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The 2024 European Universities Games: Their Success and Impact on the University of Miskolc

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SUMMARY

The University of Miskolc implemented one of its most significant and complex projects by hosting the 2024 European Universities Games. In this research, which is partly descriptive and partly empirical, I examine the success and impact of the event from the perspective of the University of Miskolc, utilizing management theory and sports science approaches. To provide a better understanding of the research question, I introduce the process of organizing the event. Changes in the legislative environment and organizational model of international sports events hosted in Hungary significantly affected the event's project organization and, consequently, its execution. I will also look at another factor that influenced the large-scale project, the transformation of the University of Miskolc into a private university, also true of the co-organizer University of Debrecen. As I participated in all phases of the organization of the event, I use primary data for the research.

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INTRODUCTION

The European University Games is one of the largest international multisport events in terms of attendance, currently only surpassed by the Olympics, Asian Games, World University Games, European Games, Commonwealth Games, and the Paralympics. It is also one of the most significant higher education events in Europe. Organized biennially by the European University Sports Association (EUSA) since 2012, the Games have previously been hosted in the following locations: Cordoba, Spain (2012), Rotterdam, Netherlands (2014), Zagreb and Rijeka, Croatia (2016), Coimbra, Portugal (2018), and Lodz, Poland (2022). Belgrade, Serbia was scheduled to host in 2020, but the event was canceled due to COVID-19. Future hosts include Salerno (2026), Split (2028), and Granada (2030) (https://www.eusa.eu/games). Unlike the University World Games and University World Championships, which are organized under the International University Sports Federation (FISU), the European Universities Games feature athletes and teams representing their higher education institutions rather than competing under national flags.

The Hungarian University Sports Federation (MEFS), in collaboration with the University of Miskolc and the University of Debrecen, and with support from the municipalities of Miskolc and Debrecen, successfully bid to host the 2024 European Universities Games. The hosting rights were awarded on April 12, 2018. The event took place from July 12 to 24, 2024, with 4,736 participants representing 414 higher education institutions from 36 countries. Competitions in ten sports were held in Miskolc and seven in Debrecen, with the opening ceremony in Miskolc and the closing ceremony in Debrecen.

This event can be viewed as a unique and extremely complex megaproject. Therefore, this study considers both management theory and relevant sports science literature. The uniqueness of the event, and consequently the challenges associated with its execution, stem from the following factors:

a. Hungary had never hosted an international sports event of this scale before. The

participant numbers were supplemented by around 800 volunteers, and the total number of referees, national and international sports federation delegates, staff, and other sports professionals involved reached 1,000.

b. The event was connected to two fields, both in content and organization: sports and higher education.

c. While it is common for competitions or program elements to be held at different venues during sports events and other large-scale events, in this case, the participant numbers and the number of guest nights were nearly evenly split between Miskolc and Debrecen, two cities 100 kilometers apart.

d. The traditional stakeholders of sports events were joined by representatives of university sports, leading to a high number of stakeholders in the project, whose interests needed to be aligned along various values.

Although the event has only recently concluded, its success can already be examined qualitatively. Regarding the impacts, only the immediate effects following the event can be analyzed at this point; more time is needed to quantitatively assess the long-term economic and social impacts, such as through a cost-benefit analysis. The scope of this study does not allow for an examination of the event's success and impact from the perspective of all stakeholders involved in the project. Therefore, the research questions focus on one of the host institutions: Was the 2024 European University Games successful from the perspective of the University of Miskolc, and what impacts did the event have on the University of Miskolc? Where relevant to the analysis, and where the success and impact can be better understood by considering other stakeholders, the study will also reference other project owners.

Review of Relevant Literature

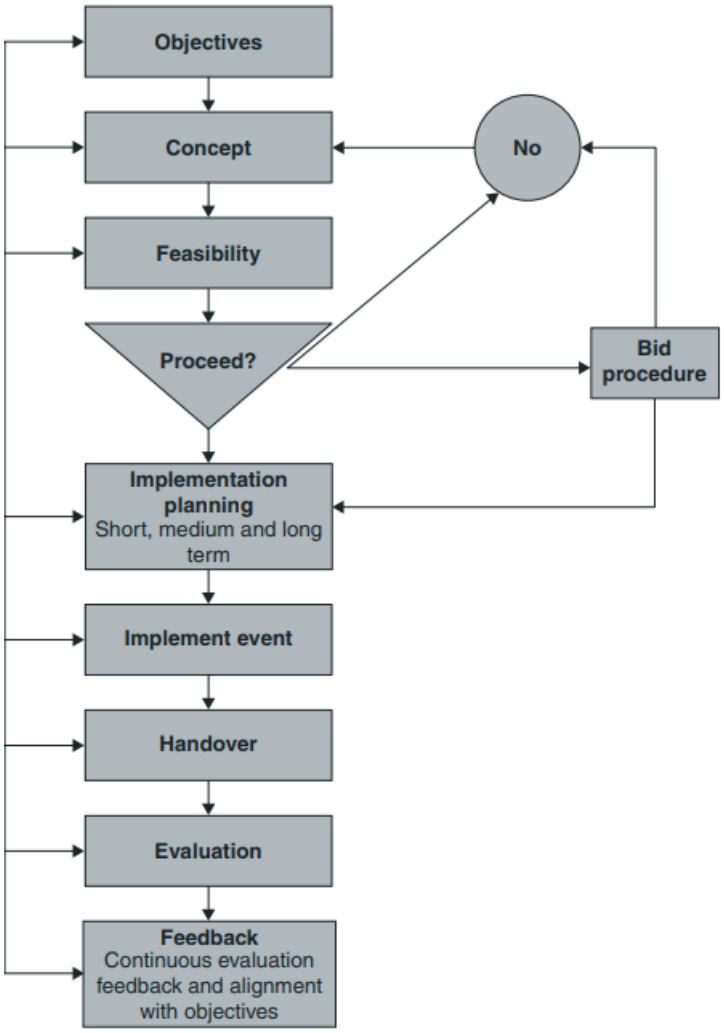
Szabó and Dancsecz (2009) interpret international sports events as projects, defining success criteria based on the achievement of project goals and stakeholder satisfaction. Turner (1993) refers to a group of interrelated projects managed cohesively and aimed at achieving objectives that would not be possible through independent management as a program. A program is characterized by its high complexity and is created for the successful and efficient execution of medium- to long-term processes. The projects within a program serve the purpose of realizing the program's goals. Programs are often called megaprojects, typically established to carry out unique processes with significant (social) impacts.

According to Piskóti's (2012) definition, large-scale events are one-time or recurring events of limited duration, attracting a significant number of visitors and receiving global media attention. The awarding of such events typically involves a formal bidding process, and the implementation is usually managed by a separate organization closely linked to the entity transferring the hosting rights. In the case of the European Universities Games, the number of visitors and amount of media attention is far below that of the Olympics, or world and continental championships in athletics, aquatic sports, or major team sports. However, the participant numbers are outstanding, the event is associated with cultural, scientific, and tourism-related programs (sub-projects), and its long-term impacts can significantly influence university sports in the host country, as well as the lives of the organizing universities and cities. Therefore, the European Universities Games can be considered a megaproject (Rakaczki, 2023b).

In sports science, distinctions are made between sports competitions, sports events, and sports activities. In the case of sports events, while sports are central, the primary goal is not necessarily competition. According to Máté's (2017) classification of international sports events, the European Universities Games are a competitive sports event held biennially in various locations, representing the European university sports movement and organized within EUSA's competition system as an international multisport event.

Mega-sporting events are also distinctly different from regular (normal) sports competitions or sports activities in terms of organization. While with regular events, operational work can begin soon after the concept of organizing the event is developed, mega-sporting events require significant preparatory work, such as feasibility studies and bidding processes. The host country and city win the hosting rights several years in advance through a formal bidding process. In the case of European or world championships, the bid is formally submitted by the sporting federation of the organizing country, with the right to host the event most often awarded to the winning bidder by the international organization of the sport. In most cases, a valid bid requires state guarantees (Sterbenz & Géczi, 2016).

The process of organizing sports events is described by Masterman's (2009) model (Figure 1), which includes 10 distinct phases, with each phase requiring the completion of the previous one.



Source: Masterman (2009)

Figure 1: The organizational process of sports events

The commonly accepted method for assessing project success is Mihály Görög's hierarchical model. This model consists of three interdependent levels of success, though each level's success can be understood independently (Görög, 2007):

- Level 1: Primary project goals (time, cost, quality),
- Level 2: Satisfaction of the project owner organization (strategic alignment),
- Level 3: Satisfaction of stakeholder groups involved in the project.

In their research, Szabó and Dancsecz (2009) break down success criteria into the achievement of project objectives, including primary and additional project objectives, and the satisfaction of external project stakeholders, including collaborating partners and additional stakeholders. The consequences of international sports events should be examined from the perspectives of impact, legacy, and multidimensional effects. Legacy refers to the more enduring outcomes, while multidimensional effects pertain to the broader community impacts (Hover et al., 2016). Stocker and Szabó (2017) identify several types of impacts related to international sports events, including sports professional, sports political, social, economic, technological, and environmental impacts.

METHODOLOGY

The research methodology is descriptive and includes empirical elements. Through a case study, I present the Hungarian-hosted European Universities Games of 2024, which are the focus of this research. I describe the organizational process and organizational model. To describe the relevant information for this study, I also conducted document analysis, reviewing materials such as the bid documentation and the event's master plan.

I have been involved in the entire project cycle – concept, planning and organization, implementation and completion – so I use primary data. I have first-hand information regarding the event's details, organizational processes, challenges, and outcomes, which I use to provide a comprehensive description of the event. This approach allows me to assess success and impact from the perspective of the University of Miskolc based on direct experiences and observations.

The research is primarily qualitative in nature, although it also includes quantifiable data from which I draw conclusions about the event's success and impacts. The primary aim of the research is to present and interpret the findings rather than to delve into deeper causes, such as identifying success factors.

THE EVENT ORGANIZATION PROCESS

On February 15, 2017, the EUSA announced the call for bids to host the 2022 and 2024 European Universities Games. Based on the successes achieved in international university sports – such as the 2016 World University Orienteering Championship and the 2017 European Universities Basketball Championship – the University of Miskolc emerged as a potential host. Additionally, the University of Debrecen was considered due to its significant role in Hungarian university sports, high-quality sports services, and infrastructure. The scale of the event did not allow independent hosting, but the idea of a joint bid was well received by both universities and by the leadership of the Hungarian University Sports Federation (MEFS).

The first step was to formulate the objectives related to the potential hosting and understanding the bid requirements. MEFS had previously brought numerous World University Championships and European Universities Championships to Hungary, and winning and successfully hosting the event was a central element of their strategy (the Hajós Alfréd Plan). Through this event, they aimed to develop the Hungarian University Championships system and advance their sports diplomacy efforts. Among the objectives of the host universities were to improve their infrastructure and services thanks to the event, to further strengthen their reputation both at home and abroad, and to improve their competitiveness to organize major events in the future.

The next step was to develop the hosting concept and engage strategic partners essential for the event, including the State Secretariat for Sports, Miskolc Municipality, and Debrecen Municipality. Common thinking began on a wider scale. Based on the minimum organizational requirements, potential sports venues (in Miskolc or Debrecen) and facilities were identified. EUSA's call specified nine mandatory sports and eleven optional sports, from which applicants had to commit to organizing at least three. In addition, applicants could nominate a sport not included in the list but which they would like to involve because of its local popularity. The number, selection, and location of sports changed several times during the planning phase. The final, realized version is presented in Table 1.

Table 1

Sports for the 2024 European University Games

Miskolc	Debrecen
Judo (individual)	3x3 basketball (men, women)
Karate (individual)	Table tennis (men, women)
Kickboxing (individual)	Futsal (men, women)
Basketball (men, women)	Handball (men, women)
Volleyball (men, women)	Football (men, women)
Chess (open, women)	Beach handball (men, women)
Beach volleyball (men, women)	Badminton (mixed)
Taekwondo (individual)	
Tennis (men, women)	
Water polo (men)	

Source: Own compilation

Compared to the 2022 European Universities Games in Lodz, sports climbing and swimming were removed from the competition program, while the other sports remained the same. Individual competitions were held in the four combat sports and team competitions were organized for the remaining sports.

A bidding committee was formed to compile and discuss the bid at appropriate levels. The bidding book effectively served as a feasibility study, outlining the motivations and goals of the participants, the roles and responsibilities of the stakeholders involved in implementation, a detailed presentation of the hosting concept, key organizational milestones, the anticipated legacy of the event, a detailed budget, and various supporting statements (e.g., from universities, cities, and sports federations).

Based on the feasibility study (bidding document), the initiators decided to proceed with the project, and the hosting bid was submitted by the deadline of January 15, 2018. The bidding book included a ministerial support statement and a supporting letter from the State Secretary for Sport. The state guarantee received on February 20, 2018 (Government Decree 1050/2018 (II. 20.)) regarding the hosting of the European Universities Games in Debrecen and Miskolc) enabled the completion of the bidding process. In the following months, EUSA confirmed the level of support for the intention to and the feasibility of the hosting plans, which involved numerous discussions and site visits. Based on background discussions with the government and considering the fact that Hungary would assume the presidency of the European Union starting July 1, 2024, the bidding committee's representatives presented the bid in Madrid, aiming to host the 2024 event. On April 12, 2018, EUSA's Executive Committee awarded MEFS the right to host the 2024 European Universities Games, with the location of Miskolc and Debrecen.

Among the various phases of event organization, the planning phase was the longest (just over six years), extending from the award of the hosting rights until the arrival of the first participants. The first major task was the preparation, included technical and financial consultations, of Government Decree 1201/2019 (IV. 15.), which ensured state support. The next milestone was to draw up the Master Plan for the event, from which the scenarios for all the organizational areas could be derived. Initially, the plan was for the two universities, two cities, and MEFS, or MEFS independently, to establish a company to implement the event. However, it was decided that since preparatory tasks would primarily be financed by MEFS and the two universities (as approximately 90% of state support was available in the year of the event), each entity would manage its respective organizational tasks within its own jurisdiction. However, from 2023, the company National Event Management Agency Nonprofit Plc. assumed the role of the project organization, as detailed in the next section.

The official event dates are July 12-24, 2024, with the opening ceremony on the first day and the closing ceremony on the last. However, the first participants arrived on July 8, as some sports competitions began on July 10, and the departure of the last participants, which was also coordinated by the organizers, took place on July 25. Thus, the implementation phase can be considered from 8 to 25 July 2024.

The event was followed by returning the venues, facilities and equipment used to the operators/owners. In the case of the University of Miskolc, investments in sports infrastructure were also made, the handover of which, had already been developed at the planning phase, along with and its operation and use after the event.

The event's evaluation must be conducted both in the short and long term, based on the fulfillment of the original objectives. Short-term evaluation should focus on the event's direct costs and revenues, success, and impacts. The indirect costs and revenues, legacies, and multidimensional impacts of the event will be explored in medium and long-term evaluations. The complete closure of the event will involve feedback to the project owners, including recommendations for organizing future events.

Changes in the Legislative Environment and Organizational Model

The organizational model of international sports events in Hungary changed during the preparation phase, significantly affecting the project organization for the event. Under the previous model, sports federations received the rights to organize events and the necessary state funding, and they established an internal organizational unit or founded a company to carry out the implementation. For the European Universities Games, Government Decree 1201/2019 (IV. 15.) outlines the amount of support provided to the relevant sports federation (MEFS) for the preparation and organization of the event between 2020 and 2024.

For the 2023 World Athletics Championships, the Hungarian Athletics Federation initially created an economic company, Budapest 2023 Nonprofit Plc., for the event. However, the project organization was later restructured with the entry of National Sports Agency Nonprofit Plc. as a shareholder representing the state.

With Government Decree 1571/2022 (XI. 28.), a new situation was created by assigning the preparation and organization of major sports events and significant state events to National Event Management Agency Nonprofit Plc. starting January 1, 2023. This legal framework resulted in the following organizational model for international sports events:

- Events receiving state support over 500 million HUF fall under the responsibility of the National Event Management Agency.
- Events with state support between 100 million and 500 million HUF fall under the National Sports Agency.
- Events with state support below 100 million HUF continue under the previous model, with sports federations handling the organization.

In accordance with these guidelines, the organization of the 2024 European Universities Games was transferred to the National Event Management Agency from January 1, 2023. This also meant that the state funds shifted from the ministry responsible for sport to the Prime Minister's Cabinet Office, and the beneficiary was no longer MEFS, but the National Event Management Agency. The National Event Management Agency planned to entrust the execution to an event-organizing company selected through public procurement, similarly to other major state events. MEFS remained responsible for sports-related matters and communication with EUSA, and numerous tasks continued to fall on the organizing teams from Miskolc and Debrecen. The scope and schedule of tasks were defined by the EUSA requirements, the Organizing Committee, and the Master Plan prepared in the meantime.

The Government's goal in establishing the National Event Management Agency was to ensure quality assurance for major events, guarantee proper use of state support, optimize the event budget, and provide additional funding if necessary. The project initiators indicated that the state support awarded based on the 2018 budget needed to be supplemented due to higher-than-expected inflation. The project organizers optimized the budget by reducing the number of sports from 20 to 17, and the National Event Management Agency ensured that the required additional state support was included in the 2024 budget. By early 2024, the National Event Management Agency faced another budget shortfall due to the adverse economic situation (spill-over effects of an energy crisis and war inflation) and the additional costs of involving an event-organizing company. Instead of seeking further state support, a decision was made in March 2024 that the co-host universities and MEFS would need to take on a larger role in the implementation. The National Event Management Agency divided the organizational tasks as follows:

- National Event Management Agency: project management, opening and closing ceremonies, communication.
- Host Universities: accommodation, catering, transportation, venue provision, event technology, security services.
- MEFS: sports program, volunteering, health insurance, general event insurance, decoration and signage.

