the second largest exporter of food products in the EU-13 in terms of value (11.7%). A similar growth rate of exports and imports of the products meant that the position of this country as a strong net exporter of food remained significant and quite stable (the positive exchange balance increased from USD 1.4 billion in 2004 to USD 4.2 billion in 2021). After accession to the EU, the balance of trade in food products in Lithuania was systematically improving. In the years 2004–2021, the country's food exports increased almost seven times, and the positive balance of trade increased to USD 1.7 billion. In Bulgaria, the food trade balance fluctuated strongly, but over the entire analyzed period, with an almost seven-fold increase in exports, it increased to over USD 1.9 billion. In 2021, the largest deficit was in the food trade of the Czech Republic and Romania. The negative trade bal-

ance of the countries amounted to USD 2.1 and USD 2.0 billion, respectively. What is particularly important, both the countries were both important exporters of food products in the EU-13 (with shares of 9.7% and 10.5%, respectively) and importers of the products (with shares of 13%, 1 and 12.6%) (Figure 1), which indicates the high importance of intra-industry exchange in their trade.

During membership in the European Union, the share of exports of food products of the EU-13 countries in the exports of the products in the entire EU showed a systematic upward trend. In 2021, it was 15.9%, while in the year of accession (2004) it was around 7% (Table 1). The largest exporter of food products among the new Member States was Poland continuously, followed by Hungary, Romania, the Czech Republic, Bulgaria and Lithuania. The combined share of the six countries in EU-13 food exports in 2021 was around 85%. In 2004–2021, export of food products was systematically developing in all NMSs. This process was particularly visible in Romania, where the value of exports increased fifteen-fold during the period. In Poland, Bulgaria, Lithuania and Latvia, food exports increased almost seven times, and in the Czech Republic, Croatia, Slovenia and Slovakia – more than four times. The lowest dynamics was maintained in the two smallest countries, i.e. Malta and Cyprus, where increase in the value of exports was twofold.

The share of imports of food products from the EU-13 countries in the imports of the entire EU was slightly lower than in the case of exports and in 2021 and amounted to 15.4% (while in 2004 it was higher and reached 8.4%) (Table 1). The main importers are: Poland, the Czech Republic, Romania, Hungary, Slovakia and Lithuania, which accounts for nearly 78% of NMS imports. In 2004–2021, in most EU-13 countries, the growth rate of imports was lower than that of exports. A different tendency was observed only in Hungary, Slovakia and Cyprus (but the differences were small). In Poland, the value of food imports increased more than five times.

In 2004–2021, the exchange balance improved in six of the EU-13 countries, with Poland the most, and Lithuania, Bulgaria and Hungary slightly less (Table 1). In the remaining new Member States, the deficit in trade in food products deepened. Despite slightly worse balance sheet results in some countries in 2021, the benefits achieved by the new Member States in the period after accession to the EU were very large in the field of foreign food trade. Full liberalization of trade in food products in intra-EU trade turned out to be beneficial for the countries.

While the analysis conducted on the basis of absolute values showed that Poland occupied a leading position among the EU-13 countries in trade in food products, the assessment based on relative values is not so unam-

biguous. In 2021, Poland ranked only fifth among the countries in terms of the value of food exports per capita (Figure 2). Despite a clear improvement in the value of this indicator in the period after accession to the EU, it was still quite low and in 2021 it amounted to only USD 1,148 *per capita*. Baltic countries, i.e. Lithuania, Latvia and Estonia, are at the forefront of this ranking. The value of Lithuanian food exports per capita this year was more than twice as high as in Poland. Higher rates than in Poland were also recorded by many other NMSs. After accession to the EU, this indicator improved significantly in all countries, but it was particularly significant in Lithuania and Latvia.

Poland fared similarly among the new Member States in terms of the relation of exports of food products to gross domestic product (GDP), calculated in current prices. In 2021, the value of exports of the products accounted for 6.4% of GDP, which allowed Poland to rank fifth among the EU-13 countries (Figure 3). The share of food exports in GDP was higher than in Poland in Lithuania, Latvia, Bulgaria and Hungary (due to the size of the economies, this export was relatively more important in the countries). During the period of membership, this indicator improved significantly in most countries.

The dynamic development of trade in food products, which took place in the first years after the EU enlargement with new Member States, was also pointed out by other researchers. The phenomenon was analyzed both from the perspective of the new Member States (Bojnec & Fertő, 2015; Szczepaniak & Tereszczuk, 2016) and the old Member States (Antimiani *et al*., 2012). For example, various paths of food trade development implemented in individual countries were indicated. The impact of the EU enlargement on the trade results of the entire grouping was also studied, paying much attention to the benefits achieved (Carraresi & Banterle, 2015; Wijnands & Verhoog, 2016). Irrespective of the applied approach, objective and time scope, the conducted research clearly shows that EU membership gave a strong impetus to the development of NMS food trade. The enlargement of the EU also influenced the improvement of the quality of the food market in the entire European Union.

Conclusions

The impact of accession to the European Union on trade in food products of the new Member States was varied. In almost all countries, there was a development of foreign trade in the products, more pronounced in exports than imports, but the dynamics of the growth of trade streams in individual

countries was different. Poland continued to be the main food exporter among this group of countries, with a 40% share in 2021, followed by Hungary, Romania and the Czech Republic. An improvement in the food trade balance in 2004–2021 was recorded by six countries, including primarily Poland, Lithuania, Hungary and Bulgaria, which had been net exporters before the EU enlargement. By far the highest and fastest growing surplus in food trade was achieved by Poland. There was a deepening deficit in trade in food products in the Czech Republic, Slovakia, Croatia and Slovenia. The assessment of Poland's position in trade in food products on the basis of selected export relations ranks it fifth among the NMS. The rankings based on relative values were topped by the Baltic countries. This does not change the fact that the Polish food sector plays an important role in the EU economy.

The development of foreign trade in food NMSs was mainly due to: full liberalization of trade within the European single market, increasing income *per capita* in the countries, and as a result, an increase in purchasing power and willingness to purchase new and more diverse products, inflow of foreign capital in the form of direct investments, as well as an increase in the quality and expansion of the range of exported products, as a result of the producers' adjustment processes to operate on the EU food market.

Research on the assessment of Poland's position in trade in food products of the new Member States will be continued. Their further direction will be an indicator analysis of competitiveness in trade in these products of individual countries, in particular those that – next to Poland – play the largest role in NMS food trade. In the assessment, a properly selected set of competitiveness indicators will be used. These studies will be presented in subsequent studies in the cycle.