The 850 million HUF allocated to each host university by the National Event Management Agency did not cover the planned technical specifications of their assigned tasks. The minimum organizational requirements set by EUSA did not allow for a reduction in technical specifications, and any reduction would have been contrary to the strategic goals of the host universities (to provide a high-quality event and create satisfaction and a positive image among participants). Therefore, both the University of Miskolc and the University of Debrecen contributed a significant amount of their own funds to the implementation of the event. Additionally, it was a challenge for both universities and the MEFS to involve the needed number of professionals with the needed competences in the organization of the event to cope with the increased tasks in the relatively short period until the event.

Impact of the University Model Change

In 2021, the University of Miskolc, like the University of Debrecen, transitioned from direct state maintenance to a specifically established asset management foundation that took over the founder and maintenance rights. For universities undergoing this model change, state support has been retained, provided through a framework agreement including long-term guarantees and individual financing agreements linked to tasks and results for 3–5 years. In this new model, the infrastructure transitioned from state ownership to university ownership, which required the universities to manage it. Besides its educational mission, revenue-generating activities also emerged to cover operational costs.

The organization of the 2024 European Universities Games was facilitated by this model change for the following reasons, especially considering the situation mentioned above, where the organizing universities had to assume a greater role in the implementation than originally planned, within tight deadlines:

a. Since the infrastructure became university-owned, the provision of necessary sports and other facilities (e.g., dormitories) could be handled internally.

b. The procedures for infrastructure development were simplified, as the relevant properties were no longer under the national property law.

c. From 2022, a new funding source specifically aimed at developing university sports (sectoral sports funding) became available to model-changing universities, totaling HUF 2.5 billion. Both the University of Miskolc and the University of Debrecen received significant

sectoral sports funding, which allowed them to finance expenses related to organizing the event (the University of Miskolc, for instance, utilized HUF 50 million for this purpose).

d. Due to becoming private universities, the University of Miskolc and the University of Debrecen fell outside the scope of the Public Finance Act, which enabled faster and more flexible processes for decisions, contract signings, and commitments related to the event organization. In the case of the University of Miskolc, the institution's economic manager established a separate procedure for handling matters related to the event.

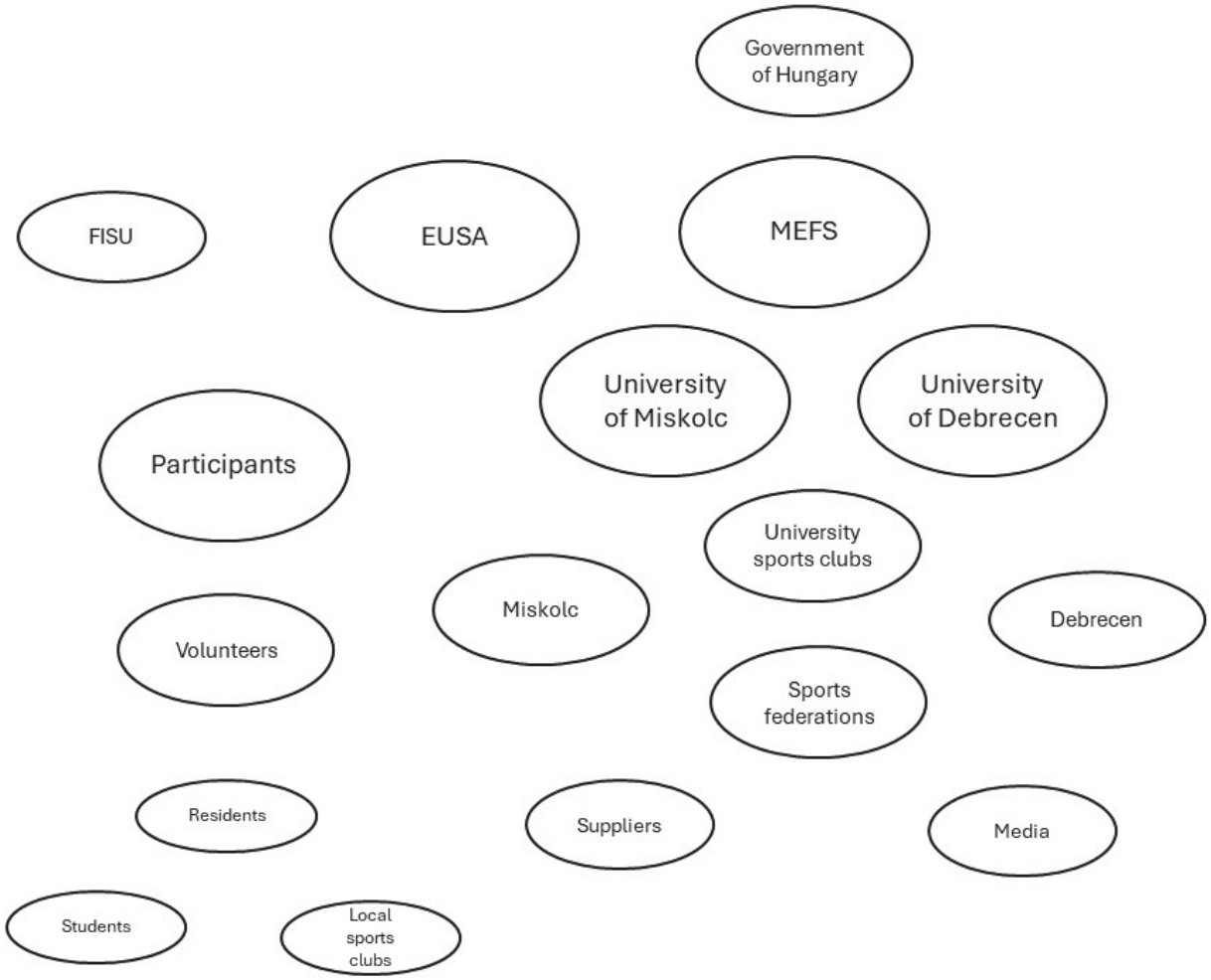
SUCCESS FROM THE PERSPECTIVE OF THE UNIVERSITY OF MISKOLC

In terms of the primary project objectives, the organizational tasks assigned to the University of Miskolc and to the project management (Organizing Committee) were executed within the defined budget, in compliance with – and in several cases exceeding – the EUSA requirements, thus achieving the expected quality. When examining the primary project goals, the actual values of the parameters should be compared to the revised (updated) values. Therefore, my observations on the budget are based on the revised cost framework set in March 2024. Given the nature of the project, the timeline was fixed. Thoughtful and complex work organization was required for achieving the primary project goals; however, with the detailed event organization requirements available, the main challenge was to ensure the availability and proper allocation of resources, as well as the involvement and management of competent individuals (Rakaczki, 2023a).

The project was initiated by MEFS, the University of Miskolc, and the University of Debrecen. The project ownership structure initially included the municipalities of Miskolc and Debrecen, which were later removed (their role in terms of event implementation became supportive and service-oriented), while the National Event Management Agency entered as a new stakeholder. For the University of Miskolc, in line with the original goals, the planned infrastructure and service developments were realized, the competitions and related services were of high quality, and the event gained significant visibility in both social and local media. Thanks to the European Universities Games, the university's reputation and positive image improved both domestically and internationally. The same conclusions apply to the University of Debrecen, with the exception of infrastructure developments related to the event. This is because, in the case of the University of Miskolc, the necessity of certain developments was known at the time of the bid submission to meet EUSA requirements, while the University of Debrecen already had the required sports facilities and accommodation at that time. From MEFS's perspective, a strategic goal was to ensure a large and successful Hungarian participation, which was achieved: the Hungarian delegation was the largest, Hungary topped the overall medal table, and one Hungarian university (Hungarian University of Sports Science) ranked second in the institutional medal standings. It can be stated that the strategic alignment was achieved for all three initiating organizations of the project.

Figure 2 illustrates the stakeholders involved in the project. EUSA granted the organizing rights of the European Universities Games, part of its competition system, to MEFS, which applied with the University of Miskolc and the University of Debrecen. In domestic organization, the National Event Management Agency represented the Government of Hungary. Although MEFS continued to be the contracting party and in contact with EUSA, the event fell under its jurisdiction according to domestic regulations and fulfilled the role of the project organization. The International University Sports Federation (FISU) is mentioned not because EUSA is its continental organization, but because EUSA needs to coordinate the timing of its events with FISU events, and the European Universities Games represent competition for the FISU-organized World University Games. The sports clubs of the two universities played a key role in both the organization and the participation of the host universities, as a significant portion of participants from Miskolc and Debrecen were involved in sports clubs at their respective universities. The relevant sports federations actively participated in the management of the seventeen sports competitions. The event also involved city facilities and services, which is why the municipalities of the two cities were also involved and supported the organization in numerous ways. Naturally, the participants were at the center of the event. Volunteers played a crucial role not only in the organization but also in contributing to the overall positive atmosphere and perception of the event. Volunteers were often interested in gaining organizational experience, building connections, and practicing their foreign language skills. Of course, suppliers related to the event, companies tasked with various organizational duties, and media outlets reporting on and broadcasting the event are also among the stakeholders. Students from the two universities and residents of the two cities interacted with the event in various ways, either as fans or by meeting participants and organizers at university or city venues. Local sports clubs became involved through their athletes, participating in sports tasks or benefiting from the event's outcomes (infrastructure developments).

Generally, it can be stated that the stakeholders involved in the event were satisfied. EUSA's communication highlighted that Hungary hosted the best European Universities Games ever. Such statements should be approached cautiously, as there is always a certain euphoria at the end of large-scale events; however, EUSA leaders repeatedly expressed their satisfaction on-site. It is a fact that the organizers met every point of the comprehensive requirement system prepared by EUSA, which serves as a recipe for successful organization. Additionally, there were no participant complaints that needed to be addressed officially at committee levels, only a few inconveniences and incidents were requiring other action. Having participated in all previous European Universities Games, I observed that the event has three critical organizational areas: accommodation, catering, and transfer. In past events, there were always issues with at least one of these areas, which led to complaints from participating delegations. In Miskolc and Debrecen all three areas were resolved smoothly and at a high standard.



Source: Own editing

Figure 2: Stakeholders of the 2024 European Universities Games

From the perspective of the University of Miskolc, the project was accepted and both the institution's leadership and colleagues involved in the implementation fully supported the event. The success of the project from the standpoint of the University of Miskolc should be evaluated by examining how acceptable the event was to the stakeholders involved in the project results, who are the most important current and future partners for the university. These stakeholders are the followings: participants, volunteers, students, the university sports club, the Municipality of Miskolc, the University of Debrecen, and MEFS. Participant satisfaction has already been mentioned; this factor was particularly important for the University of Miskolc, as

it can enhance the institution's reputation across Europe and may lead to future enrollment of international students. Many volunteers were students from the University of Miskolc, and many students from the University of Miskolc participated as spectators. Special attention was paid to the selection and preparation of volunteers The university's sports club, which is the main strategic partner in managing and developing the institution's sports life, was involved in the organization as a contributor beyond its fundamental task of preparing participating students from Miskolc. Through programs promoting Miskolc, emphasis was placed on ensuring that participants also get to know the city, leaving with positive experiences not only from the university but also from the city itself. The seven-year collaborative and ultimately successful work with the University of Debrecen and MEFS created a foundation for implementing future joint projects in either educational or sports fields. It is also worth pointing out that the fact that the University of Miskolc took on the organization of ten sports and that the maximum number of teams and numbers of participants in these sports was reached, and even – when the need arose – entries beyond the maximum number were accepted, resulting in a larger event, with even greater impact for all partners.

IMPACTS ON THE UNIVERSITY OF MISKOLC

The research was carried out at the end of the event, so it examines the immediate impacts observed directly after the event. In line with the formulated research question, this is done from the perspective of the University of Miskolc, but where significant impacts for other stakeholders are identified, they are also mentioned.

Sports Professional Impacts

The typical sports professional impact of hosting a domestic event is larger and more successful national participation. This is largely due to the host's automatic entry opportunity and the motivating, supportive effect of local spectators. Before being awarded the hosting rights, the University of Miskolc had not participated in the European Universities Games. However, since then, it participated in one sport in 2018 (11 athletes), six sports in 2022 (21 athletes), and eight sports in 2024 (27 athletes). In 2022, Miskolc athletes won one gold, two silver, and two bronze medals, while in 2024 they won one bronze medal. Notably, in 2022, Miskolc athletes achieved most of their medals (one gold, two silver, and one bronze) in swimming, but this sport was not included in the 2024 competition program. Ignoring the results of swimming, no significant difference in participation or success is observed between the 2022 and 2024 Games from the perspective of the University of Miskolc. In terms of Miskolc sports, a significant fan presence was observed in basketball (an average of 400 people per match). The performance of the men's basketball team is worth examining as they participated in 2018 (8th place), 2022 (8th place), and 2024 (7th place) with similar results, meaning the presence of local fans did not have a substantial impact on their performance.

The situation is different when examining Hungarian participation (Table 2) and success. Since the first round of general entries for the 2018 Games had already closed when the hosting rights were awarded, 2022 and 2024 participation should be examined. Government Decree 1201/2019. (IV. 15.) allocated special funding for the development of the Hungarian University Championships between 2020–2024, aiming to prepare for successful domestic participation. The 2022 event showed significant participation, but the 2024 event achieved the highest number of Hungarian participants so far, with Hungary finishing first in the medal table out of 36 countries. The Hungarian University of Sport Science finished second in the medal table out of 414 participating higher education institutions, achieving the most successful Hungarian performance in the history of the European Universities Games. It can be concluded that in the case of Hungarian university sports, sports professional impacts were significant.

Sports Political Impacts

In the case of the University of Miskolc, it can be said that the institution successfully showcased its hospitality to foreign students and various bilateral relations were established, particularly through ambassadorial visits. However, the sports political impacts were more significant from the perspective of the Hungarian University Sports Federation, as MEFS holds leadership and committee positions in both EUSA and FISU, which were strengthened as a result of the event's success. The following interaction can be observed: successful hosting of various international university sports events supports effective sports diplomacy and effective sports diplomacy supports winning the hosting rights of various international university sports events. Among MEFS's goals is the future hosting of the World University Games (formerly Universiade); a feasibility study for the 2019 event has already been prepared, and the successful hosting of the European Universities Games serves as a strong reference for achieving this goal.

Table 2

Sports and Hungarian participation for the European University Games (2012–2024)

Year	City	Sports	Hungarian participation			
			Sports	Institutions	Athletes	Medals
2012	Cordoba	10	1	1	2	0
2014	Rotterdam	10	2	4	38	4
2016	Zagreb-Rijeka	21	11	11	94	13
2018	Coimbra	13	6	8	78	10
2022	Lodz	20	18	17	314	49
2024	Debrecen-Miskolc	17	17	22	541	58

Source: Own compilation

Economic Impacts

The infrastructure investments at the University of Miskolc related to the event had significant economic impacts. In 2018, the University received HUF 500 million, and in 2019 an additional HUF 450 million from dormitory development support, which led to the renovation of one of its dormitory buildings by 2022. In 2023, the University received HUF 20.6 billion in government support for infrastructure developments related to the European Universities Games. Due to the relatively late decision from the aspect of the event, only some of the planned investments (renovation of two dormitories, tennis hall construction, tennis court renovations and beach volleyball center construction) were completed by the event, with others (two more dormitory renovations, university restaurant renovation) are planned for after the event. The full amount of government support was disbursed in 2023, indicating that the investments were pre-financed and may continue to be pre-financed in the future. It is likely that the university allocated the funds, taking advantage of the favourable interest rate environment at the time. This would have been a rational economic decision, potentially generating a return that could have been used to cover future expenses related to the event (provision of own services of HUF 200 million, financial support of HUF 100 million). The investments were originally part of the institution's medium and long-term development plan, but the event provided the funding and timing for their realization. Therefore, the later maintenance and utilization of these investments are well-planned. The investments increased the competitiveness of the University of Miskolc. They provided jobs for the local construction industry and did not have a crowding-out effect, meaning they were not realized at the expense of other investments.

According to the accreditation software data, the event saw the participation of 2,421 people at the Miskolc location (1,888 athletes and 533 accompanying persons), 381 volunteers and 20 volunteer coordinators, 152 referees, and 320 sports federation delegates and other sports professionals. This totals 3,294 people, with an additional 490 contributors (organizers, security service workers, cleaners, etc.). The number of guest nights spent in Miskolc during the event was 21,988, and 75,694 meals were provided.

Preuss (2004) pointed out that the direct economic impacts of the Olympic Games consist of investments, event organization ("Organizing Committee consumption"), and tourist spending in the host city. He noted that only locally spent, so-called autonomous funds impact the local economy. At this point, it is worth extending the analysis to cover the entire city of Miskolc. The investments completed before the event were carried out by Miskolc-based companies. The investments created new jobs and did not have a crowding-out effect.

At the time of the research, settlement with various service providers and partner organizations was still ongoing, but it is already clear that the total cost of Miskolc's tasks related to the European Universities Games will be between HUF 1,000 million HUF and 1,050 million. The largest portion of the costs was covered by state support (HUF 850 million) and the University's own resources (HUF 100 million). It is important to mention that the University of Miskolc provided approximately 200 million HUF worth of services free of charge – that is, not included in the budget – including HUF 152.5 million for dormitories, sports and other facilities, and 47.5 million for related services (security, cleaning, laundry, technical supervision). An important factor in terms of economic impacts is the personal payments related to the event (project team salaries, various assignments for contributors, overtime accounting, payments of taxes

and contributions), which will amount to around HUF 70–75 million. Another significant data point is that HUF 870–920 million was spent at Miskolc service providers and companies. A 2% local business tax is generated from the revenues of Miskolc companies, and a tourist tax of HUF 450 per night from 1,817 guest nights spent in Miskolc hotels provided revenue for the Miskolc Municipality.

There was no sports tourism related to the event, as few spectators traveled to Miskolc, and those who did were mostly domestic. However, the number of participants was outstanding, and while they received full board, they naturally also consumed at city restaurants and cafés. The impact on the retail sector will be assessed later, when data for July 2024 is available and can be compared to similar periods in previous years.

Five hotels and one high school dormitory accommodated EUSA officials and staff, volunteers, referees, sports federation delegates, and other contributors, totaling 439 people and 4,360 guest nights. This has already been included in the aforementioned amount spent at Miskolc service providers and companies, but it is also worth examining later whether the event led to significant additional bookings for accommodation providers compared to similar periods in previous years.

The value of the media appearances, which are discussed in detail in the social impacts section, are difficult to quantify, especially since most of the communication occurred on social media, promoting the event as well as the host universities and cities. However, the University of Miskolc received these media opportunities free of charge, which should be mentioned in the context of economic impacts.

Technological Impacts

At the University of Miskolc, two technological developments specifically associated with the event can be identified: the basic functions of the beach volleyball center have been supplemented with a sun sail and the basic functions of the tennis center with separating nets. Significant event-related technological development, dissemination, and use can be identified for Hungarian university sports. The primary platform for informing participants, including competition schedules and results, as well as communication with them, was an app developed specifically for the event. However, the goal during the development was to ensure that the app could be used for future major Hungarian university sports events (e.g., the Hungarian University Sports Festival). In the future, the standard of domestic university sports events will improve due to the technological impacts of the European Universities Games.

Social Impacts

The investments mentioned under the economic impacts also had social effects, as they enhanced the competitiveness of the University of Miskolc. The renovated and modernized dormitories, along with the expanded and developed sports infrastructure, have made the University of Miskolc even more attractive to potential students. The event widely promoted the University of Miskolc as a unique and compact event venue, as it is located within a defined area of the university campus, offering accommodation, a large-capacity restaurant, sports facilities for various disciplines, conference rooms, and entertainment venues.

An important social impact is the accumulation of know-how and a team of professionals during the event's organization, which makes the institution capable of winning and successfully hosting future major events.

Thanks to the event, the University of Miskolc gained significant – primarily online – media exposure. The number of followers on social media platforms developed as follows: 5,100 on Facebook, 3,900 on Instagram, 3,170 on YouTube and 5,168 on TikTok.

Nearly 20,000 photos were published, with at least three times that amount in raw photo stock. Those who could not attend the event in person to support their university teams were able to follow the matches via a total of 424 live streams. The University of Miskolc covered a total of 1,358.6 square meters with various marketing tools and decorative elements.

The University of Miskolc established a “FunZone” in a central area of the university campus, where participants who were not competing and volunteers could engage in various events (workshops, roundtable discussions, lectures, awareness-raising activities) or simply relax thanks to the numerous services available at the venue. The FunZone was an unprecedented initiative, but it was so successful that it is likely to be included in future European Universities Games, making it a legacy of the Miskolc and Debrecen event. The FunZone also ensured that the majority of participants spent their time on the university campus in a supervised, controlled, and safe environment. The organizers also focused on establishing collaborations with downtown restaurants, cafés, and entertainment venues that uphold high standards, where the staff speaks foreign languages, and where correct billing is guaranteed. These were marked as "EUG Friendly" places in the event’s app, ensuring that those who visited the downtown area were not disappointed with the service. The University of Miskolc organized two parties at the famous Cave Bath and collaborated with city programs (Kvaterka, GastroFest) during the event, where participants of the European Universities Games received discounts and special attention. Overall, it can be said that the event introduced many people (participants or those who followed the competitions of

their relatives, friends, fellow students, or trainees from home) to the University of Miskolc and created a positive image of the institution.

Environmental Impacts

The environmental impact of the event is observed as a negative effect. In my research, I examined the measures taken by the organizers in Miskolc to minimize the event's ecological footprint. I identified the following:

- Placement of water dispensers, with each participant receiving a reusable water bottle in their welcome package.
- Use of reusable boxes and cups.
- Optional cancellation of the mandatory room cleaning scheduled every two days if not needed.
- Most event venues (seven sports, catering, accommodation, fun zone) were located on the university campus, making them accessible by foot.
- Local transfers were organized in collaboration with the local public transportation company.
- Free use of public transportation for participants within the city.
- Organization of awareness-raising programs.
- Information materials (e.g., house rules, event schedules, catering menus, timetables) and promotional materials (e.g., publications by the University of Miskolc) were provided in digital format.
- Use of biodegradable packaging and marketing materials in many cases.
- Reuse of marketing tools (organizers only replaced the printed content).

CONCLUSIONS

The 2024 European Universities Games represented one of the largest and most complex projects in the history of the University of Miskolc, featuring numerous unique project attributes and challenges. The preparation, planning, organization, and execution of the event spanned a seven-year period, with the closure phase still ongoing at the time of this study. The project was initiated by three organizations: the University of Miskolc, the University of Debrecen, and the Hungarian University Sports Federation. Changes in the legislative environment and thus the organizational model for hosting international sports events in Hungary transformed the project ownership structure and project organization. During the event's organization, the model change of the co-hosting universities positively impacted the execution of the event. Based on the achievement of the primary project goals, the event was deemed successful from the perspectives of both the University of Miskolc and the project management (Organizing Committee). The University of Miskolc, as one of the initiating project-owning organizations, considered the event successful, with the strategic goals outlined by the university being met. When examining the satisfaction of other stakeholders affected by the project – due to the wide range of these stakeholders and because the research question concerned the University of Miskolc – it was assessed whether the project was accepted within the university and whether strategically important stakeholders of the university were satisfied. For the University of Miskolc, economic and social impacts were significant and positive, and efforts to mitigate the negative environmental impacts of the event were successful. Technological, sports political, and sports professional impacts were also identifiable from the perspective of the University of Miskolc, though these were not significant. This study, by its nature, focused only on the immediate post-event impacts, but it will be worthwhile to examine the medium- and long-term effects, analyze the event's legacy, and assess any potential multidimensional impacts as more time passes.

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A Theoretical Framework to Measure Social Acceptance of Nuclear Energy among Hungarian Residents

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SUMMARY

Global warming is a pressing issue, but so are economic development and the constantly increasing electricity demand. Governments have to find the balance between conserving the Earth's climate for future generations and fueling their country's economy to achieve higher output. Nuclear energy seems like a solid solution for both problems. It can help to replace fossil fuels in the electricity mix and at the same time reduce CO_2 emissions; however due to certain features of the technology many people are skeptical about it. The aim of this study is to review the currently available behavioral and technology acceptance models - such as TRA, TPB, TAM, Risk-Benefit Concept, PADM - and based on the results build a new model, that could serve as a basis for a future survey among Hungarian residents related to the acceptance of nuclear energy generation.

Keywords: Social acceptance, Technology acceptance, Nuclear energy, Theory of Planned Behavior, Risk-Benefit Concept,
JEL Classification: D71, D81, O33
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INTRODUCTION

Our daily lives are built on a cheap and steady electricity service, which is mostly produced by burning fossil fuels (coal, oil, or natural gas). With this constant energy supply, a wide range of services are available to the majority of the population (central heating, household electronic devices, or automobiles), which would have been unimaginable a couple of decades ago. While our lives have become extremely comfortable, the usage of fossil fuels carries two main risks, which will have a significant effect on our future lifestyle. The first one is that the availability of these resources is limited on Earth, so soon they will become scarce, and the second one is that burning fossil fuels releases greenhouse gases (GHG) into the atmosphere, which are responsible for global warming.

Instead of fossil fuels, nuclear energy could be a suitable solution for this problem, but many people do not share this belief. In case of a nuclear accident, the damage could be severe, and because of that fear, many countries do not support the spread of nuclear power plants or the development of the technology.

In order to support the phase-out of fossil fuels from the electricity mix researchers try to investigate the driving forces behind social acceptance, related to nuclear energy. Following different approaches, many technology acceptance and behavior analysis models have become popular, but none of them seems to perfectly cover the topic; therefore, scholars usually use a mixture of models and factors to support their own theories. In this article, I will do the same by reviewing the popular methods and then creating a new model, which could be later on used to measure the public acceptance of Hungarian residents related to nuclear energy generation.

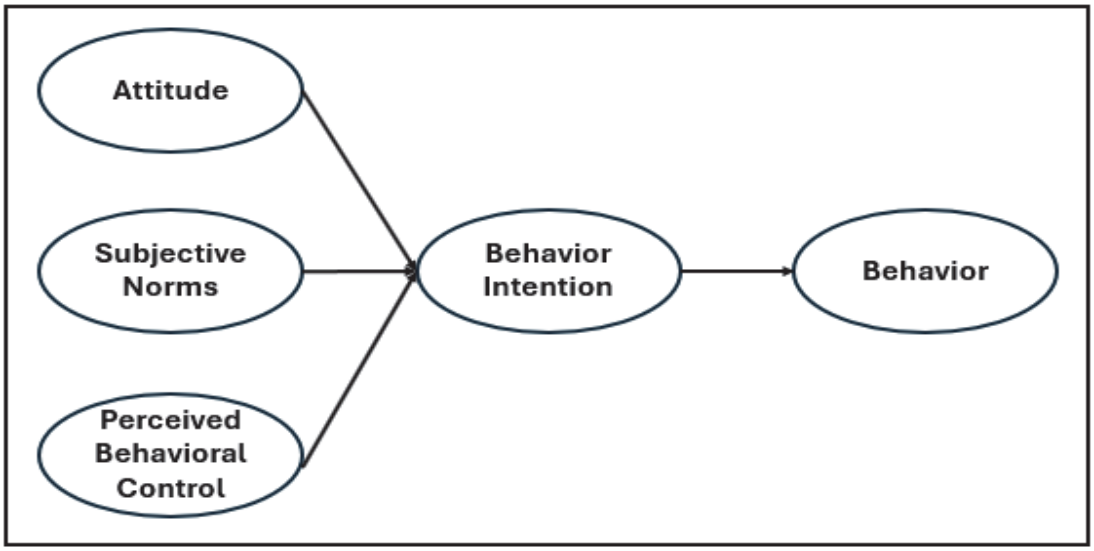
LITERATURE REVIEW

Scholars and business professionals alike are constantly trying to predict people's behavioral intentions associated with new products and technologies, and thus there is a wide range of methods available and used for such investigations. One of the most popular theories originates with Fishbein and Ajzen (1975) and is called the Theory of Reasonable Action. It supposes that

different motivational factors have an aggregated effect on people's behavioral intention, which directly influences their behavior and also the level of their engagement. The motivational factors identified by Fishbein and Ajzen (1975) are the following:

- Attitudes, which indicates that people always evaluate the outcome of their behavior in a given situation based on the assumption that it will have a favorable or harmful outcome for them and this perception will define their relation to the matter (Ajzen, 1991),
- Subjective norms, which refer to the individual's perception of their expected behavior based on the rules set by society or by the important people in their environment (for example: family, friends, or other meaningful connections in their life such as colleagues, doctors or personal trainers) (Fishbein & Ajzen, 1975; Nickerson, 2023).

Later Ajzen (1991) further improved his model by adding a third factor (Figure 1), named Perceived Behavioral Control, which aggregates the individual's belief and commitment to the desired behavior; this theory is known as the Theory of Planned Behavior (TPB). Studies have confirmed that if people believe that they can carry out a task successfully they will exert greater effort even against the odds, while those, who do not believe in their own capabilities tend to give up more easily. (Bandura, 1982; Bandura & Schunk, 1981; Schunk, 1984, 1991). The Theory of Planned Behavior has been widely and successfully used over the years in many areas such as health care and environmental-related topics. (Capasso et al., 2023; Chen, 2016; Wang et al., 2024; Xu et al., 2024)



Source: Ajzen (1991)

Figure 1: Theory of Planned Behavior model

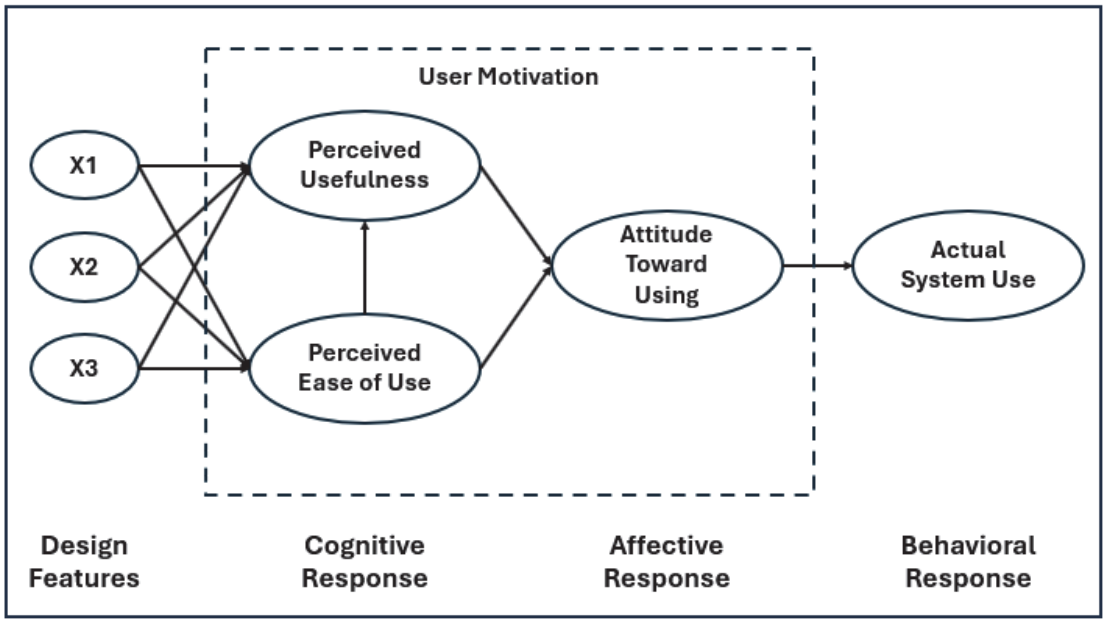
While researchers are using TPB in many cases, there are some limitations to take into consideration before applying it blindly:

- The model expects people to act rationally while excluding unconscious influences or emotions (Conner et al., 2013; Sheeran et al., 2013),
- It does not consider other important factors such as past experience, socio-economic status, or health (Sniehotta, 2014); however, it is a flexible model and therefore can be expanded with additional variables if needed (Aparna et al., 2024).
- The model does not consider that the behavioral intention can change with time (LaMorte, 2022).

Scholars usually extend or mix the TPB model, with other methods and factors such as the Technology Acceptance Model (TAM) (Ong et al., 2022; Wong et al., 2024) or the risk-benefit concept (Chang, 2023; Chen, 2016; Tang & Jiang, 2024).

The Technology Acceptance Model was introduced by Davis (1985) specifically for modeling users' acceptance of information systems or technologies. This time coincided with the growth of the use of personal computers, which in the long term significantly improved performance both on an individual and organizational level (Foley, 1984; Sharda et al., 1988).

For this reason, it was crucial to analyze when to switch from the old methods to the new ones and TAM was a great supporting tool for that. The model is a three-stage process (Figure 2), where numerous different Design Features can be selected to be analyzed depending on the technology and these external factors trigger a Cognitive Response in the potential user. Based on the perception of usefulness and ease of use a positive or negative Affective (emotional) Response forms, which eventually leads to a Behavioral Response determining whether someone will use the new technology or reject it (Davis, 1985; Lai, 2017).



Source: Davis (1985)

Figure 2: Technology Acceptance Model

In the model, Perceived Usefulness is defined as the user's belief that in time the use of a new technology will improve his performance, while Perceived Ease of Use refers to the effort that the user has to exert (whether is it mental or physical) to use the new technology. (Innovation Acceptance Lab, 2024; Lai, 2017) While the model was first used for measuring behavioral acceptance of personal computers, nowadays it is widely recognized and adopted in many areas related to new technologies such as chatbots, mobile banking, the sharing economy, or nuclear energy (Munoz-Leiva et al., 2017; Saif et al., 2024; Tang & Jiang, 2024; Zhang et al., 2020).

Over the years researchers have found many limitations of the model, mostly related to the parsimoniousness of external factors and their predictive power, therefore even Davis contributed to further develop his original model (TAM 2 by Venkatesh and Davis (2000) and TAM 3 by Venkatesh and Bala (2008)), but due to the simplicity and flexibility of the first model scholars are still commonly using the original version (Marikyan & Papagiannidis, 2023).

As mentioned before, the risk-benefit concept is also a popular method to measure the population's perception of technology-related topics such as nuclear energy. (Guo & Ren, 2017; Ho et al., 2019; Mah et al., 2014; Wang et al., 2019). The basic nature of people is to look for benefits in all situations and even in our relations, we cannot evade this mindset (Heider, 1958). A common interpretation of perceived benefits is the perceived likelihood that taking a recommended course of action will lead to a positive outcome, whether it results in material benefits or only those on a psychological level, such as reduced risk or worry. Related to nuclear energy, Heider's (1958) explanation can be modified in the study as the perceived belief that the individual or the society will benefit from utilizing nuclear energy technologies.