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Annex

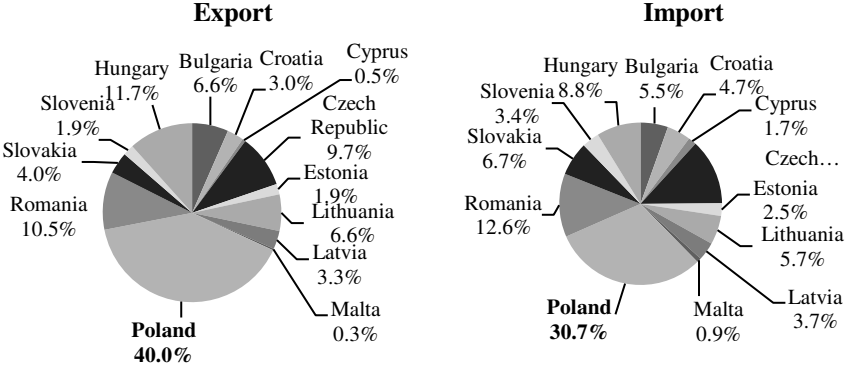
Table 1. Results of foreign trade in food products of the new EU Member States, in the year 2004 and 2021 (in USD million)

Countries	Export			Import			Balance	
	2004	2021	2004 = 100	2004	2021	2004 = 100	2004	2021
Bulgaria	1,060	7,142	674	810	5,221	644	250	1,921
Croatia	740	3,278	443	1,454	4,444	306	-714	-1,166
Cyprus	278	592	213	701	1,580	225	-423	-988
Czech Republic	2,336	10,453	447	3,522	12,462	354	-1,186	-2,009
Estonia	628	2,048	326	933	2,368	254	-305	-320
Hungary	3,856	12,644	328	2,489	8,395	337	1,367	4,248
Latvia	526	3,552	675	1,150	3,513	306	-624	39
Lithuania	1,067	7,130	668	1,065	5,429	510	2	1,700
Malta	147	332	226	454	829	182	-308	-497
Poland	**6,484**	**43,346**	**669**	**5,453**	**29,250**	**536**	**1,031**	**14,097**
Romania	730	11,313	1,550	2,128	11,975	563	-1,398	-662
Slovakia	1,070	4,300	402	1,559	6,407	411	-488	-2,107
Slovenia	443	2,104	475	1,105	3,280	297	-662	-1,176
EU-13	**19,364**	**108,233**	**559**	**22,823**	**95,153**	**417**	**-3,458**	**13,079**
EU-14*	258,161	572,109	222	247,832	523,140	211	10,329	48,969
EU-27*	**277,525**	**680,341**	**245**	**270,655**	**618,293**	**228**	**6,871**	**62,048**

* without Great Britain

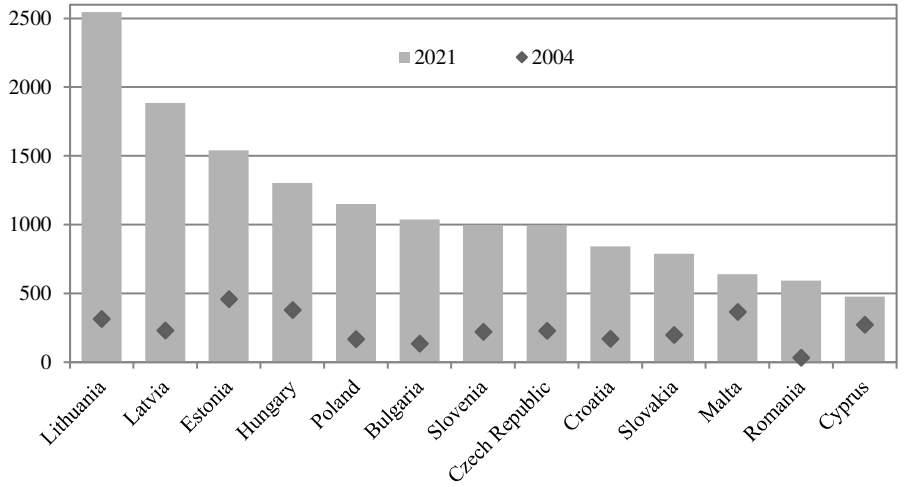
Source: own calculations based on WITS-Comtrade data.

Figure 1. Structure of food products exports and imports of the new EU Member States, by country, in the year 2021



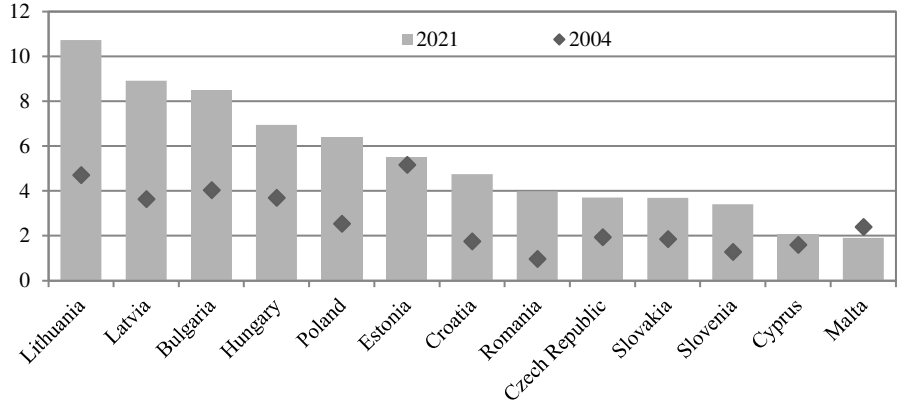
Source: own calculations based on WITS-Comtrade data.

Figure 2. Exports of food products by individual new EU Member States per capita in the year 2004 and 2021 (total within and outside the EU, in USD)



Source: own calculations based on WITS-Comtrade data.

Figure 3. Exports of food products by individual new EU Member States in relation to GDP in the year 2004 and 2021 (total within and outside the EU, current prices, in %)



Source: own calculations based on WITS-Comtrade data.