At the same time, risk can be generally described as "the probability of an event and the magnitude of its consequences" (Jacobs & Worthley, 1999, p. 226). In most countries, nuclear energy production is considered as a grave danger, because in case of an accident (malfunctioning, leakage, improper waste management) the consequences should be foreseeable, which would affect not just the individual's health, but the whole society, environment, and the economy of the region (Cha, 2000; Keller et al., 2012; Parkhill et al., 2010). Due to this perception, perceived risk will be used in this study as the extent to which the public believes that they

may be exposed to a certain risk or hazards arising from the usage of nuclear energy production (Wang et al., 2019). Based on the benefit-risk concept, people are constantly analyzing whether or not they can gain something from a given situation or technology. If they perceive more benefits, then they will probably engage, while if they feel that the potential risks outweigh the advantages then they will reject it.

It is also very important to understand that risk communication influences the individual's behavior, especially related to disasters or hazardous activities (e.g., the operation of nuclear power plants) (Lindell & Perry, 2004). Information about a dangerous situation or technology triggers people's risk perception and people may take protective actions in order to reduce this threat (Zhu et al., 2016).

DATA METHODS

Whether to use nuclear power plants (NPPs) for energy generation is a popular topic nowadays, thus many scholars have investigated the subject in the last two decades. Since the level of public acceptance of the technology can change rapidly within different countries, I used the ScienceDirect database to become familiar with the previous findings. I have chosen this database because there are more than 18 million pieces of content available on the site, which are all peer-reviewed, thus guaranteeing the high quality of the works. Then I used advanced search on the platform with the following criteria:

- Keywords: nuclear energy and social acceptance
- Years: after 2010
- Article type: research articles only
- Language: English

After filtering there were 5204 articles, so I sorted them by relevance and then chose to scrutinize the first 100. From these articles I found twelve which are indeed about nuclear energy, using one of the above-mentioned social acceptance models (or a mixture of them), while testing the different factors of the models one by one.

To avoid the chance of my information gathering being one-sided, I used the snowball sampling method on the selected articles for mapping other databases (this method refers to using the reference list of a paper to identify additional related papers). After I expanded my research one level backward from the original twelve articles I improved my data pool with two additional articles, so overall fourteen items were available to create an ideal model for the future Hungarian survey (Table 1).

Table 1

Considered articles related to nuclear energy acceptance with models

Title	Purpose of the study	Conceptual Framework and Factors	Conclusion
The acceptance of nuclear energy as an alternative source of energy among Generation Z in the **Philippines**: An extended theory of planned behavior approach (Belmonte et al., 2023)	The study aims to investigate the acceptance of nuclear energy among Generation Z citizens of the Philippines.	**Extended Theory of Planner Behavior** Factors: 1. Knowledge about Power Plant 2. Attitude 3. Perceived Behavioral Control 4. Intentions 5. Risk Perception 6. Benefit Perception 7. Subjective Norm 8. Technological Acceptance	Empirical results show that Risk Perception and Behavioral Intention had the greatest impact on the acceptance of nuclear energy, but knowledge also positively affects Behavioral Intentions, while Attitudes have a negative effect on it.
Social acceptance of nuclear power plants in **Korea**: The role of public perceptions following the Fukushima	The study investigates the public perceptions of NPPs in South Korea, after the Fukushima accident.	**Theory of Planned Behavior and Benefit-Risk concept** Factors: 1. Perceived Awareness 2. Perceived System Reliability 3. Environmental Knowledge 4. Perceived Costs	Perceived benefits played a key role in determining the public's intention to use NPPs. Perceived benefits are significantly affected by perceived costs, system reliability, awareness, and environmental knowledge.

accident (Jang & Park, 2020)		5. Perceived Benefits 6. Perceived Risks 7. Attitudes 8. Intention to use	
A framework of examining the factors affecting public acceptance of nuclear power plant: Case study in **Saudi Arabia** (Alzahrani et al., 2023)	The purpose of the study is to analyze the public attitudes and acceptance of nuclear energy among Saudi Arabian citizens by utilizing Protection Motivation Theory and the Theory of Planned Behavior.	**Theory of Planned Behavior and Protection Motivation Theory** Factors: 1. Nuclear Knowledge 2. Trust in Regulations 3. Social Influence 4. Proximity 5. Perceived Risk 6. Perceived Benefit 7. Acceptance	Regarding the first NPP constructed in Saudi Arabia people overweigh the perceived benefit compared to the perceived risk, but the location of the plant could seriously influence their acceptance. Although the benefit perception is strong in the country, 40% of the population is less than 24 years old, so to keep their support a national awareness program is proposed by the authors.
Modeling individual preferences for energy sources: The case of IV generation nuclear energy in **Italy** (Contu et al., 2016)	The study analyses the social acceptance of the new, fourth-generation nuclear energy technology in the light of the Fukushima Accident.	**Benefit-Risk Concept** Factors: 1. Egoistic 2. Altruistic 3. Biospheric 4. Benefits 5. Risks 6. Confidence 7. Acceptance	The study highlights the Confidence factor in the model as one of the most important components of public acceptance. At the same time it proposes that by deploying information campaigns, public confidence can be increased towards new generation NPPs.
An empirical study of the risk-benefit perceptions between the nuclear and non-nuclear groups towards the nuclear power plant in **Bangladesh** (Islam et al., 2023)	The study investigates the sectoral influence on people's risk and benefit perception regarding nuclear energy.	**Benefit-Risk Concept** Factors: 1. Public Participation 2. Risk Perception 3. Benefit Perception 4. Public Acceptance	The study revealed that non-nuclear people's participation in nuclear energy education is way lower than in the nuclear group. Obviously, risk and benefit perception was also significantly different between the two groups.
Predicting unsafe behaviors at nuclear power plants: An integration of Theory of Planned Behavior and Technology Acceptance Model (Zhang et al., 2020)	The study states that unsafe behavior is a key contributor to nuclear power plant accidents. For this purpose, the study investigates how worker's attitudes and perception factors would predict errors and violations at **Chinese** NNPs.	**Theory of Planned Behavior and Technology Acceptance Model** Factors: 1. Subjective norm 2. Perceived Behavioral Control 3. Perceived Usefulness 4. Perceived Ease of Use 5. Attitude	The results showed that attitude and perception play a key role in shaping unsafe behaviors, but Perceived Usefulness and Perceived Ease of Use also help reduce unsafe behavior through the Attitude factor.
Effects of information strategies on public acceptance of nuclear energy (Hu et al., 2021)	The study uses two types of information strategies (interest-focused and technology- focused) to identify the	**Theory of Planned Behavior and Protective Action Decision Model** Factors: 1. Environmental Concern	The study identifies the key determinants of psychological perception and public acceptance to be environmental concern and energy shortage belief. At

	predictors of public acceptance of NPPS in **China.**	2. Energy Shortage Belief 3. Perceived Risk 4. Perceived Benefits 5. Public Acceptance	the same time, the two types of questionnaires reveal that people in the interest-focused group have higher risk perception and lower benefit perception than people in the technology-focused group.
Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: Investigating an explanatory model (Visschers et al., 2011)	The study investigates public opinion on rebuilding nuclear power stations in **Switzerland** using a telephone survey.	**Extended Benefit-Risk Concept** Factors: 1. Trust 2. Affect 3. Risk Perception 4. Benefit perception on climate mitigation 5. Benefit perception on energy supply 6. Acceptance	The results showed that when investigating benefits, people give more value to the energy supply factor than to the climate mitigation factor, while trust and affect both can influence risk and benefit perception.
When it is unfamiliar to me: Local acceptance of planned nuclear power plants in **China** in the post-fukushima era (Guo & Ren, 2017)	Analyzing challenges at the planning stage rather than operation stage, the authors investigate local acceptance in two Chinese cities where the government was planning to build an NPP.	**Extended Benefit Risk Concept** Factors: 1. Perceived Knowledge 2. Emotional Identification 3. Social Trust 4. Perceived Benefits 5. Perceived Risks 6. Local Acceptance	The study revealed that people who live closer to the plant sites are less willing to accept nuclear power than those who live farther away. Surprisingly, the authors found that Perceived Knowledge does not significantly influence local acceptance, while Social Trust and Emotional Identification were accepted as significant factors.
Anti-nuclear behavioral intentions: The role of perceived knowledge, information processing, and risk perception (Zhu et al., 2016)	The study investigates the key factors behind people's anti-nuclear behavioral intentions in **China**	**Theory of Planned Behavior, Heuristic-Systematic Model and Protective Action Decision Model** Factors: 1. Perceived Knowledge 2. Information Seeking 3. Information Insufficiency 4. Risk Perception 5. Systematic Processing 6. Behavioral Intentions	The results showed that there is an inverted U shape relationship between Perceived Knowledge and anti-nuclear behavioral intention, and reducing Risk Perception is effective in decreasing opposition against nuclear power generation. The only hypothesis rejected in the model is that Behavioral Intentions can be stimulated by Systematic Processing.
How and when does information publicity affect public acceptance of nuclear energy? (Wang et al., 2020)	The study aims to investigate that how can nuclear energy development supported among **Chinese** residents by publicizing information about the technology	**Extended Benefit-Risk Concept** Factors: 1. Information Publicity 2. Perceived Risk 3. Perceived Benefit 4. Personal Willingness to Accept 5. Willingness to Persuade Others to Accept 6. Information Credibility	The study found that Information Publicity positively and directly impacts public acceptance, but the effect is relatively small, while also impacting acceptance indirectly via Perceived Benefit and Perceived Risk.

Investigating the acceptance of the reopening Bataan nuclear power plant: Integrating protection motivation theory and extended theory of planned behavior (Ong et al., 2022)	The study focuses on the acceptance and reopening of previously closed NPPs (shut down because of political reasons not because of safety problems) among **Philippine** residents who live close to the Bataan nuclear power plant.	**Extended Theory of Planned Behavior and Benefit-Risk Concept** Factors: 1.Knowledge about Nuclear Plant 2. Perceived Benefit 3. Perceived Risk 4. Perceived Behavioral Control 5. Subjective Norms 6. Attitude 7. Intention 8. Acceptance	The results showed that PBC and Attitude influence the local resident's acceptance, while the individual's knowledge can lead both ways based on the Benefit-Risk perception. If the Perceived Benefits outweigh the Perceived Risks, then this will have a positive effect on acceptance, but if not, then it will strengthen the willingness to reject.
Public Perception of the Nuclear Research Reactor in **Thailand** (Tantitaechochart et al., 2018)	The study analyses the public perception among local citizens regarding the future construction of a nuclear reactor in their neighborhood.	**Benefit-Risk Concept** Factors: 1. Social status 2. Information Perception 3. Trust 4. Risk Perception 5. Benefit Perception 6. Technology Acceptance	The study found that trust was the main exogenous variable that affected the risk and benefit perceptions, while social status had only a slight impact on the endogenous variables.
Extending the Coverage of the Trust–Acceptability Model: The Negative Effect of Trust in Government on Nuclear Power Acceptance in **South Korea** under a Nuclear Phase-Out Policy (Roh & Geong, 2021)	The study investigates trust toward nuclear energy in a country where nuclear phase-out is initiated by the government.	**Extended Trust-Acceptability model** Factors: 1. Trust in Government 2. Trust in Nuclear Energy Authority 3. Trust in Nuclear Academia 4. Trust in Environmental NGOs 5. Benefit Perception 6. Risk Perception 7. Nuclear Power Acceptance	The results show that in a nuclear phase-out situation trust in the government has a negative impact on nuclear power acceptance, thus on perceived benefits also, while higher trust in nuclear energy authorities resulted in a positive effect on public acceptance.

Source: own editing based on the database search

As can be seen in Table 1, researchers are building the core of their theoretical framework based on the available behavioral models, while adding different External Factors in to find a better explanatory model, since based on Aziz et al. (2020) the main TAM and TPB models usually have around 40-50% explanatory power.

At the same time based on the questionnaire literature, it is highly recommended to keep the survey as short as possible otherwise the response rate and the reliability of the results may drop, therefore in the article only the most relevant external factors will be selected. (Sharma, 2022)

HYPOTHESES

When talking about external factors, many scholars have concluded in recent years that knowledge can be a strong psychological factor that can influence risk perception and benefit perception, and based on the information gathered by the individuals, the scale could swing in either direction. Insufficient knowledge can even hinder the development of renewable energy sources, and this effect applies even more to nuclear energy projects (Frederiks et al., 2015; Kardooni et al., 2016, Ong et al., 2022). This was supported by S. Wang et al. (2019) in China, who found a positive effect between knowledge and perceived benefit among residents, while Huang et al. (2013) after the Fukushima accident investigated the same topic in China and found that the news about the catastrophe negatively affected people's risk perception. Based on Alzahrani et al. (2023) it is confirmed that as a result of people widening their knowledge about nuclear energy technologies, they became more favorable towards the operation of NNPs because their benefit perception became more significant than their risk perception. During this process, they also give up their

previous preconceptions and start to make decisions based on scientific facts instead of their faith, which can support the spread of this type of energy source (Wallquist et al., 2010). On the other hand, it could be unreasonable to expect deep knowledge about nuclear energy from the majority of the population, if only because of the lack of relevant knowledge and information available to them (Siegrist & Cvetkovich, 2002). For this reason people used to rely on the judgment of the experts on the field; however, this trend is slowly deteriorating due to increased internet availability. (Guo & Ren, 2017) Based on the findings, I propose the following hypothesis:

- H1: Knowledge about nuclear energy has a significant impact on Risk Perception.

- H2: Knowledge about nuclear energy has a significant impact on Benefit Perception.

Another interesting factor is trust, which based on the TAM model can be identified as a design feature. In modern societies people usually specialize in a single discipline alone to achieve well-being, thus they become greatly dependent on other persons or groups who are skilled in other disciplines or technologies. When people evaluate an object that is beyond their knowledge, they highly rely on the opinion of the authorities or experts and in this case, the presence of trust is necessary (Roh & Geong, 2021). Mayer et al. (1995) defined trust as the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party. Trust can be measured on many levels such as trust in the technology, in the regulations, in the government, in the regulatory authorities, in the media, or belief in honesty, integrity, and reliability of others, which is also known as social trust. As revealed by Jager (2006), in a situation where many homeowners equipped their property with photovoltaic solar energy systems, people who are part of an extensive social network are more dedicated to choosing this technology, because they perceive the installation as being less difficult than others do. Meira et al. (2024) investigated in Brazil the role of trust in the purchase intention of vegetables produced with pesticides and concluded that trust is a fundamental factor that influences risk and benefit perception. He also found that trust alone in the regulatory environment is not sufficient; people have to believe that the laws are enforced and stakeholders are regularly monitored. The effect of trust in the media on behavior intention was analyzed by Schultz and Kaiser (2012), who confirmed that the mass media and the quality of the information provided play an important role in decreasing perceived risks. The nuclear energy literature scrutinizing the role of trust in benefit and risk perception is also wide. Alzahrani et al. (2023) found that accidents related to nuclear energy generation can deteriorate the level of trust, especially when there are other, cleaner renewable energy sources available. Hoti et al. (2021) concluded that the lack of trust plays an important role in low public participation intention, while Tantitaechochart et al. (2018) argued that the presence of trust could reduce the resident's risk perception and at the same time increase their attitude and benefit perception towards nuclear energy. Based on the findings, I propose the following hypothesis:

- H3: Trust has a significant impact on Risk Perception.

- H4: Trust has a significant impact on Benefit Perception.

As discussed in the Theory of Planned Behavior model, Attitude describes people's relation to a given behavior or towards a new technology, which is the result of their evaluation of whether this behavior or in this case technology will be beneficial for them in a long term, or detrimental (Ajzen, 1991). Sometimes people can see both benefits and drawbacks and cannot choose a side so they take a neutral attitude, which means that they tolerate the technology, but that is hardly the case for nuclear energy generation (Huijts et al., 2012). Since this technology is considered as a two-edged sword, usually there is no middle ground; people either support it or reject it and take action against it, which is why it is extremely important to manage public acceptance, especially if policymakers would like to extend the usage of this energy source (Huang et al., 2018). These statements were confirmed by Ryu et al. (2018), who found that there is a negative relationship between perceived risk and public attitudes in case of nuclear energy technologies. Huhtala and Remes (2017) came to the same conclusion; if the risk perception of the locals is high, then this is directly shown in a lower public acceptance and larger social expenses for the community. On a positive note, Siegrist et al. (2014) affirmed that over the course of time attitudes can change, thus, paying attention to the influencing factors can have a positive effect on public acceptance. On the other hand, in case of a serious accident, it can have negative effects too, and abruptly reduce support, especially for those individuals who live near the nuclear facility (for example in the Fukushima accident). At the same time Choi et al. (1998) found that basic traits such as gender can fundamentally affect public acceptance towards nuclear energy, because male participants usually focus on the benefits of the technology, while female participants tend to give more credit to the perceived risks. Based on the findings, I propose the following hypothesis:

- H5: Risk Perception has a significant impact on Attitude.

- H6: Benefit Perception has a significant impact on Attitude.

Subjective norms represent the individual's perception of their expected behavior based on the perceived opinions of the most respected family members, friends, or close ones (Ajzen, 1991). Based on these opinions people assess their own values and the societal acceptability of their actions and decide whether they will carry out the given behavior (Zhu et al., 2024). The connection between subjective norms and behavioral intention has been proved by many scholars, such as Ursavas et al. (2019), who investigated preservice and in-service teachers' intentions to use new technology in teaching, or by Abushanab and Pearson (2007), who found that social norms have a significant impact on the adoption of internet banking in Jordan. In the field of nuclear energy, the studies of Perko et al. (2012), Zhang et al. (2020) and Ong et al. (2022) all concluded that the opinion of important relatives can influence the individual's behavioral intention. Based on the findings, I propose the following hypothesis:

- H7: Subjective norms have a significant impact on Behavioral Intention.

Perceived Behavioral Control refers to the individual's perceived level of control over their behavior, taking into consideration their past experiences, anticipated issues, and their skills and abilities. As slightly mentioned before, it is important to highlight, that PBC focuses on the perception of the control and not on the actual control, which are two different things. (Foltz et al., 2016) Based on Ajzen (1991) this is one of the strongest factors influencing behavioral intention, therefore this construct is widely known and analyzed among scholars in different areas. In the online space, Perez et al. (2023) identified PBC as one of the main indicators that influence people to engage in NFT games, while Meng et al. (2024) found the same when investigating the habits of people traveling with pets and staying at a pet-friendly hotel. In nuclear energy Ong et al. (2022) verified that one of the most important factors influencing behavioral intention is PBC, while this statement was also confirmed in the Philippines by Belmonte et al. (2023) Based on the findings, I propose the following hypothesis:

- H8: Perceived Behavioral Control has a significant impact on Behavioral Intention.

In the TPD model intention captures the essence of the antecedent motivational factors in order to measure a person's determination to perform a behavior. (Beck & Ajzen, 1991) "The stronger the intention, the more likely it is that the behavior will follow." (Ajzen, 2020, pp. 315) Based on Ajzen (1991) the core motivational factors that have a significant effect on the behavioral intention are Attitude, Subjective Norms, and Perceived Behavioral Control. In China, Liao et al. (2023) demonstrated that these factors impact behavioral intention throughout a survey about low-carbon travel preferences, while in Italy Capasso et al. (2023) came to the same conclusion when investigating the predicting factors of how mothers choose the food to buy for their children.

Ajzen's concept was proved in many areas by scholars and it is still a very popular research method, especially in environmental-related topics such as low-carbon-emission technologies (Li et al., 2020; Stigka et al., 2014; Wang et al., 2018) or nuclear energy development (Jang & Park, 2020). Although the model is attractive, the weight of the components may vary in different countries or it can even happen that some of them do not support the overall model, as was found by He et al. (2024), who - based on a survey - rejected the hypothesis that Attitude and Subjective norms affect behavioral intention. Therefore it is highly recommended to pay attention to these factors in any given analysis. Based on the findings, I propose the analysis of the following hypothesis:

- H9: Attitude has a significant impact on Behavioral Intention.

Public or technology acceptance refers to the society's general attitude towards an invention, which derives from complex social, cultural, and historical factors (Liu et al. 2008). Behavioral intention has a huge role in acceptance because it can drive people to use the technology thus making it popular and desired by others, or in case of rejection it can make the idea totally unacceptable to someone (Belmonte et al., 2023; Savari & Gharechaee, 2020). In the literature, examples are available for both outcomes. Based on Savari and Gharechaee (2020), who conducted their research on Iranian farmers, behavioral intention has a strong effect on technology acceptance and it could be influenced in such a way that would lead to complete rejection by the residents. In nuclear energy, Lim et al. (2017) investigated technology acceptance among Korean people and found that even if it would be beneficial on a national level for the society to build NPPs, the development could be prevented by those who live near the construction site if their willingness to accept is not managed properly. Xiao et al. (2017) came to the same conclusion; without the support of the local communities, there is no chance to successfully build nuclear power plants. This underlines the importance of the topic, especially in Hungary, where policymakers are trying to expand the capacity of the currently operating Paks Nuclear Power Plant. Based on the findings, I propose the following hypothesis:

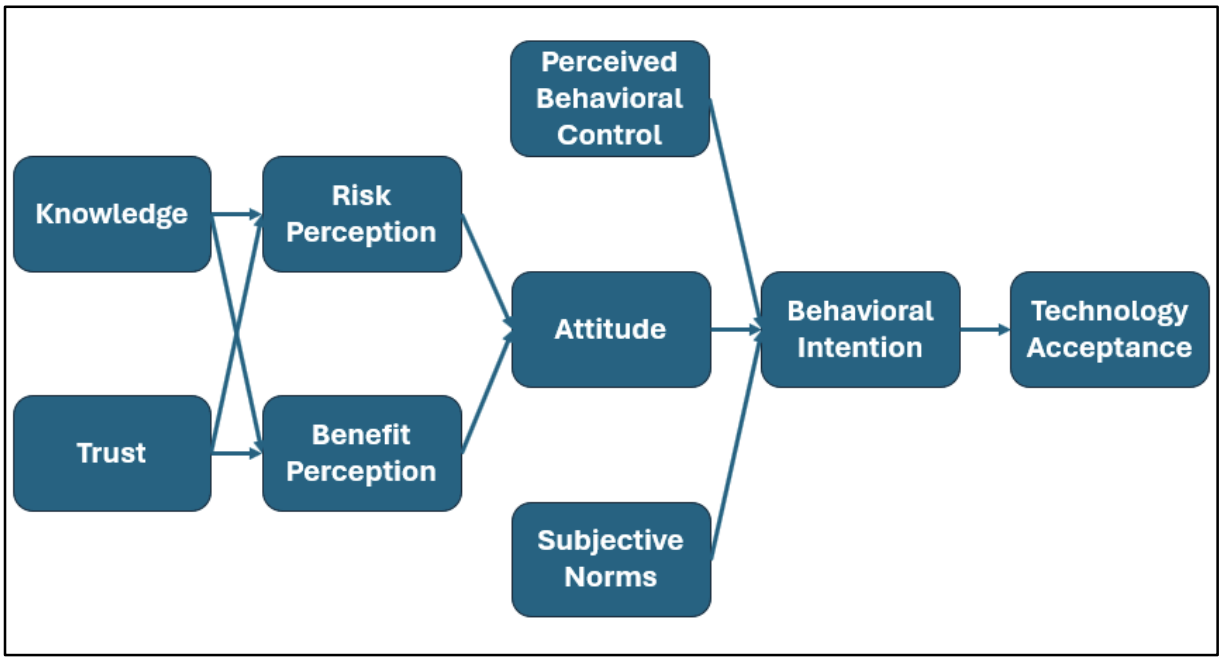
- H10: Behavioral Intention has a significant impact on Technology Acceptance.

As a result of the literature review, the following model is designed in order to capture the Hungarian resident's mindset related to nuclear energy.

THEORETICAL FRAMEWORK

The theoretical framework is built on the core of the TPB model because scholars in other countries have widely accepted these factors (see Table 1), and presumably Hungary should not be an exception. Figure 3 outlines the components of the model. In many research studies on technology acceptance - conducted in different fields - the process ends with the actual (system) use; however, related to nuclear energy, this type of behavior cannot be measured, because a single (Hungarian) resident has no chance to harvest the benefits of the technology on his own; it can be interpreted only on a community level, thus this stage is not added to the investigation.

Since the usage of nuclear energy can directly impact people's lives (especially in case of an accident), residents usually have a strong opinion about the risks and the benefits. Based on the articles listed in Table 1, risk perception can be extremely important to those people who live near a nuclear power plant or have previously been affected by an accident, while people living far from the operation site or not affected by accidents usually prioritize the benefits. Hungary is one of the few European countries where a nuclear power plant is still in operation, and although our country was not affected by the latest major nuclear accident (Fukushima), older residents still remember the accident in Chernobyl; these facts solidify the presence of the Risk Perception and Benefit Perception in the analysis.



Source: own editing based on the reviewed materials

Figure 3: Theoretical framework to measure social acceptance of nuclear energy among Hungarian residents

In the model Knowledge and Trust are considered as Design Features/External Factors, which can improve the explanatory power of the model by indirectly influencing the Behavioral Intention. These components are not just simply added to the model based on the fact that they were previously used in many scientific works, but also because of their relevance to the current geopolitical situation. The Hungarian government already started to explore the possibilities for a nuclear power plant expansion in 2009, which would involve the construction of two new units with a combined capacity of 2,000 MW, located next to the existing nuclear power plant. Since the implementation entered into the construction phase in 2023 there have been many ongoing debates about the necessity of the project, leaving people in doubt or even in fear. For this reason, it is crucial to scrutinize the following questions:

- What does an average Hungarian resident know about the process of generating nuclear energy in a power plant? (Knowledge factor)

- Do people trust in the local authorities, experts, or even in the media, when they are making a statement about the necessity of the construction? (Trust factor)

The validity of the model can be tested with a survey among Hungarian residents, using a 1 to 5 Likert scale. This has been selected because based on previous research the data from this type of questionnaire can be easily analyzed with statistical methods, such as Structural Equation Modeling. As can be seen by checking the related articles listed in Table 1, the number of questions for each factor may differ, but usually varies between two and six.

Although the model was designed for Hungarian citizens, this does not rule out the possibility of using it in other countries or other areas, if local researchers find the External Factors relevant based on the geopolitical situation.

CONCLUSIONS AND RECOMMENDATIONS

To reduce the global GHG and CO_2 emissions the electricity sector has to undergo serious changes in the future. As Rust (1979) and Knief (1981) pointed out, nuclear energy could be a solution for this purpose, because during its lifecycle nuclear fuels produce significantly less CO_2 than fossil fuels and are equivalent or in some cases even less than the renewables if measured on a generated energy unit basis. Simply based on this fact, the shift appears to be easy. However, there are other factors that also play a significant part in the transition, such as public acceptance. Based on their previous experience (either personal or only gained from the news) many people deem nuclear energy generation as an unsafe process, and therefore they oppose the spread of it. For this reason, scholars all over the world continue to investigate the attitude of residents toward this technology and identify the different external factors, which could speed up the development of social acceptance. Fortunately, several technology acceptance and behavioral intention models are available in the literature (TAM, TPB, Risk-Benefit concept, PADM) that could be used as a basis of the investigation; however, there is no single model which is universally accepted by everyone. The most frequently referred to limitation of the different models is that they cannot perfectly catch all the external factors because these factors may vary based on the economic sector being analyzed and on the given country, too. To tackle this inconsistency, mixed theoretical frameworks have come into use in the last decade, all trying to use the most suitable model for a particular country.

Related to nuclear energy, the most commonly used model is the Risk-Benefit concept in an extended version with various external factors and combined with the TPB model. Based on the literature review, the results are convincing, so I have decided to use the same model as the basis of my theoretical framework while adding two more external factors, namely Knowledge and Trust, which are also significant antecedents of technology acceptance.

Although measuring the social acceptance of the Hungarian residents related to nuclear energy generation is not part of this article, the developed model will serve as a basis for a future investigation on the topic.

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Before Russo-Ukrainian War: How Did EU-Ukraine Association Agreement of 2014 Transform Ukraine's Economy?

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SUMMARY

In this paper is tried to identify, if exists, any qualitative divergence in Ukraine's economic structure before and after the EU-Ukraine Association Agreement, and examine whether the agreement fulfilled its promises. The way in which we investigate the issue is by employing ADL modelling, bifurcating the whole chunk of series as before agreement model (BAM) and after agreement model (AAM). It's been observed severe disruptions in the structure of export, import and foreign direct investment, transformed Ukraine's economy into less favorable position, accelerating economic down-swing. Under these considerations, hypothesis that EU-Ukraine Association Agreement is transformative in an unpromising sense is scientifically substantiated, with the fact that it has been of no little effect in building up a new and unfavorable economic paradigm for Ukraine.

Keywords: EU-Ukraine Association Agreement; ADL modelling; export; import; Ukraine's economy.
Journal of Economic Literature (JEL) code: F1, F13, F51, F53, F55
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INTRODUCTION

On February 23, 2022 Vladimir Vladimirovich Putin, president of the Russian Federation (RF), announced the Special Military Operation (SMO) for the demilitarization and *denazification* of Ukraine due mostly to NATO's illegitimate eastward expansion (Nikolsky, 2022) and Ukraine's alignment with the European Union (EU), the conspicuous outcome of which is the EU-Ukraine Association Agreement — drafted on March 30, 2012, signed on March 21, 2014, provisionally and extensively implemented from November 1, 2014 to January 1, 2016, entered fully into force on September 1, 2017, promising deeper political ties along with stronger economic links, standing for a legal framework of economic integration and political affiliation between EU and Ukraine.

This paper covers concrete outcomes of the EU-Ukraine Association Agreement for Ukraine's economy, and effectiveness of bilateral trade agreements EU signed with non-member countries. Above all, it is scientifically crucial for decomposing outputs of the agreement, separating the wheat (benefits) from the chaff (risks) at macro level. Long ago, Emerson et al. (2006) called attention to costs of possible elimination of tariffs and non-tariffs applications of the Deep and Comprehensive Free Trade Area (DCFTA), giving rise to trade-diversion effects if a candidate country, Ukraine, has an enormous trade share with another third-party country, i.e., Russia. It was recommended that EU should have formed a free trade area with Russia as well, which has yet to become an option. Sadowski (2012) opined that the reason why application of DCFTA was particularly significant for Ukraine and secondary for EU lied behind the size of Ukraine's GDP, population, number of consumers and volume of internal market incommensurate to those of EU. Dreyer (2012) assessed the benefits and agreement-engendered-costs that resulted from EU negotiations with countries of poorest economies, and from the injection of EU laws into these countries' legislative bodies. Through AGLINK-COSIMO partial equilibrium model by OECD, Nekhay

et al. (2012) simulated possible implications of DCFTA on Ukrainian agriculture sector, drawing the conclusion that DCFTA between parties, for many agricultural products, offered opportunities for EU producers, and challenges for Ukraine's due mostly to natural comparative advantages of EU countries over Ukraine in most agricultural goods. Modelling gravity model, Yatsenko et al. (2017) drew attention to the advantages, such as elimination of trade asymmetry between parties, modernization of agriculture and trade, rise of exports by abolishing duties, and such disadvantages as increase in raw material prices, decrease in state income caused by elimination of import tariffs on agricultural goods, etc. Analyzing the pros and cons of the agreement for specific sectors, Bazhenova et al. (2018) found the impact of the agreement on Ukrainian economy to be indecisive— beneficial significantly for metallurgy and mining sector, and insignificantly for imports, however, detrimental significantly to both foreign capital inflows and commodity production, and insignificantly to chemical industry.

It is worth noting that one of the well-known premises of the Agreement was to secure and uphold the transparency in Ukraine. There exist several attempts at examining Ukraine's corruptıon related economic problems, covering the period between 2013 and 2020 — after the Ukrainian coup d'état, i.e., the Euromaidan uprising, and before the Russian SMO. Ukraine, first and foremost, though considered a sovereign democracy by many, used to oftentimes be referred as most corrupt country in Europe, so much so that in a prominent corruption index, International's Corruption Perceptions, Ukraine ranked 142nd along with Uganda and Comoros right behind Nigeria (Bullough, 2015). Stretching back as far as early 1990s, and with some from Carnegie Institute sponsored by Open Society Foundations believing it has made certain positive reforms in several spots particularly since 2013 (see Waal, 2016), Ukraine still holds its position among the most corrupt nations ruled by venal authorities on earth, with numerous reforms against corruption, yielding zilch (Transparency International, 2014). In 2014, the Ukrainian black market was estimated to form 50% of total GDP, sending bribery among bureaucrats through the roof (Smith, 2022). As a direct consequence of its oligarchic model of economy with a high scale of monopolization, perpetual increase in economic inequality, unemployment, and impoverishment of the majority, numerous studies emphasize the volume of black market rooted in Ukraine vacillating between 28% and 40% of total economy (Kobielieva, 2019, p. 35). In 2023, the Kiev International Institute of Sociology reported that citizens found the corruption to be "second-most-serious" issue in the country, knowing that getting rid of oligarchs and money laundering was a requirement to gain accession to the EU (Stockman, 2023). Corruption in Ukraine is the stark combination of such societal and economic issues as institutional infirmity, weak economic policies, insoluble public finance, dilapidated business environment with a lack of attraction to investment, persistent energy insecurity, inability to implement direly-needed social policies and conflict between the central authority and peripheral regions (Garmash & Pererva, 2020, p. 42), i.e., Donetsk and Luhansk, inter alia, within the Donbass region located in Eastern Ukraine, the majority of whom is predominantly Russian speaking population and even looking forward to reemergence of the Union of Soviet Socialist Republics (USSR) (Yang, 2023, p. 611) to which Ukraine owes its current territory to a large degree.

Even though Ukraine's economic failure with global downturn tend to be linked to political conflict with Russia that peaked in 2014 and 2022 (see The Economist, 2022), it had already suffered a huge economic loss by 14.8% during the financial crisis of 2008, well above average global figures of recession. Long before the Russian conflict, Ukraine was always economically performing below average compared to the Commonwealth of Independence States (CIS), with its GDP having grown only by 69.8% relative to the 1990s. Such a "provocative" operation as seeking to join NATO added to its economic and political mediocre governance (Yang, 2023, p. 603). To put it briefly, nevertheless, tenable though it might seem at first glance that the economic conflict with Russia accounts for a significant part of the recent economic instability, the underlying truth is the permanent precarious policies, tenuous reforms and widespread corruption that perpetuate the problems of which country has been in the throes for decades (The Economist, 2014).