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Evolution of the regional innovation system in terms of covid pandemic, financial and economic crisis: The case of Lower Silesian in Poland

JEL Classification: *O31; O33; O38; L14; C35*

Keywords: *innovation system; research and development; determinants of innovation; evolution of innovation systems; triple helix*

Abstract

Research background: The various external shocks could have a great influence on any regional innovation system. The new technology can be initiated through both passive (purchase of machinery and equipment) or active way (research and development activity). With regard to regional innovation systems, the factors determining these processes are according to the country development level where the region is located. Furthermore, by the years the conditions can be changed in case of the natural evolution process or revolution shock as financial, economic or pandemic crisis.
Purpose of the article: Therefore, the purpose of this paper is to identify the impact of crisis on the evolution of the implementing new technology to the regional innovation system (Lower Silesian) in a catching-up country (Poland).
Methods: Using stepwise logit modelling, industrial enterprises were analysed in three periods: 2004-2006, 2010-2012 and 2019-2021. The territorial scope covered one of Poland's well advanced regional innovation system – the Lower Silesian Voivodship.
Findings & Value added: The evolution of the innovation system may be interrupted by short-term and periodic crises appearing on the market and fully

independent to the firm. We can divide them in two alternative groups: a high and low resilience to various market shocks. To the first groups we could include: R&D and Equipment interrelations (the growing competence effect) and cooperation within the industry (with supplier and customer only). The low resilience is observed in the four other categories as follows: the cooperation with R&D and business support units (the isolated effect), the lack of external sources of funding (the sinking effect), changes in the innovative activity (adaptation effect). As we pointed above some of them are more sensitive to external shocks and the others are not. It means the evolutionary development of any system, including the technology one, can be disrupted by an external shock. From the past it been called "the creative destruction" established by Schumpeter. It radically slows down some evolutionary development or changes its directions. A entrepreneur needs to learn and adapt. We showed both: a direction and strength of external different kind of shocks to evolution of regional innovation system in a catching-up country. Knowing them let us in the future react on time or with low delay to reduce negative consequences to the regional economy.

Introduction

The concept of innovation systems (whether national or regional) involves the interactions taking place between the different actors in the system (Cooke & Morgan, 1993, pp. 543-564). Creating the right framework for building support mechanisms for innovation systems requires an understanding of the functioning of the different system elements and their interactions. In this context, the determinants established by the triple helix model prove useful as a starting point (Galvao et al., 2019, pp. 812-833). This model indicates that the elements influencing the functioning of innovation systems are three groups of actors: companies, public administrations and scientific institutes (Leydesdorff & Etzkowitz, 2001, pp.1-31). The state of these institutions and the relationships between them are closely related to the level of advancement of the country in which they occur, i.e. in emerging countries they do not occur at all, while in middle-income/developing countries they begin to develop. Strong relationships are found in developed countries (Kimatu, 2016, Article Number 16).

Research on the evolution of the Triple Helix is relevant to innovation decisions made by companies. Adequately identifying trends related to innovation activities at a systemic level will allow support tools to be better adapted to the needs of entrepreneurs. This is because a firm's technological innovation strategies change as firms and industrial innovation networks evolve (Sun & Li, 2012, pp. 1317-1321).

This raises the question of how innovation systems function in industry as a whole and how they change over the years. The following research questions are therefore revealing:

1. Do all Triple Helix actors play a positive role in stimulating innovation activity?
2. Has there been a strengthening of the industry-science nexus in the functioning of the Triple Helix over the years, i.e. are developing countries thus moving towards the development paradigm characteristic of developed countries?

The authors of this paper will attempt to answer these questions on the example of the regional innovation system of one of the Polish regions, namely Lower Silesia. Therefore, the aim of the paper is to indicate the influence of the individual elements of the Triple Helix on the functioning of enterprises in the studied system and to determine the scale and quality of deviations in the evolution of this system following shocks in the form of the global financial crisis and the COVID-19 pandemic. The hypotheses put forward as follows:

H0: *The regional innovation system of Lower Silesia is not sufficiently developed to be able to defend itself against external crises.*

H1: *Innovation activity of firms is deflected by external market shocks.*

H2: *Innovation cooperation with science is deflected by external market shocks.*

H3: *Innovation cooperation with business support organization is deflected by external market shocks.*

Research methods

Surveys in the Lower Silesian Voivodship were carried out three times in the different time periods: 2004-2006, 2010-2012, 2019-2021. The companies surveyed were active in industry.

Logistic regression (logit) with a stepwise regression forward was used in the statistical modelling of innovation processes. The reason for using this method is the binary form of the dependent variables.

The following additional statistics were used to determine the goodness of fit of the model: Wald χ 2, R^2 Cox-Snell, R^2 Nagelkerke, AUC value, p-value and Hosmer-Lemeshow test (Wald χ^2, p-value).

The variables adopted for the study were adjusted according to the standards of the Oslo methodology (OECD & Eurostat, 2005, pp. 1-162). New production technology as a result of R&D activities and market-purchased ready-to-use production technologies were used as dependent variables. The independent variables were divided into seven groups:

1. firm attributes: R&D expenditure and investment in new equipment and machinery investment;
2. innovation cooperation: between enterprises (with a supplier, customer, competitor, and within a capital group) and with science institutions (with universities, the Polish Academy of Science (PAN) departments, domestic and foreign R&D institutes);
3. business support organizations: technology parks, technology incubators, academic business incubators, technology transfer centres, business angel networks, local or regional loan funds, loan guarantee funds, training and advisory centres;
4. sources of the new knowledge: internal sources, competitors, customers, suppliers, PAN departments, universities, domestic and foreign R&D institutes, professional conferences and meetings, branch literature and journals, professional associations, and trade unions;
5. barriers for innovation: lack of funds within the enterprise, lack of finance from sources outside the enterprises, too-high cost of innovation, lack of qualified personnel, lack of information on technology and markets, difficulty in finding co-operation partners, market dominated by established companies, uncertain demand;
6. effects of innovation: increasing the range of goods and services, entering new markets, improving the quality of goods and services, improving the flexibility of production or service provision, increasing the capacity of production or service provision, reducing unit labour costs, reducing the consumption of materials and energy, meeting regulatory requirements;
7. control variables: firm size (small, medium, or large), ownership (domestic, foreign, or mixed), sale range (international, domestic, regional), revenue (drop down, stable), used technology (high, medium high, medium low), and age of the company.

Results

Lower Silesian Voivodship is one of the most dynamically developing industrial regions in Poland. It has a strong urban centre - the Wrocław agglomeration - and outside it mainly agricultural and tourist areas. In

2005, the share of total expenditure on innovative activities in the voivodship in national expenditure was 7.08%, to reach 9.91% in 2021 (bdl.stat.gov.pl).

The study in the Lower Silesian Voivodship was carried out three times. The first time focused on the years 2004-2006, when Poland joined the European Union and was on a path of dynamic economic growth. The next survey was conducted in 2010-2012, in the final phase of the global financial crisis. The third period is 2019-2021, the COVID-19 pandemic time and the beginning of economic stagnation in Poland (high inflation rate, negative consumption rate).