In spite of which there exists an abundance of études examining the general economic and political impacts of Russo-Ukrainian conflict (Cifuentes-Faura, 2022; Khudaykulova et al., 2022; Kusa, 2022; Liadze et al., 2022; Tank, 2022; Tong, 2024), the literature is still short of the studies investigating and subsuming the vast content of Agreement into the SMO, which is what the contribution of this paper we think is. It is possible to find some papers focused on such sociological and economic specificities of ongoing war as the impact on international and national food markets and the risk for hunger (Abay et al., 2023; Ben Hassen & El Bilali, 2022), the concern mainly arising from Russia and Ukraine's position in grain exports, humanitarian crisis by deaths and injuries (Haque et al., 2022), prospective effects of the war's external shock on currencies around the world (Chortane & Pandey, 2022) and investment decisions of the firms (Novinska & Olesen, 2022), however, almost difficult to come across the papers that examine the specific macroeconomic indicators together, e.g., gross domestic product, import, export, capital formation, industrial output, foreign investments etc. in the axis of the EU trade agreement for Ukraine, further presenting a general picture of the efficiency of such agreements.

RETROSPECTION INTO THE AGREEMENT

First and foremost, the concept of association and trade agreements with an external partner as the direct consequence of EU's ambition in enlargement towards eastern countries derives from any attempts at constructing European Economic Area (EEA) and Single European Market in the 1980s and 1990s (Dabrowski & Taran, 2012, p. 7). Retrospection of the bilateral negotiations between EU and Ukraine formally dates back to *December 18, 1989* when a partnership treaty was signed between European Economic Community (EEC), European Atomic Energy Community (Euratom) and the USSR to have established close trade linkages. After an agreement came to pass on *March 23,1994*, an interim agreement on *December 4-20, 1995* was concluded between the European Coal and Steel Community (ECSC) and the European Community (EC), on one side, and Ukraine, on the other side that imports of goods between Ukraine and EC respectively would be conducted free from quantitative restrictions ("Interim Agreement on Trade", 1995, p. 3). On *February 19, 1998* another agreement was established, dwelling on the EEC's willingness to deliver technical assistance in order for Ukraine to carry out economic reforms ("Partnership and Cooperation Agreement", 1998, p. 2). Following negotiations on *December 8, 2003*, another protocol to the Partnership and Cooperation Agreement (PCA) dated *April 29, 2004* was initiated and new adjustments were adapted to the agreement. On the heels of *Pomarancheva Revoliutsiia* 2004*,* Ukraine was acknowledged on *February 21, 2005* as the first country of European Neighborhood Policy (ENP), aim of which was to ensure the liberalization of the trade of goods and services, and on which Ukraine expended utmost effort to take advantage as a "springboard" towards full-fledged EU membership (Dragneva & Wolczuk, 2014, p. 218). On *June 13, 2005*, a protocol germane to the exchange of "classified information" on security basis was settled at Luxembourg ("Agreement on the Security Procedures", 2005, p. 84). After a series of negotiations from December 22, 1994 to November 19, 2004, an agreement was concluded that both parties were poised to accomplish perfect liberalization of trade referring to products of steel ("Agreement on Trade in Certain Steel Products", 2005, p. 43). Another co-operation agreement on *April 4, 2006* was founded between Euratom and Ukraine's cabinet ministers pertaining to peaceful utilization of nuclear energy in an attempt to bolster up previous co-operation association ("Agreement for Co-operation in the Peaceful Uses of Nuclear Energy", 2006, p. 26). An accord regarding trade on textile products between EEC and Ukraine was initiated on May 5, 1993 and implemented on a large scale on *January 22, 2007* when tariff rates, concluded, imposed by Ukraine on exports of EC origin products of HS chapters 50 to 63 would not have exceeded the main quotas previously agreed upon ("Agreement on Trade in Textile Products", 2007, p. 18). Through missives between parties dated to *December 11, 2007*, government of Ukraine guaranteed that duties charged on goods originated in Ukraine and exported to EC would have been abolished ("Agreement in relation to Export Duties", 2008, p. 15). On *January 1, 2008* an agreement was settled that EU citizens would have been exempted from any visa necessities when travelling to Ukraine for a period of time not exceeding 90 days ("Agreement on Facilitation of Visas", 2008, p. 68).

Shortly after *Pomarancheva Revoliutsiia,* Viktor Yushchenko, third president of Ukraine, was in heatedly favor of deep and comprehensive political and economic alignment with the EU, started negotiations for a new Association Agreement in *March 2007*. Following Ukraine's membership of World Trade Organization (WTO) on May 16, 2008, DCFTA was initiated. On the heels of the elections, as the fourth president of Ukraine, Viktor Yanukovych, former governor of Donetsk Oblast, announced that Ukraine would have been looking for a foreign policy that would have helped Ukraine get maximum results from mutually and equally beneficial relations with Russia and EU ("Yanukovych's Inaugural Speech", February 25, 2010). Yanukovych, at the same speech, manifested that they were ready to become a "European non-aligned state".

After DCFTA segment was established in *July 2012*, EU announced, on *15 May 2013*, to have been technically ready to sign the Association Agreement with DCFTA in the near future ("Signature of Association Agreement", 2013), which would have later been suspended on the eve of Vilnius summit by the Ukrainian prime minister Mykola Azarov on *November 21, 2013* to restore economic and political ties with Russia and aligning with Eurasian Economic Union (Petrov & Holovko-Havrysheva, 2021, p. 7). Indeed, since nineties Ukraine has been used to oscillating between two camps: Moscow and Brussels (Van der Loo & Elsuwege, 2012, p. 422). Likewise, the political turmoil in Odessa where the Trade Union House was set on fire by pro-Euromaidan protesters in May 2014, resulted in 42 victims of anti-agreement activists, led to *coup d'état* having overthrown Yanukovych's government. A provisional pro-agreement government led by Arseniy Yatsenyuk was established right after the coup, manifesting that proceeding with the ratification of the agreement was only the case for short-run (Petrov & Holovko-Havrysheva, 2021, p. 8). The entire text of the EU-Ukraine Association Agreement was signed by Petro Poroshenko on *June 27, 2014* at Brussels, having launched the approval process (Van der Loo et al., 2014, p. 6) depending on 28 EU member states approval.

On *September 1, 2017*, the EU-Ukraine Association Agreement came fully into force with some objectives: stimulating rapprochement between EU and Ukraine based on "common values", strengthening regional stability, ameliorating economic circumstances, in turn, leading to Ukraine's integration into EU market, consummating full-blown market economy (Association Agreement, 2014, p. 6). DCFTA stands for the complete elimination of tariffs and non-tariffs in agricultural and manufacturing goods, comprehensive liberalization of Ukrainian trade for European service providers, providing foreign companies with an economic shield, and reliefs for international capital. Opening up Ukraine's economy towards competition with aggressive European multinationals is one of most striking articles in agreement (Kravchuk et al., 2016, p. 4).

IDIOSYNCRASIES OF THE AGREEMENT

In the EU's eastern neighborhood, Ukraine is the largest country in terms of its population, location and economic attraction along with the geopolitical properties (Smith, 2016, p. 7), which is why the EU is "far more Machiavellian than Kantian" (Smith, 2016, p. 14) in the Ukraine matter. Conditional and large in scope, the EU-Ukraine Association Agreement is conducive for the EU to shape internal and external relations with Ukraine, predicated upon Ukraine's allegiance to EU's polity and economic principles (Petrov, 2018, p. 59).

The Agreement is so idiosyncratic as to be made up of the bulk of 1,000 pages from 43 annexes, 486 articles, 28 chapters, and 7 titles with novelties, most prominent of which is DCFTA —the main idiosyncrasy as exhaustive outline of trade-related regulations germane to EU standards (Bazhenova et al., 2018, p. 4). Accordingly, the agreement falls roughly under the category of "integration-centered-agreements" with third-party country (Petrov, 2018, p. 50). However, to some scholars, the agreement with Ukraine had never aimed at accession to the union, having only been qualified to framework for cooperation in some economic and political matters (Spiliopoulos, 2014, p. 256). EU-Ukraine Association Agreement with DCFTA — far-reaching trade liberalization, sanitary standards for agricultural products, better conditions for domestic and foreign companies, rehabilitation of Ukraine's gas and oil transportation network ("Eastern Partnership", 2008, p. 5 and 8), is a novel phenomenon in theoretically terms of building up a political and economic approximation (Van der Loo, 2014, p. 63), providing a fresh model for some sort of *anschluss* without membership despite Ukraine's ambition, so keen to deeply advertise its pro-European ardor (Delcour & Wolczuk, 2015, p. 503). Nevertheless, provisions of agreement prudently evade unequivocal indication to membership chance of Ukraine (Van der Loo et al., 2014, p.10).

Additionally, DCFTAs do not only stipulate abolishing the tariffs on manufactured goods, but insinuate total elimination of them on imports of services, reduction in such non-tariff barriers as quotas, levies, embargoes, sanctions (Dabrowski & Taran, 2012, p. 6), security barriers and asymmetric information—at least as important determinant of trade as standard tariffs per se (von Cramon-Taubadel et al., 2010, p. 3). Likewise, DCFTA goes beyond economic matters, comprising socio-economic and institutional integration since new generation agreements are also set to encourage the adoption of *acquis Communautaire* (von Cramon-Taubadel et al., 2010, p. 10), alleviating production chain rupture, expediting know-how transfer, widening scale economies, guaranteeing fair increments in productivity (Evans et al., 2004, p. 14).

Although Ukrainian elites regard any accord with EU as nothing but a compelling political and security matter rather than an economically binding case (Langbein & Wolczuk, 2012, p. 867) DCFTA is the indispensable economic segment of new generation agreements. It is worth adding, some reports came to indicate that DCFTA was literally premature and rife with problems in which the only party benefitting from the agreement was the Ukrainian elites at a cost to the grassroots (Kravchuk et al., 2016, p. 4). In a nutshell, political alignment, of the superstructure, and economic approximation as substructure was subsumed into a new generation Association Agreement.

RESEARCH METHODOLOGY

Hypothetical Construction

The objective of this paper is to shed some light on the effects of EU-Ukrainian Association Agreement of 2014 on Ukraine economy well before the special military operation of Russian Federation gotten off the ground in February 2022. The hypothetical construction of this study is built up as below:

> **H_0:** EU-Ukraine Association Agreement is not transformative, having little effect in building up new economic paradigm for Ukraine.
>
> **H_A:** EU-Ukraine Association Agreement is transformative, having no little effect in building up new economic paradigm for Ukraine.
>
> **H_{A1}:** EU-Ukraine Association Agreement is transformative in a promising sense, having no little effect in building up new and favorable economic paradigm for Ukraine.
>
> **H_{A2}:** EU-Ukraine Association Agreement is transformative in an unpromising sense, having no

little effect in building up new and unfavorable economic paradigm for Ukraine.

Data Composition

To carry on, the data have been compiled for the Ukraine over a period of 21 years-84 observations from 2001-2021 with the quarterly organized frequency. The investigation assumes the following variables: Ukraine's Gross Domestic Product, Export to EU, Import from EU, Industrial Production, Gross Capital Formation and Foreign Direct Investment. Data for the Gross Domestic Product and Industrial Production are obtained from World Bank Global Economic Monitor and Ukraine Statistical Institute by the Classification Type of Economic Activity, Import and Export data from EUROSTAT-EU trade since 1988 by HS2, 4, 6 and CN8 (DS-645593), Gross Capital Formation from EUROSTAT International Data Cooperation, and Foreign Direct Investment from Balance of Payments Analytic Presentation by Country from International Investment Position Statistics (BOP/IIP) in IMF. (See Table 1)

Table 1.

Explanatory information on model

Variable	Explanation	Form
LNGDP	The Natural Logarithm of Gross Domestic Product of Ukraine (Billion €, 2010=100)	Dependent Variable
LNEXPEU	The Natural Logarithm of Ukraine's Export to EU (Billion €, 2010=100)	Regressor
LNIMPEU	The Natural Logarithm of Ukraine's Import from EU (Billion €, 2010=100)	Regressor
LNIP	The Natural Logarithm of Ukraine's Industrial Production (Billion €, 2010=100)	Regressor
LNGCF	The Natural Logarithm of Ukraine's Gross Capital Formation (Billion €, 2010=100)	Regressor
FDI*	Foreign Direct Investment Inflow into Ukraine (Million €, 2010=100)	Regressor
SYN_{2009}	Structural Shift for BAM in 2009Q1, Q2, Q3 by the 2008 Global Financial Crisis	Synthetic Variable
SYN_{2014}	Structural Shift for AAM in 2014Q4 and 2015Q1, Q2 by 2014 EU-Ukraine Association Agreement	Synthetic Variable
SYN_{2020}	Structural Shift for AAM in 2020 by 2020 Supply Shock	Synthetic Variable
TOTAL SAMPLE SIZE: 2001Q4-2021Q4 | OBSERVATION: 84		

Note: All series are deflated, and seasonally adjusted through US Bureau Census X-13ARIMA-SEATS. BAM is acronym of "Before Agreement Model" and AAM "After Agreement Model". (*) Unlike BAA, and having negative observations, FDI in AAM is not logarithmically transformed.

Source: EUROSTAT, IMF, Ukraine Statistical Institute, and World Bank

Some authors have argued that the seasonality blurs the relationship among time series, exogenous events, and exogenous variables (Bell & Hillmer, 1984, p. 300) despite the problem in deleting important data during the execution of seasonal adjustment (Oh, 2005, p. 40). Facilitated to peruse relationships, variables have seasonally been adjusted. Helped diminish variance, converge series to normal distribution (Lütkepohl & Xu, 2012, p. 620), alleviate heteroscedasticity problem (Shawa & Shen, 2013, p. 15) and make the model linear (Nguyen, 2017, p. 522), natural logarithm of the variables has implemented.

Variable Analysis

In this article, time series analysis—the set of observations belonging to the values of a variable at various times (Gujarati, 2004, p. 25-26), is employed. Seemed more convenient, entire model will be bifurcated as "Before Agreement Model (BAM)" and

"After Agreement Model (AAM)" to look into Ukraine's economic transformation triggered by the agreement concerned. AAM includes the frequency over a period of 12 years-48 observations from 2010Q1-2021Q4 as does BAM model over a period of 12 years-48 observations but from 2001Q1-2012Q4, which suffice to avoid any possible small sample problem, frequently ending up with bias in variance estimation (Montgomery et al., 2015, p. 158) and low statistical power. Descriptives are provided in Table 2.

Table 2.

Descriptive information on models

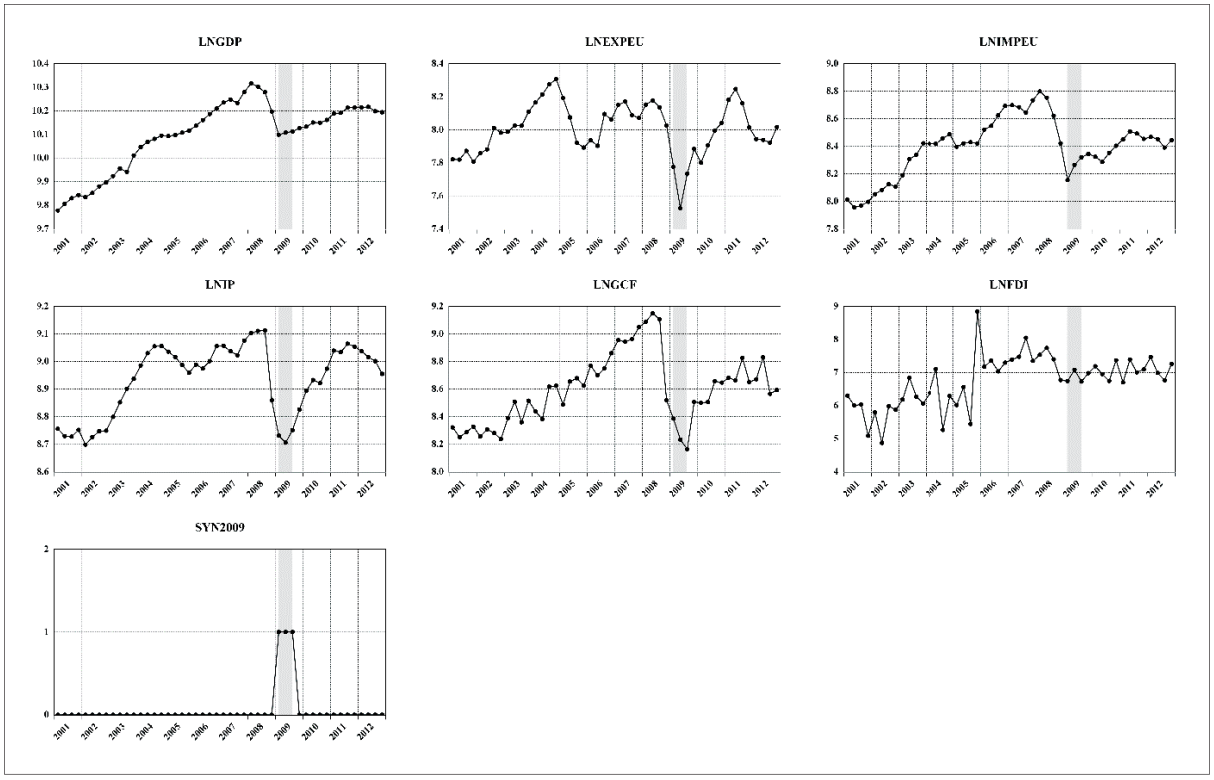
	LNGDP	LNEXPEU	LNIMPEU	LNIP	LNGCF	LNFDI(*)
	Before Agreement Model					
Mean	10.0986025	8.00643881	8.39337458	8.93444292	8.59406107	6.758678662
Median	10.1305024	8.01482894	8.42057271	8.98032680	8.60557053	6.900736310
Maximum	10.3165815	8.30719705	8.79870124	9.11305217	9.15084425	8.845926783
Minimum	9.77834803	7.52446856	7.95549162	8.69888399	8.16526520	4.875531461
Std. Dev.	0.14454956	0.15808102	0.21326534	0.13023981	0.25505632	0.776744848
Obs.	48	48	48	48	48	48
	After Agreement Model					
Mean	10.1304411	8.10442528	8.39512866	8.81877664	8.32056950	766.3343623
Median	10.1286381	8.14312685	8.41025519	8.80645946	8.43175494	887.5682141
Maximum	10.2277259	8.33017059	8.51691289	9.06449110	8.83199053	2726.170191
Minimum	10.0182452	7.79409616	8.18779158	8.59479344	7.39188956	-3337.96483
Std. Dev.	0.05934917	0.14340328	0.07972551	0.13332992	0.35988433	908.8079220
Obs.	48	48	48	48	48	48

Note: (*) Having negative observations, FDI in AAM is not logarithmically transformed.

Source: Author's calculations

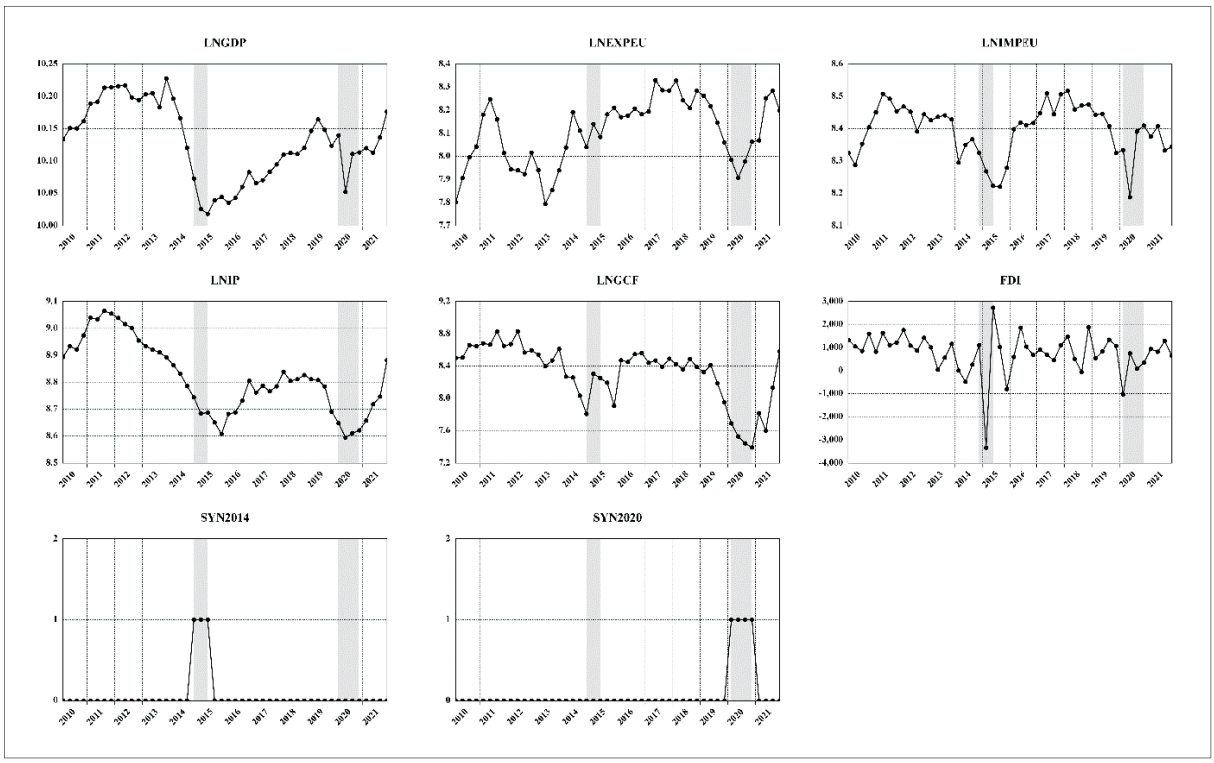
As important as descriptive analysis is the visual representation of the series, being first step into time series analysis (Gujarati & Porter, 2004, p. 795), which is introduced for BAM variables in Figure 1 and AAM in Figure 2.

Before formal introspection into the existence of unit roots, graph of each variable gives some hints at the variance based upon the spread, and stability relied upon the mean of the variables. Some appear to have stable trajectory, fluctuating around the mean with less variance and outlier, e.g., Foreign Direct Investment in both models and slightly Export in the first model, and Import and slightly Gross Capital Formation in the second model, other variables posit instability, being under effect of trend and breaks, most of which are both in intercept and trend, e.g., Gross Domestic Product in both model, Import and Industrial Production in the first.



Source: Authors' calculation based on data kindly provided by Ukraine Statistical Institute, World Bank, EUROSTAT and IMF.
Shaded areas denote economic breakdown.

Figure 1. Visual representation on BAM variables



Source: Authors' calculation based on data kindly provided by Ukraine Statistical Institute, World Bank, EUROSTAT and IMF.
Shaded areas denote economic breakdowns.

Figure 2. Visual representation on AAM variables

Unit Root Tests

Visual representation on both models above adumbrates that most variables are unstable, bearing stochastic trend, a phenomenon leading to "spurious regression", which is pervasive in time series (Yule, 1966, p. 12), and leading to incorrect interpretations because of which F statistical value does not fit to Fisher's F distribution under the nil hypothesis (Granger & Newbold, 1973, p. 114). Unit root tests are implemented to this end — results are provided in Table A-1 in the appendix.

The table illustrates the results of traditional Phillips & Perron (1988) test, which, compared to Augmented Dickey Fuller test, gives more effective results in the case of linear trend that must be included in regression analysis for unit root tests— thus is of great significance in taking this possibility into consideration (Phillips & Perron, 1998, p. 336), along with structural unit root tests, which are Zivot & Andrews (2002) and Enders & Lee (2012), latter of which employs Fourier LM test and allows for sharp as well as smooth shifts for unknown number of breaks.

For both BAM and AAM, Phillips & Perron results show all the variables at level being nonstationary except LNFDI. After first difference, stabilization in series is ensured. However, structural shifts might pervasively exist in time series, and, if not reckoned with, have serious consequences — even if series seem to be stationary, unit root tests often tend to reject alternative hypothesis of no unit root. Analyzes without considering structural shifts end up with illative errors, bias in estimators, in turn, misleading policy recommendations (Hansen, 2001, p. 127). Accordingly, the existence of structural shifts in BAM variables in 2009 caused by 2008 global financial crisis, and in AAM variables in 2014 engendered by the agreement of interest and in 2020 incited by global supply shock as a direct impact of COVID-19 pandemic, are highly probable. Structural unit root tests are also conducted along with traditional ones, shown in Table A-1 in which some variables, unlike the rest, have unit roots with structural shifts, including LNGDP and some other variables.

Empirical Modelling

Unit root tests concluded that some variables are integrated at level [I(0)] with others stable at first order [I(1)], pointing out the case for which Ordinary Least Squares (OLS) method is not applicable whatsoever. Fortunately, linear combinations of two or more series might possess stationary process even as all are not integrated at level (Gujarati, 2004, p. 830). In this case, Pesaran's (2001) Autoregressive Distributed Lag (ADL) model comes to the fore as a general dynamic specification technique (Kanjilal & Ghosh, 2014, p. 138). Dynamic specification technique stands for the methods that employ lagged values of dependent variable with lagged and simultaneous values of regressors while synthetic, i.e. exogenous, variables are kept unlagged. Dynamic specification by which long- and short-term effects could be decomposed, is what ADL model does, estimating short term effects directly while producing long-run equilibrium indirectly. By means of ADL model Abakumova & Primierova (2018) in their study examined long-run relationship between income equality and growth in the axis of globalization and Kuznets curve for Ukraine, and hit upon a "hidden" cointegration among variables. Yatsenko (2020) built ADL model so as to decide whether weather conditions had significant effects on such economic sectors as agriculture, manufacturing, construction, and energy in Ukraine. Their findings brace for the view that weather is of a noticeable but short-term impact on the dynamics of individual economic activities. Ziernhold & Jung-Ivannikova (2021) using ADL method and looking into the relationship between corruption, economic growth and financial development in Ukraine stumbled upon the long-term relationship among variables, revealing that corruption played negative influence on financial development while economic growth had positive effect on financial sector. Stryzhak et al. (2022) by exploiting ADL model investigated the long-run relationship between Geopolitical Risk Index (GPR), Ukraine's GDP and its Tourism revenues, and found out the less geopolitical risks the more tourism revenues with economic growth. Oleksiv & Mirzoleva (2022) developed an ADL/Error Correction Model (ECM) to decompose the impacts of remittances to the exchange rate appreciation in the short- and long-term perspectives. They discovered remittances produced positive outcome for the exchange rate appreciation in Ukraine.

In this paper, it's been investigated how Ukraine's economy was transformed by the EU Association Agreement of 2014 before the Ukro-Russian War. To this end, bifurcated regressions would be modelled by means of ADL technique to peruse short- and long-term effects of the agreement. ADL model seems convenient to employ since it allows to include synthetic variables for structural shifts as well as it doesn't demand specify regressions' integration degrees before the tests for any kind of level relationship between dependent and independent variables (Pesaran et al., 2001, p. 315).

The formulation of the conditional error correction model of the ADL bounds test-Case 4: Constant restricted with no trend for BAM is as below:

$$\begin{aligned}\Delta LN\text{GDP} = {} & \mu_0 + \alpha_1 LN\text{GDP}_{t-1} + \alpha_2 LN\text{EXPEU}_{t-1} + \alpha_3 LN\text{IMPEU}_{t-1} + \alpha_4 LN\text{IP}_{t-1} + \alpha_5 LN\text{GCF}_{t-1} + \alpha_6 LN\text{FDI}_{t-1} \\ & + \omega_1 LN\text{EXPEU}_t + \omega_2 LN\text{IMPEU}_t + \omega_3 LN\text{IP}_t + \omega_4 LN\text{GCF}_t + \omega_5 LN\text{FDI}_t + \sum_{i=0}^{p-1} \varpi_{1t} \Delta LN\text{GDP}_{t-i} \\ & + \sum_{i=0}^{p-1} \varpi_{2t} \Delta LN\text{EXPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{3t} \Delta LN\text{IMPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{4t} \Delta LN\text{IP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{5t} \Delta LN\text{GCF}_{t-i} \\ & + \sum_{i=0}^{p-1} \varpi_{6t} \Delta LN\text{FDI}_{t-i} + \lambda_1 \text{SNT}_{2009} \\ & + \upsilon_t \end{aligned} \tag{1}$$

The formulation of the conditional error correction model of the ADL bounds test-Case 2: Constant unrestricted with trend restricted for AAM is as below:

$$\begin{aligned}\Delta LN\text{GDP} = {} & \mu_0 + \eta TREND + \alpha_1 LN\text{GDP}_{t-1} + \alpha_2 LN\text{EXPEU}_{t-1} + \alpha_3 LN\text{IMPEU}_{t-1} + \alpha_4 LN\text{IP}_{t-1} + \alpha_5 LN\text{GCF}_{t-1} \\ & + \alpha_6 \text{FDI}_{t-1} + \omega_1 LN\text{EXPEU}_t + \omega_2 LN\text{IMPEU}_t + \omega_3 LN\text{IP}_t \\ & + \omega_4 LN\text{GCF}_t + \omega_5 \text{FDI}_t \\ & + \sum_{i=0}^{p-1} \varpi_{1t} \Delta LN\text{GDP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{2t} \Delta LN\text{EXPEU}_{t-i} \\ & + \sum_{i=0}^{p-1} \varpi_{3t} \Delta LN\text{IMPEU}_{t-i} \\ & + \sum_{i=0}^{p-1} \varpi_{4t} \Delta LN\text{IP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{5t} \Delta LN\text{GCF}_{t-i} + \sum_{i=0}^{p-1} \varpi_{6t} \Delta \text{FDI}_{t-i} + \lambda_1 \text{SNT}_{2014} \\ & + \lambda_2 \text{SNT}_{2020} \\ & + \upsilon_t \end{aligned} \tag{2}$$

The error correction (conditional) results for BAM and AAM are given in Table A-2, which illustrates that the parameters, to wit, the coefficients of most variables optimally lagged by ADL (4, 4, 2, 5, 5, 2) for BAM and ADL (1, 5, 5, 3, 2, 5) for AAM are significant, including those of synthetic variables injected into models that represent structural shifts incited by the financial crisis of 2008 for BAM, and political shift of 2014 agreement of interest as well as global supply shock of 2020 pandemic for AAM. Significance of synthetic variables' coefficients adds up to the clear fact that shocks engendered by the financial crisis, 2014 agreement, and global supply chain rupture are permanent, having no little bearing upon the series.

General equation of the Error Correction Form of the ADL bounds test-Case 4: Constant restricted with no trend for BAM is as below:

$$\Delta LN\text{GDP} = \sum_{i=0}^{p-1} \varpi_{1t} \Delta LN\text{GDP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{2t} \Delta LN\text{EXPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{3t} \Delta LN\text{IMPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{3t} \Delta LN\text{IMPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{4t} \Delta LN\text{IP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{5t} \Delta LN\text{GCF}_{t-i} + \sum_{i=0}^{p-1} \varpi_{6t} \Delta LN\text{FDI}_{t-i} + \lambda_1 \text{SNT}_{2009} + \Pi\text{ECT}_{t-1} + \upsilon_t \quad (3)$$

General equation of the Error Correction Form of the ADL bounds test-Case 2: Constant unrestricted with trend restricted for AAM is as below:

$$\Delta LN\text{GDP} = \mu_0 + \sum_{i=0}^{p-1} \varpi_{1t} \Delta LN\text{GDP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{2t} \Delta LN\text{EXPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{3t} \Delta LN\text{IMPEU}_{t-i} + \sum_{i=0}^{p-1} \varpi_{4t} \Delta LN\text{IP}_{t-i} + \sum_{i=0}^{p-1} \varpi_{5t} \Delta LN\text{GCF}_{t-i} + \sum_{i=0}^{p-1} \varpi_{6t} \Delta \text{FDI}_{t-i} + \lambda_1 \text{SNT}_{2014} + \lambda_2 \text{SNT}_{2020} + \Pi\text{ECT}_{t-1} + \upsilon_t \quad (4)$$

Not merely having provided short-term coefficients but also described how much of deviations from short-term equilibrium would be rectified in the long-term, the Error Correction Form is illustrated for BAM and AAM in Table A-3.

The Error Correction Term (**ECT_{t-1}**) is the benchmark representing speed of adjustment towards long-term equilibrium, and meets the assumption -1<Π<0. That means deviation among variables emerged one period earlier would be adjusted by 73% for BAM and 74% for AAM closely after one period. In other words, for both models over 70% of disparity is ruled out, i.e., about 75% of any deviance toward imbalance would be eliminated within a period.

Before the agreement paradigm, in the same table, Ukraine's exports to EU, imports from EU, industrial production, and gross capital formation in Ukraine have a significant and simultaneous bearing on its GDP. When it comes to foreign direct investment inflows to Ukraine, it starts influencing GDP after only one quarter. As an indicator of the structural shift caused by global financial crisis, it turns out that the synthetic variable sheds a permanent shock on Ukraine's economy.

After the agreement paradigm, first and foremost, structural shift marked by the agreement of 2014 is proved to be *datum*, as is structural shift engendered by the supply shock of 2020 now that both of their coefficients are highly significant. Moreover, Ukraine's export to EU, import from EU, and gross capital formation in Ukraine keep concurrently bearing upon GDP, except industrial production that stops significantly and simultaneously affecting Ukraine economy. Industrial production and foreign direct investment inflows belatedly affect GDP. It turned out that the EU-Ukrainian Association Agreement, provisionally applied in the last quarter of 2014, laid the foundation for a novel paradigm, at least in the short-term.

It is necessary to carry out hypothetical examination to detect any kind of valid cointegration among BAM and AAM variables to corroborate former and following results. In Table A-4 are illustrated the hypothetical examinations to test valid cointegration for BAM and AAM.

Evident in first compartment of Table A-4 that F-test statistic exceeds lower and upper bound critical values, meaning nil hypothesis of no level relationship is rejected at 1% significance, certifying the presence of long-run cointegration for BAM variables. Regarding second compartment of the table, F-test statistic, as is former, is greater than lower and upper bound critical values, rejecting nil hypothesis of no level relationship, and bearing out the long-run cointegration for AAM at 1% significance. Holistically, detection of cointegration through bounds test ends up with corroborating the soundness of both BAM and AAM's level equation, coefficients of which are provided in Table A-5.

To derive coefficients of variables for level equation in Table A-5, parameters of all level regressors in the conditional error correction form demonstrated in Table A-2 are divided by an additive inverse of the coefficient belong to "LNGDP_{t-1}", to wit, "$-\alpha_1$" whose values are 0.73018451701966 for BAM and 0.74217484204578 for AAM. Only after long-run derivative coefficients

hinged upon the conditional error correction form are allotted, the long-run equation could be established. Based on the conditional error correction model, the final long-term equation of the OLS method, which is built up through a technique adapted to ADL, is as follows:

Long-run level equation for BAM is:

$$LN\text{GDP}_t = 3.8511 - 0.3094LN\text{EXPEU}_t + 0.0909LN\text{IMPEU}_t + 0.6640LN\text{IP}_t$$
$$+0.2180LN\text{GCF}_t + 0.0293LN\text{FDI}_t + \upsilon_t \quad (5)$$

Long-run level equation for AAM is:

$$LN\text{GDP}_t = 0.0102Trend_t - 0.3601LN\text{EXPEU}_t - 0.2689LN\text{IMPEU}_t$$
$$+1.1333LN\text{IP}_t + 0.1731LN\text{GCF}_t - 0.0001\text{FDI}_t + \upsilon_t \quad (6)$$

Before the agreement paradigm, Ukraine's export to EU, its industrial production, gross capital formation, and foreign direct investment flows into it have produced significant effect on GDP. Surprisingly, Ukraine's export to EU countries does negatively affect its economy, by the by, "Ukraine's import from EU produces positive and insignificant influence on GDP"— common property of many third world countries that must first import intermediates to export and grow. **After the agreement** paradigm, Ukraine's export to EU, its industrial production, gross capital formation, and foreign direct investment flux into it as well as Ukraine import from EU have no little effect upon GDP, which means all regressors produce significative influence for the Ukrainian economy, a kind of influence that cannot be taken for granted. As it is, industrial production and gross capital formation do positively affect Ukraine's GDP whereas import from EU and foreign direct investment inflows have passed through somehow transformations of which the association agreement in question afflicted on the economy. Another outcome is that coefficient of the Ukraine's exports to EU is negatively higher than that of it in BAM. Holistically, after the agreement, almost all indicators have worsened.