The two models built for the first period show a simple structure of factors inhibiting and dynamising the development of the young innovation system in Lower Silesia (Table 1). New production technology as a result of R&D activities depends mainly on innovation cooperation with universities (chances for such innovations are 5.28 times higher than in enterprises that do not cooperate with universities) and with suppliers (twice as high odds). New production technologies are mainly introduced in exporting entities (241% higher odds), and the effects achieved by such innovations are an increase in production capacity (almost three times more often than in entities without such solutions).

In terms of market-purchased ready-to-use production technologies, a wide range of effects are obtained in the terms of higher production capabilities, more new products and improved quality. Also important are the research and development activities carried out (81% higher chances), cooperation in the supply chain with suppliers (73% higher chances) and customers (64% higher chances). On the one hand, the presence of R&D activities in the model is important, as it indicates the generation of new knowledge combined with the implementation of new technical equipment. On the other hand, it was found that the research potential of such investments can be afforded by large firms (120% higher odds), which have more financial capacity to implement novelties and are more likely to implement process innovations than product ones.

Despite the presence of a barrier in the form of limited availability of external finance or lack of information about new markets, such firms are more likely to purchase new technologies anyway. This is due to the pressure of the market, its dynamic development and the ability of entrepreneur to cope with the negative circumstance.

It can be seen that the regional innovation system in Lower Silesia is young, dynamic and market conditions support its development. It is not complex, and innovation cooperation in the supply chain or with universities (although at a low level in the second case) significantly accelerates

technological development. Entrepreneurs cope with negative external circumstances.

The second survey was conducted in Lower Silesia in 2010-2012 just after the global financial crisis. It can be seen that the innovation system has clearly diversified. More conditions have emerged. On the one hand, this means a greater complexity of relations to new technologies there (Table 2), and on the other hand, regularities in the functioning of the system have emerged. Those created through research and development activities appeared in entities applying medium-low technology (chances increase by 80%).

Enterprises with a partial share of foreign capital have appeared in the model, in which the chances of creating new production technologies as a result of R&D work increase more than three times. Combining R&D activities with passive technology transfer (purchase of machinery and equipment) is not without significance. Entrepreneurs, as a result of unfavourable market circumstances, decided to implement new technologies reducing material and energy intensity, while entering new markets and improving product quality. Companies experiencing stagnation were more likely to reduce the implementation of new production technologies by 43%.

The purchase of ready-to-use technological innovations took place in the case of using the services of technological incubators (almost 10 times increase in opportunities). Also important is innovative cooperation with institutes of the Polish Academy of Sciences (chances increase by 329%).

In these firms, where revenues were falling, the purchase of production technology was reduced by 46%. R&D activity accelerates the passive technology transfer (a two-way relationship). If the R&D exists, ready-to-use technologies are twice as likely to be purchased on the market. Material suppliers are still important, although such cooperation is losing momentum.

Enterprises buy ready technologies to reduce material and energy consumption, increase production capacity and diversify products. Still, despite limitations in access to external sources of innovation financing, entrepreneurs are able to overcome these difficulties and decide to make further investments in innovation.

The final period, 2019-2021 is related to the COVID-19 pandemic. The effect of the pandemic is evident in the group of medium-sized companies (Table 3). Although evolutionarily they should have strengthened their position, the consequences of the shock are too strong for them. Small enterprises have evolutionarily shifted from new technologies supported by the purchase of new machinery towards R&D-based technologies.

Despite this, it's a period with the large firms returning, which are three to four times more likely to introduce innovations than others. Such a trend should not happened, as it sets the regional system back in time for some 20 years (the flashback effect). Stagnating revenues decrease the interest of new technologies purchased on the market.

A progressive relationship between the purchase of new machinery and R&D activity naturally emerges. Entrepreneurs are more than five times more likely to implement new production technologies if they are engaged in activities combining these two activities (the growing competence effect).

Innovation collaboration is evidence of a partly progressive evolution of the system. Here we can see a decline in the importance of suppliers and a shift of influence towards customers. At the same time, the strengthening of collaboration with scientific institutes is not evident. The interaction has changed and the quality and quantity of interactions has declined. At the same time the lack of external funding sources significantly limits innovation activity.

Business incubators are the most important in stimulating innovation in this region. Entrepreneurs using their services are more than 20 times more likely to decide to implement new production technologies as a result of R&D activities, and seven times more likely when these technologies are created through new investments.

Despite the increased importance of cooperation with customers, they are not a source of knowledge about new solutions for the companies. Internal sources of innovation are also in decline. Instead, branch magazines are the main factor supporting investment decisions in companies. This may be due to the limited personal contact of company employees with others during the pandemic (lockdown).

Only one barrier significantly limits technological innovation in Lower Silesia, i.e. the lack of external funding sources. At the same time, it is worth noting that this factor was also present in previous research periods, but was not strong enough to limit the innovativeness of enterprises. Now it's unfortunately the main restriction issue (the sinking effect).

The effects of innovation activities increased in product mix, production elasticity and production capacity. The first of these is a symptom of the evolution of the innovation system in Lower Silesia. In spite of external difficulties, it is constantly up to date, increasingly strong, and the range is also being developed on the basis of ongoing research and development activities. This time, entrepreneurs have chosen to improve production elasticity rather than reduce costs. This new approach is evidence of technological advancement. But is this enough in times of crisis? It is difficult to

answer this question. Companies continue to increase production capac-ity in the hope of a future upturn. It is worth noting that this is occurring in each study period, varying in range and impact.

Conclusions

The study in Lower Silesia was conducted during three periods: (1) dynamic development, (2) after the global financial crisis, and (3) after the COVID-19 pandemic. It shows the evolution of the regional innovation system in combination with disruptions from external shocks.

The evolutionary trajectory suggests that a properly formed innovation system should develop naturally strengthening the relationships between the elements of the triple helix, moving it to a higher level of maturity. Showing up market shocks disrupt this process at different stages of its life cycle.

The conclusions obtained from the study were divided into three main groups: (1) evolution, (2) lack of relationship, (3) regression. Within their framework, the following effects were defined:

(1) Despite the market shocks appeared, the industrial system is resisting them and, moreover, evolving. This applies to changes in cooperation with suppliers and customers (learning by cooperation) and the combination in enterprises of active creation of technology with its passive transfer (the growing competence effect). It means the slow change has been made and innovation maturity of enterprises in Lower Silesian is growing. Unfortunately, these are the only manifestations of an evolutionary approach, and it is worth to mention that they only apply to B2B relationships and enterprises themselves.

(2) Science institutes and business support organizations, as another important part of the triple helix, are failing. There is a lack of continuity here. Their influence on the system is strong, but spotty. It is hard to tell whether this is the result of market shocks or the shallowness of the innovation system. These two areas do not fit into the evolutionary trajectory and have been named as the "isolated effect." In contrast, companies themselves react and adapt to changing external market conditions (the adaptation effect).

(3) In two areas, the regress of the innovation system has been noted. Although small and medium-sized companies are expected to pull technological change over time, in Lower Silesia this role is being taken back by large companies (the flashback effect). This may be related to the shock, which strongly limit the innovative activity of mainly medium-sized enti-

ties, or the inadequacy of policies to stimulate innovation of small and medium-sized enterprises in crisis terms. The second area of backsliding in the system is the limited ability to raise external funds to finance innovation. With the time ticking and the presence of shocks, this factor has evolved from a non-obstacle to a real threat (the sinking effect). Over the time of fifteen years, we haven't seen a systemic solutions to stop growing this negative impact.

In light of the above conclusions, the main hypothesis (H0) has been partially confirmed - the regional innovation system of Lower Silesia is not developed enough for its natural evolution to allow it to fully withstand the shocks of external crises. There are elements in the system that perform their functions. The core of the system, i.e. the enterprises and the relations between them, are strong and resistant to shocks. This results in the rejection of hypothesis H1. The functioning of the other elements of the triple helix is disrupted, resulting in the acceptance of hypotheses H2 and H3. Hence, a stunted development of the system in some aspects is observed.

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Annex

Table 1. Regional innovation system in Lower Silesian region (years 2004-2006)

Variable	TECH_INN_EQUIP	TECH_INN_R&D
Age	0.8*	-
LargeF	2.24*	-
Foreign_cap	-	3.41***
R&D_*inv*	1.81***	-
COOP_*sup*	1.73**	3.03***
COOP_*cus*	1.64*	-
COOP_*univ*	-	5.28***
SOUR_*assoc*	0.27**	-
EFF_*num*	2.24***	-
EFF_*qual*	1.99***	-
EFF_*capa*	3.59***	2.93***
BARR_*extfound*	1.59**	-
BARR_*markknowl*	2.61**	-
Sample	492	492
Wald $\chi 2$	131.36	99.60
R^2 Cox–Snell	0.23	0.18
R^2 Nagelkerke	0.31	0.27
AUC	0.79	0.78
p-value	0.00	0.00
Hosmer–Lemeshow test		
Wald $\chi 2$	20.54	9.73
p-value	0.008	0.08

(***) – statistical significance at 1%, (**) – statistical significance at 5%, (*) – statistical significance at 10%.

Source: Questionnaire research with our own calculation with Statistica 13.3 software.

Table 2. Regional innovation system in Lower Silesian region (years 2010-2012)

Variable	TECH_INN_EQUIP	TECH_INN_R&D
MLT_firm	-	1.78**
HT_firm	0.31**	-
SmallF	1.58**	-
MediumF	2.67***	-
Foreign_cap	-	3.14***
Rev_drop	0.54***	-
Rev_stab	-	0.57**
DomMarket	1.51**	-
R&D_*inv*	2.05***	-
Equip_*inv*	-	3.08***
COOP_*sup*	1.44*	-
COOP_*PAN*	4.29**	4.09**
COOP_*univ*	-	4.31***
SUPP_techinc	9.60***	-
SUPP_businangel	-	4.06*
SUPP_*traincentr*	-	1.60*
EFF_*num*	1.76***	-

Table 2. Continued

Variable	TECH_INN_EQUIP	TECH_INN_R&D
EFF_*mark*	-	1.54*
EFF_*qual*	-	1.98**
EFF_*capa*	1.70**	-
EFF_*mat*	2.25**	3.04***
EFF_eco	-	2.17**
BARR_*extfound*	1.46*	-
BARR_ *cooperation*	-	0.23***
BARR_*monopoly*	-	2.01*
Sample	761	761
Wald $\chi 2$	126.46	149.72
R^2 Cox–Snell	0.15	0.18
R^2 Nagelkerke	0.22	0.31
AUC	0.76	0.81
p-value	0.00	0.00
Hosmer–Lemeshow test		
Wald $\chi 2$	13.68	16.26
p-value	0.09	0.04

(***) – statistical significance at 1%, (**) – statistical significance at 5%, (*) – statistical significance at 10%.

Source: Questionnaire research with our own calculation with Statistica 13.3 software.

Table 3. Regional innovation system in Lower Silesian region (years 2019-2021)

Variable	TECH_INN_EQUIP	TECH_INN_R&D
SmallF	-	1.85*
LargeF	2.87 **	3.96***
Foreign_cap	0.32*	-
Rev_stab	0.50**	-
RegSale	-	0.37**
R&D_*inhouse*	5.46***	-
Equip_*inv*	-	5.27***
COOP_*com*	-	0.15**
COOP_*sup*	2.62***	3.23***
COOP_*dom*	-	3.00*
SUPP_*business*	7.34	21.45**
SOUR_*inside*	0.49**	-
SOUR_*cus*	0.49**	-
SOUR_*mag*	2.61***	-
EFF_*num*	2.07***	4.40***
EFF_*elast*	-	2.30**
EFF_*capa*	2.77***	-
BARR_*extfound*	0.47**	-
Sample	396	396
Wald $\chi 2$	129.20	126.11
R^2 Cox–Snell	0.28	0.27
R^2 Nagelkerke	0.40	0.43
AUC	0.83	0.86
p-value	0.00	0.00

Table 3. Continued

Variable	TECH_INN_EQUIP	TECH_INN_R&D
Hosmer–Lemeshow test		
Wald $\chi 2$	13.38	19.77
p-value	0.09	0.00

(***) – statistical significance at 1%, (**) – statistical significance at 5%, (*) – statistical significance at 10%.

Source: Questionnaire research with our own calculation with Statistica 13.3 software.

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Analysis of the functioning of bicycle roads as an element of Smart City on the example of Poland 10 bigest cities

JEL Classification: *R52; R53; R58*

Keywords: *smart city; smart mobility; bike; bikeway; bike sharing; quality of life*

Abstract

Research background: The use of bicycle transportation for travel whether within a city or between cities is an important factor that has a positive impact on the quality of life of residents, particularly in the aspect related to the environmental friendliness of transportation. Also, it is an important part of the quality of life in the Smart City because of not only the ability to move to work, store, etc. but also the extensive network of bicycle paths provides many opportunities for leisure activities.
Purpose of the article: To investigate what is the amount of bicycle roads in polish 10 biggest Cities and how they changed between 2012 and 2021. To investigate what is the amount of bicycle roads in polish 10 biggest cities per capita. Investigate whether the number of bicycle roads in each analyzed city is related to the wealth of the population as measured by the level of GDP per capita.
Methods: The statistical analysis of the data from various databases especially from the GUS database. The analysis used indicators like – the km bike route per 1000 inhabitants and the km bike route per 100k2 of the city area to use in the analysis.
Findings & Value added: The extensive analysis of the factors influencing the increase of bicycle roads in polish biggest cities. The analysis of how economical and others factors impact this phenomenon. The value of the paper is connected with finding patterns in the case of bike road building in polish cities and recommendations for the government for the future development.

Introduction

The implementation of intelligent transportation solutions in cities has positive effects on all city users. By reducing traffic congestion through the promotion of alternative transportation modes and the use of a modern traffic control system, it is possible to decrease the emission of exhaust fumes and other air pollutants (low-emission transport), improve traffic flow, increase the comfort of movement (including reducing travel time), and enhance traffic safety (Dudycz et al., 2018; Wolniak and Jonek-Kowalska, 2021). The utilization of bicycles for transportation, whether within or between cities, is an important factor that positively impacts residents' quality of life, particularly in terms of transportation's environmental friendliness. Additionally, the extensive network of bicycle paths provides opportunities for leisure activities, making it an essential aspect of Smart City living (orłowski and Romanowska, 2019, Rahman and Dura, 2022).

Looking at leading European cities such as Copenhagen, it is difficult to consider a city "Smart" if it lacks a well-developed network of bicycle paths within and between cities (Ploeger and Oldenziel, 2020; Simonofski and Handekyn, 2023). However, simply having a network of bicycle paths is insufficient, as it is also necessary to invest in tools, such as city bicycles, to support the frequent use of bicycle transportation (Tahmasseby , 2022). Without a sufficiently extensive and well-designed bicycle path network, it is difficult to develop an urban bicycle system since residents will be less likely to use it, even if it is available (Wolniak, 2023).

An analysis of Scopus and Web of Science databases' publications regarding Smart City issues reveals a research gap in terms of a comprehensive analysis of the Polish cities' bicycle network's recent development and whether it depends on the level of wealth of individual provinces.

Based on the identified research gap, the following research objectives were set:

- C1: To investigate what is the amount of bicycle roads in Polish ten biggest cities and how it changed between 2012 and 2021.
- C2: To investigate what is the amount of bicycle roads in Polish ten biggest cities per capita.
- C3: Investigate whether the number of bicycle roads in analyzed cities is related to the wealth of the population as measured by the level of GDP per capita.

To realize those goals we formulated the following scientific hypothesis:

H1. *The length of bicycle paths in a city is correlated with GDP per capita in that city.*

H2. *The length of bicycle paths per 10000 inhabitants in a given city is correlated with GDP per capita in that city.*

Research methods

The publication's opening section outlines the main goals of the research, which is centered on a particular aspect of smart mobility infrastructure - namely, biking infrastructure in smart cities. In order to assess this infrastructure, it is necessary to use appropriate indicators. The publication utilizes indicators from Wawre et al. (2022) which group smart mobility indicators into various categories. One of these groups is a technical infrastructure indicator. The study specifically employs these indicators to analyze bicycle infrastructure, with a particular emphasis on the prevalence of bicycle paths in smart cities. This analysis serves as the basis for the discussions presented in the publication. A set of indicators is developed by adapting this concept to the subject matter being studied.

This publication utilizes data on the operation of bicycle roads in Poland between 2012 and 2021, gathered by the Polish Central Statistical Office and stored in databases available at https://bdl.stat.gov.pl/bdls/start. The analysis covers the past decade, and the latest complete statistical data available is from 2021, which was chosen as the endpoint for the analysis.
The study analyzed data from the 10 biggest cities in Poland, including Wrocław, Bydgoszcz, Lublin, Łódź, Kraków, Warszawa, Białystok, Gdańsk, Poznań, and Szczecin. The analysis used data on the length of bicycle routes in each province, as well as GDP per capita, province area, and population.

Using the collected data, the study calculated indicators of bicycle path saturation for each province, utilizing the following formulas:

$$Bp_I = \frac{Bp}{I} * 10000 \quad (1)$$

where:
Bpi - length of bicycle paths per 10000 inhabitants
Bp - length of bicycle paths
I – numer of inhabitans

Results

Tables 1 and 2 contain data on the length of bicycle paths in Poland's 10 largest cities for 2012-2021. Correspondingly, Table 1 contains data for 2027-2021, while Table 2 contains data for 2012-2016.

From the collected data, it can be seen that the length of bicycle paths in the surveyed cities has been increasing over the years. In 2021, the longest system of bicycle paths in Polish large cities is characterized by Warsaw, for which the total length of bicycle paths is 708.8km. The other surveyed cities are far behind Warsaw, with another Poznań, for which the network of bicycle paths is 301.6km, having more than twice as few as Warsaw. Next is Wrocław, which has 286.4km of bicycle paths, followed by Krakow, with 258.2km of bicycle paths. Among the analyzed ten largest Polish cities, the shortest bicycle road network is found in the case of Bydgoszcz - 119.9km, Szczecin - 154.9km, and Lublin - 188km.

Since individual cities differ significantly in population, it is not enough to determine the total length of bicycle paths in a city. It is also important to check the saturation of the city with bicycle paths about the number of inhabitants. For this purpose, the ratio of the length of bicycle paths in a city per 10000 residents expressed in km/1000 inhabitants was used. The data for each of the surveyed cities for the years 2012-2021 are presented in Tables 3 and 4. Accordingly, the years 2017-2021 are in Table 3, and the years 2012-2016 are in Table 4.

Over the 2012-2021 period, an annual increase in the ratio of the length of bicycle paths concerning 10000 residents can be observed. In 2012, the ratio was 1.81 [km/1000 in-habitants], in 2017 it was 3.16 [km/1000 inhabitants], while in 2021 it was 4.88 [km/1000 inhabitants].

Among the surveyed Polish cities, the highest value of the indicator occurs in the case of Lublin and amounts to 5.65 [km/1000 inhabitants]. This is followed by Białystok at 5.55 [km/1000 inhabitants] and Poznań, for which the indicator is 5.53 [km/1000 inhabitants]. The lowest values of the indicator of the length of bicycle paths per 10000 inhabitants among the

surveyed Polish cities are characterized by: Krakow 3.22 [km/1000 inhabitants], Łódź 3.29 [km/1000 inhabi-tants] and Bydgoszcz - 3.59 [km/1000 inhabitants].

It is interesting to see whether the length of bicycle paths in the ba-dated cities is correlated with their wealth as measured by the GDP per capita index. For this purpose, relevant calculations were made for 2021 - correlation coefficients were calculated between GDP per capita and the length of bicycle paths in a given city, as well as the length of bicycle paths per 10000 inhabitants.

In the case of the correlation between GDP per capita and the length of bicycle paths per 10000 inhabitants, the correlation is very weak and not statistically significant. For this reason, it can be concluded that the results do not support the H2 hypothesis as follows: The length of bicycle paths per 10000 inhabitants in a given city is correlated with GDP per capita in that city.

Instead, a correlation of 0.94 (statistically significant at the α=0.05 level of statistical significance) was found between GDP per capita for the cities studied and the total length of bicycle paths in the city. The correlation according to Guilford's typology can be considered very high.

The research conducted supports hypothesis H1 as follows: The length of bicycle paths in a city is correlated with the GDP per capita in that city.

As a reason for this, we can cite the fact that cities with higher GDP per capita usually have a larger budget for investment in infrastructure, including the construction and maintenance of bicycle paths. They may also receive more grants and funding from the government and other sources, enabling them to implement more ambitious projects.

In cities with higher GDP per capita, residents tend to be more environmentally and health conscious. For this reason, they are more likely to use bicycles as a means of transportation. This makes the expansion of the network of bicycle paths more necessary and welcomed by the public, and city authorities are taking steps to build it. It is also worth noting that cities with higher GDP per capita tend to be better organized and planned. Urban planning takes into account the needs of cyclists and includes the construction of bicycle paths in the city's development strategy.

Based on the analysis, the equation of the relationship between the length of bicycle paths in a city and GDP per capita can be determined. This relationship can be expressed as follows:

The length of a bicycle path in a city = -341.45+0.0102*GDP per capita

Figure 1 presents a scatter plot showing the relationship between GDP per capita and the length of bicycle paths in the city. The figure shows a confidence interval of 0.95. The graph shows that most of the surveyed cities fall

within the confidence interval. The following points can be distinguished in the figure:

- A city above the confidence interval - in this case, the city has a longer network of bicycle paths than its wealth would suggest. Among the cities surveyed, this type of city is Lublin. For this reason, Lublin is the city with the highest rate of bicycle paths per 10000 inhabitants among the surveyed cities.
- Cities below the confidence interval - in this case, cities have a shorter network of bicycle paths than their wealth would suggest. Among the surveyed cities, this group includes: Bydgoszcz, Łódź and Wrocław.

Another scatter plot, shown in Figure 2, shows the correlation between GDP per capita and the length of bicycle paths per 10000 inhabitants for the cities studied. Analysis of the scatter plot allows distinguishing the following groups of cities:

- Cities are characterized by a low level of GDP per capita and a high level of saturation with bicycle paths as measured by the km/10000 inhabitants indicator. This group includes cities such as - Bydgoszcz, Gdansk, Lodz, and Szczecin.
- Cities are characterized by an average level of wealth measured by GDP per capita and an average level of bicycle path length per 10000 inhabitants. This group includes two cities - Wroclaw and Poznan.
- Cities are characterized by a low level of GDP per capita and a low level of bicycle path length per 10000 inhabitants. This group includes cities such as Lublin, Bialystok, and Krakow.
- Cities with a high level of GDP per capita and a low level of bicycle path length per 10000 inhabitants. This group includes one city - Warsaw.

Conclusions

The study shows that in Poland's 10 largest cities in the years 2012-2021, it shows that the length of bicycle paths has been increasing over the years the cities surveyed. The longest system of bicycle paths in Poland's large cities is characterized by Warsaw, with a total length of 708.8km, while the shortest system is found in Bydgoszcz, Szczecin, and Lublin. An analysis of the indicator of the length of bicycle paths in the city per 10000 residents expressed in km/1000 residents shows that it has increased annually over the 2012-2021 period. In the case of Lublin, Białystok, and Poznań, the indicator was the highest, and the lowest in Krakow, Łódź and Bydgoszcz.

The article examines whether the length of bicycle paths in selected cities is correlated with their wealth measured by GDP per capita. The calculations for 2021 showed a weak and statistically insignificant correlation between GDP per capita and the length of bicycle paths per 10000 inhabitants. However, a very high correlation was found between the total length of bicycle paths in a city and its GDP per capita. This supports the hypothesis that the length of bicycle paths in a city is correlated with its GDP per capita. Cities with higher GDP per capita typically have a greater budget for investment in infrastructure, including bicycle paths, and their citizens are more environmentally and health-conscious, which leads to greater use of bicycles and the need for more bicycle paths. The article provides a formula for this relationship and presents scatter plots with confidence intervals to illustrate the findings. The article concludes that cities with higher GDP per capita are generally better organized and planned, taking into account the needs of cyclists and planning for bicycle paths in their development strategies.

Based on the survey and literature analysis, the following recommendations can be given to Polish cities for the development of bicycle paths in the smart city:

- Cities should invest in building new and expanding existing bicycle networks. Without a sufficient number of well-designed bicycle paths, residents will not want to use bicycles as a means of transportation. It is important for the Smart City to have a well-developed network of bicycle routes both within the city itself and between cities.
- Urban bicycle systems should be developed. Urban bicycle systems are a great way to promote bicycle use in the city. They make it easy and convenient for residents to rent bicycles for their daily commuting needs.
- Residents should be encouraged to use bicycles. There should be various programs and initiatives in the Smart City that encourage residents to use bicycles, such as organizing educational campaigns, competitions, or prizes for people who cycle.
- Bicycle roads should be adapted to the needs of users. Bicycle roads should be well-designed and adapted to the needs of different users, such as bicyclists, scooters, rollerblades, etc. It is also worth considering the needs of people with disabilities.
- It is worth considering the introduction of a monitoring system. A momonitoring system makes it possible to track bicycle traffic and improve safety on bicycle paths. Data can also be collected and analyzed to improve the bicycle path network and adapt it to the needs of the population.

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Annex

Table 1. Bicycle roads in Polish biggest cities in 2017-2021 [km]

Province	2017	2018	2019	2020	2021
Wrocław	249.9	260.0	312.1	360.4	286.4
Bydgoszcz	85.0	100.5	108.7	115.4	119.9
Lublin	145.0	140.0	165.2	180.9	188.0
Łódź	155.0	158.3	166.0	177.0	218.6
Kraków	220.5	213.7	235.9	252.8	258.2
Warszawa	537.7	590.0	644.7	676.1	708.8
Białystok	117.7	128.4	149.1	158.9	162.8
Gdańsk	174.5	182.3	196.0	203.0	213.0
Poznań	175.0	242.5	248.5	276.0	301.6
Szczecin	122.3	137.3	139.3	148.6	154.9

Source: Authors own analysis on basis: (Polish Central Statistical Office databases available at https://bdl.stat.gov.pl/bdls/star).

Table 2. Bicycle roads in Polish biggest cities in 2012-2016 [km]

Province	2012	2013	2014	2015	2016
Wrocław	204.1	210.3	215.4	229.8	242.5
Bydgoszcz	69.1	76.6	77.3	81.7	83.5
Lublin	65.2	79.2	109.6	130.0	138.9
Łódź	76.4	88.0	116.0	125.0	150.0
Kraków	134.8	145.0	154.0	166.0	185.3
Warszawa	318.3	359.6	412.5	457.2	496.2
Białystok	75.2	91.8	106.0	110.0	112.0
Gdańsk	122.5	147.8	159.8	167.1	173.5
Poznań	120.7	129.0	133.9	136.0	157.0
Szczecin	87.0	98.5	110.0	114.7	120.1

Source: Authors own analysis on basis: (Polish Central Statistical Office databases available at https://bdl.stat.gov.pl/bdls/star).

Table 3. Bicycle roads per inhabitant in Polish biggest cities in 2017-2021 [km/10000 inhabitants]

Province	2017	2018	2019	2020	2021
Wrocław	3.91	4.06	4.85	5.35	4.25
Bydgoszcz	2.41	2.87	3.12	3.40	3.59
Lublin	4.27	4.12	4.86	5.40	5.65
Łódź	2.25	2.31	2.44	2.63	3.29
Kraków	2.87	2.77	3.03	3.16	3.22
Warszawa	3.05	3.32	3.60	3.63	3.80
Białystok	3.96	4.32	5.01	5.39	5.55
Gdańsk	3.76	3.91	4.16	4.17	4.38
Poznań	3.25	4.52	4.65	5.04	5.53
Szczecin	3.03	3.41	3.47	3.74	3.93
Poland	**3.16**	**3.62**	**4.05**	**4.53**	**4.88**

Source: Authors own analysis on basis: (Polish Central Statistical Office databases available at https://bdl.stat.gov.pl/bdls/star).

Table 4. Bicycle roads per inhabitant in Polish biggest cities in 2012-2026 [km/10000 inhabitants]

Province	2012	2013	2014	2015	2016
Wrocław	3.23	3.33	3.39	3.61	3.80
Bydgoszcz	1.91	2.13	2.16	2.30	2.36
Lublin	1.88	2.31	3.21	3.82	4.08
Łódź	1.06	1.24	1.64	1.78	2.15
Kraków	1.78	1.91	2.02	2.18	2.42
Warszawa	1.86	2.09	2.38	2.62	2.83
Białystok	2.55	3.11	3.59	3.72	3.78
Gdańsk	2.66	3.20	3.46	3.61	3.74
Poznań	2.19	2.35	2.45	2.51	2.91
Szczecin	2.13	2.41	2.70	2.83	2.97
Poland	**1.81**	**2.01**	**2.43**	**2.81**	**2.93**

Source: Authors own analysis on basis: (Polish Central Statistical Office databases available at https://bdl.stat.gov.pl/bdls/star).

Figure 1. relations between PKB per capita and the length of bicycle roads in 10 biggest Polish cities.

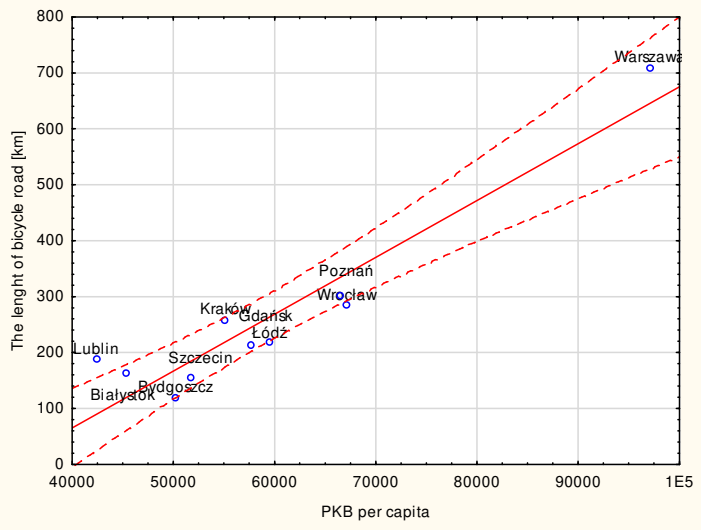
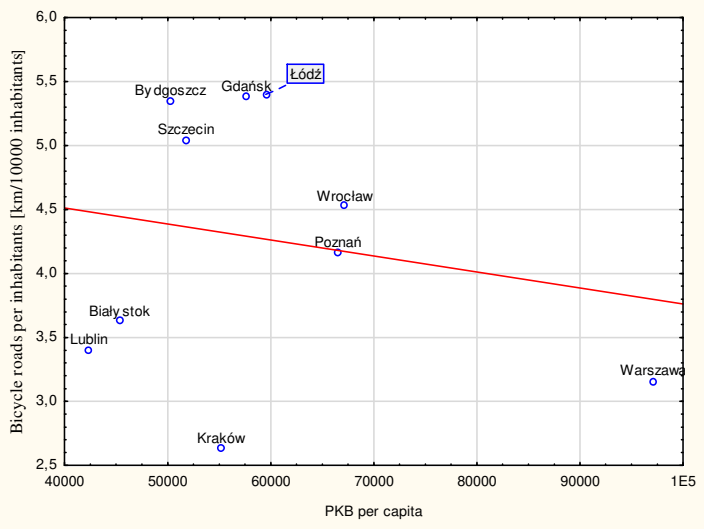


Figure 2. relations between PKB per capita and the length of bicycle roads per inhabitant in 10 biggest Polish cities



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