DISCUSSION AND CONCLUSION

In this paper, the possible transformative effects of EU-Ukrainian Association Agreement along with its idiosyncrasies are examined. The agreement of which deep and comprehensive trade deal is indispensable part, was drafted on March 30 in 2012, signed on March 21 in 2014, provisionally implemented on November 1, 2014, and extensively put into practice on January 1, 2016, standing for the legal framework of economic integration and political affiliation between EU and Ukraine. The attractiveness for foreign investments, sophisticated technologies, recovery based on competition for Ukrainian goods, modernization of national enterprises, varied financial supplies for the economic development of Ukraine and improvements in living standards, diversity in exports of goods and considerable increase in growth were among the featured premises that the agreement was built upon. Nonetheless, the results of this paper show that association agreement under review has been of challenging impacts on Ukraine's economy — apart from the industrial production level, all economic indicators of Ukraine under investigation go through numerous disruptions. Negative effect of exports to EU countries on growth gets worse, the positive outcome of the import from EU for the Ukrainian economy in "before-agreement model" turns out to be not the case for "after-agreement paradigm" — benefits from imports fade away after-agreement. Accordingly, positive sign of imports' parameter turned into negative, same as the foreign direct investment's. In addition, positive influence of Ukraine's gross capital formation after-agreement is slightly weaker than the before-agreement. There seem to be several dynamics responsible for the general results operating behind the scene that require expatiation, *ad seriatim*.

The first of which must be associated with the fact that the goods Ukraine **exports to EU** are those of which have low technological substance. Ukraine exports to EU such agricultural and low tech-goods as sunflower meal, oil and seed. With a depreciated hryvnia, Ukraine export structure does not seem to be able to produce theoretically expected positive outcome for the economy due probably to the exported commodities of low-tech, which are not determined to activate transmission channel of transferring knowledge and technology that the exported high-tech goods used to. Besides this and in parallel with the findings of Emerson et al. (2006), we think, should be connected to Ukraine's trade with Russian Federation, the volume of which

significantly decreased after the agreement, that is what is called *trade diversion effect* by which agreement must somehow have triggered. Trade diversion effect is when trade routes significantly and suddenly get shifted from the most effective partner to the less efficient one, destabilizing export pattern to a large extent. It is a *datum* that Ukraine significantly suffered from the diversion, unlike Russia remarkably gaining significant trade returns from Europe and Asia thanks to jacked up mineral prices (Steinbach, 2023, p. 5). On top of this is the Ukraine, despite having relatively a sound agricultural sector, whose farmers would hardly be competing with EU where, in contrast to its counterparts, farmers enjoy the incommensurate number of agricultural subsidies and large volume of market demand as pointed out by Sadowski (2012) and Nekhay et al. (2012). Another challenge is the high product standards of EU, difficult to meet for Ukrainian small-sized producers. All those predicaments probably disable Ukraine in even using some agricultural products with competitive advantage in foreign trade. Having been disproportionately subsidized, cheap but high-quality EU products likely push Ukrainian producers out of business through predatory pricing. It is also worthy of discussion that war inflicted heavy sufferings on Ukraine manufacture because of which annexed eastern regions of Ukraine, unlike agricultural western parts, were known to be industrial strongholds for the economy (Wolczuk, 2002; Wolczuk, 2006; Kokko & Kravtsova, 2012), particularly southeastern parts of Ukraine, e.g., Donbass, which is why Ukraine export sector, we think, seemed to lose its manufacturing foundations of high value, transformed into bare low value agricultural economic base.

The second of which probably is Ukraine's **imports from EU** that turn into negatively affecting the economic performance due high likely to the insurmountable change in the content of commodities imported. It is likely that Ukraine has begun importing from EU, along with other countries, more and more military equipment, gears, war machines and other associated hardware rather than such commodities as machinery, electrical machinery in particular, and vehicles that used to enhance economic growth through the imports of production means, which directly take part in self-valorization process of capital. It is within the realm of possibility that military defense expenditure has replaced the imports of intermediate and capital goods that are of crucial role in the economy of a developing country— Ukraine's share in EU's exports of explosives, arms and ammunition was around 25% in 2023Q2, jacked up to approximately 60% within a year (Eurostat, 2024). It was also estimated of Ukraine defense expenditure having increased from $4.7 billion in 2021 to $35 billion in 2022. Other estimations pointed out 640% rise in total military spending in 2022. With that being said, it was way before 2022 that Ukraine military spending started gaining momentum, mainly triggered by annexation of Crimea (Tian et al., 2023, p. 553). The other side of the coin is the trade liberalization counteracting against trade barriers, customs and tariffs that allow EU goods to flock into Ukrainian market at much lower prices, paralyzing domestic market and crippling down local producers, which applies not merely to agricultural sector but also industrial one, partially compatible with the results of Yatsenko et al. (2017). Having exported agricultural products and raw materials and tried to import value-added commodities such as machinery, vehicles and electronics in trade with EU, and with the removal of trade barriers, such a trade pattern of Ukraine would likely become stronger and continue to "contribute" to its trade structure.

The study shows that **foreign direct investment**'s sign has turned into negative after the agreement, which is clearly because of the political atmosphere producing instability in Ukraine, leading to severe fluctuations in the investment flows into it, supported by the findings of Bazhenova et al. (2018). It is probable that the escalation between Russia and Ukraine posed a huge investment risk to foreign investors, excluding the investments made into Ukrainian military industry complex. During the Russian SMO in Ukraine, investment in agricultural sector saw an unprecedented decrease — attracted less investment by 39% than it did in 2021, still remains less lucrative (Tomashuk et al., 2024). Some regions of Ukraine, particularly northeastern and southeastern part of it, where war is still going on, offer almost nothing but mounting risk, crumbling infrastructure and unbearable uncertainty. The same holds, more or less, for the other regions of Ukraine that suffer from underpopulation caused by conscriptions and emigration, i.e., outward migration — As of September 2024, total number of Ukrainian refugees amounts to approximately 7 million, 6 million of whom are recorded in Europe (United Nations, 2023); the most migrated to Germany (1.2 million), Poland (958,000), and Czechia (347,000) (Cuibus et al., 2024). Another contributing factor can be associated with the economic overreliance on EU and implementation of EU-based policies that reasonably produce some sort of "crowding-out" effects for the foreign investors of non-EU countries, significantly limiting Ukraine's FDI diversification structure. Last of all, undoubtedly, is the corruption that brings Ukraine to its knees. It looks like EU standards have produced nothing, and being "most corrupt nation in Europe" still persists for Ukraine. The problems regarding "property rights" and absence of some vital regulations can have posed an additional danger to the foreign investor, another deterrent for the FDI.

With regard to further research could be the specific investigation as to how the agreement affected income distribution between eastern and western parcels of Ukraine, where the economic benefits of the trade deal might have accumulated more in the west because of its proximity to EU and relatively developed infrastructure,

excluding the political tendencies of Ukrainian elites, ending possibly up with the increase in regional inequality within the country *per se*. Other contributing factor could be deeply embedded in the change of trade intensity different regions previously had and lost with the political atmosphere after the agreement, which adds to income disparity.

All in all, it is concluded that association agreement has no little bearing upon the Ukraine economy, created a novel paradigm, and negatively transformed Ukrainian economy into less favorable position, exasperating the economic predicament. Under these considerations, H_{A2} hypothesis which stands for the assertion operating under the theory that EU-Ukraine Association Agreement is transformative in an unpromising sense, and it has been of no little effect in building up new and unfavorable economic paradigm for Ukraine, is scientifically substantiated, calling as a whole the efficiency of the EU Association Agreement(s) into question.

Author's contribution

Hakan Erpolat: Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 60%, performed the analysis 70%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 55 %.

Nurtaç Yildirim: Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 40%, performed the analysis 30%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 45 %.

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APPENDIX

Table A-1. Unit Root Tests on Variables

	LNGDP	**LNEXPEU**	**LNIMPEU**	**LNIP**	**LNGCF**	**LNFDI**$^{(*)}$
	Traditional Unit Root Test					
	Phillips & Perron$^{\text{T-stat.}}$					
	Before Agreement Model					
Cons. & Trend	At Level					
	-1.464	-2.364	-1.479	-2.034	-2.261	-5.739***
	At First Difference					
	-4.374***	-4.979***	-4.616***	-4.135***	-7.029***	-16.056***
	After Agreement Model					
Cons. & Trend	At Level					
	-1.592	-2.801	-2.765	-1.749	-2.560	-8.114***
	At First Difference					
	-6.439***	-5.357***	-7.818***	-4.264***	-7.081***	-19.964***
	Structural Unit Root Tests					
	Zivot & Andrews$^{\text{ADF-stat.}}$					
	Before Agreement Model *(One Break)*					
Level	-3.365	-3.842	-2.933	-2.793	-3.403	-5.422***
Level & Trend	-5.778***	-4.762	-5.732***	-8.176***	-7.299***	-10.067***
	After Agreement Model *(One Break)*					
Level	-3.462	-4.249	-3.433	-5.039**	-3.845	-8.570***
Level & Trend	-4.497	-4.618	-4.159	-4.653	-4.549	-9.567***
	Enders & Lee$^{\text{LM-stat.}}$					
	Before Agreement Model					
-	-4.293**	-4.642**	-4.376**	-1.225	-1.849	-3.543
	After Agreement Model					
-	-2.570	-3.437**	-4.952***	-1.118	-0.171	-1.715

Table A-2. Conditional Error Correction Forms

BEFORE AGREEMENT MODEL: ADL (4, 4, 2, 5, 5, 2)

Case 4: Constant Restricted with No Trend

Dependent Variable: $\Delta LNGDP_t$

Variables	Coefficients	Std. Errors	$T_{STAT.}$	Prob.
C	2.81202318735248	0.70425430444750	3.99290876831565	0.00133448012742***
$LNGDP_{t-1}$	-0.73018451701966	0.16258168556642	-4.49118555067110	0.00050768719781***
$LNEXPEU_{t-1}$	-0.22597103686268	0.06536147516957	-3.45725117550439	0.00384875206781***
$LNIMPEU_{t-1}$	0.06640275035548	0.04990569018737	1.33056471328575	0.20459926772013
$LNIP_{t-1}$	0.48485264796607	0.12795623323172	3.78920694772282	0.00199283607613***
$LNGCF_{t-1}$	0.15920263493022	0.06824943961595	2.33265849252510	0.03510376713385**
$LNFDI_{t-1}$	0.02141406282618	0.00973026851306	2.20076792304823	0.04503542184044**
$\Delta LNGDP_{t-1}$	-0.06609286462681	0.15582160416508	-0.42415725971341	0.67789642281877
$\Delta LNGDP_{t-2}$	-1.08482355587444	0.23534304800242	-4.60954153981751	0.00040504479433***
$\Delta LNGDP_{t-3}$	-0.65753899308381	0.23049107367500	-2.85277422070997	0.01277980120983***
$\Delta LNEXPEU$	-0.11858474227122	0.04620629900805	-2.56641940205058	0.02239242558488**
$\Delta LNEXPEU_{t-1}$	0.17308486029698	0.05525348400187	3.13256011677222	0.00734175693828***
$\Delta LNEXPEU_{t-2}$	0.12760820700802	0.04762380449853	2.67950467947090	0.01796292854725**
$\Delta LNEXPEU_{t-3}$	0.07208514582463	0.02862199394568	2.51852285209176	0.02457080979906**
$\Delta LNIMPEU$	0.11743089575928	0.05227419378925	2.24644106866014	0.04133027065006**
$\Delta LNIMPEU_{t-1}$	-0.12928881762800	0.06854616097617	-1.88615694572511	0.08019188529491*
$\Delta LNIP$	0.23373901437449	0.07554144968837	3.09418227130558	0.00792341969233***
$\Delta LNIP_{t-1}$	0.01432119481657	0.08911035884880	0.16071301924473	0.87461541946868
$\Delta LNIP_{t-2}$	0.21145861116309	0.11310159545551	1.86963420198844	0.08259365616909*
$\Delta LNIP_{t-3}$	0.25129344221018	0.10900941828646	2.30524523624014	0.03698054100289**
$\Delta LNIP_{t-4}$	0.17496471118864	0.12615500538097	1.38690264932627	0.18715807615252
$\Delta LNGCF$	0.15384186358266	0.04876041199921	3.15505667969212	0.00702071374573***
$\Delta LNGCF_{t-1}$	-0.11419618542904	0.04117019201405	-2.77375887365501	0.01493148438131**
$\Delta LNGCF_{t-2}$	-0.12164115204183	0.05127272397599	-2.37243396896139	0.03254023932531**
$\Delta LNGCF_{t-3}$	-0.20022733289939	0.06373655448371	-3.14148347869277	0.00721270487413***
$\Delta LNGCF_{t-4}$	-0.05541355418746	0.05169492521462	-1.07193412036870	0.30188088559024
$\Delta LNFDI$	0.00411635179152	0.00416346599820	0.98868389781561	0.33959831775925
$\Delta LNFDI_{t-1}$	-0.00871205128007	0.00493830286775	-1.76417921569189	0.09949992004132
SYN_{2009}	-0.06346759647626	0.02359037560968	-2.69040211679482	0.01758397523762**

AFTER AGREEMENT MODEL: ADL (1, 5, 5, 3, 2, 5)

Case 2: Constant Unrestricted with Trend Restricted

Dependent Variable: $\Delta LNGDP_t$

Variables	Coefficients	Std. Errors	$T_{STAT.}$	Prob.
C	2.75105142577500	1.18089488984807	2.32963276361448	0.03658785269672**
Trend	0.00756198373182	0.00153235259528	4.93488493125070	0.00027265285952***
$LNGDP_{t-1}$	-0.74217484204578	0.17943456713385	-4.13618654365614	0.00117107470787***
$LNEXPEU_{t-1}$	-0.26723044479480	0.06518518349231	-4.09955806638657	0.00125418118682***
$LNIMPEU_{t-1}$	-0.19959810813135	0.14517774449784	-1.37485334836783	0.19241093223044
$LNIP_{t-1}$	0.84113607069726	0.18685091506956	4.50164276896433	0.00059549752470***
$LNGCF_{t-1}$	0.12849870053827	0.03099425608523	4.14588755364636	0.00115002748692***
FDI_{t-1}	-0.00009355955518	0.00002459973718	-3.80327458298125	0.00219364830930***
$\Delta LNEXPEU$	-0.08694428626180	0.04627507516134	-1.87885780754908	0.08286912803680*
$\Delta LNEXPEU_{t-1}$	0.20934205988293	0.05511516573187	3.79826599635699	0.00221461739373***
$\Delta LNEXPEU_{t-2}$	0.08201430085745	0.05275484499224	1.55463068594964	0.14403395750852

ΔLNEXPEU$_{t-3}$	0.05072059047710	0.04951441084944	1.02436017327020	0.32434965408325
ΔLNEXPEU$_{t-4}$	0.06617752718604	0.03872127613678	1.70907402308405	0.11118525219509
ΔLNIMPEU	0.28413483419755	0.05397165431794	5.26451964069429	0.00015296705991***
ΔLNIMPEU$_{t-1}$	0.37348787613245	0.15366282149278	2.43056760577579	0.03029861469028**
ΔLNIMPEU$_{t-2}$	0.43749005729483	0.12239249872754	3.57448423590683	0.00339354683030***
ΔLNIMPEU$_{t-3}$	0.21217600946920	0.08199222055799	2.58775781440323	0.02252294154257**
ΔLNIMPEU$_{t-4}$	0.15197279600253	0.06787485165780	2.23901477926931	0.04327584558556**
ΔLNIP	0.07269044043088	0.11948626817638	0.60835811127333	0.55343124238879
ΔLNIP$_{t-1}$	-0.68655869286416	0.14464498000863	-4.74650895470535	0.00038182349209***
ΔLNIP$_{t-2}$	-0.36599851350561	0.09690273047198	-3.77696801445085	0.00230609357234***
ΔLNGCF	0.05016811730196	0.01604630625579	3.12645891847320	0.00802731728317***
ΔLNGCF$_{t-1}$	-0.03387468194058	0.02864872925880	-1.18241481618826	0.25821693987473
ΔFDI	0.00000152531991	0.00000446474851	0.34163624361339	0.73808394414538
ΔFDI$_{t-1}$	0.00009464848325	0.00001947159244	4.86084964739260	0.00031106547856***
ΔFDI$_{t-2}$	0.00007499903600	0.00001608256867	4.66337421056413	0.00044364327904***
ΔFDI$_{t-3}$	0.00004044100194	0.00001098942185	3.67999358799410	0.00277389041089***
ΔFDI$_{t-4}$	0.00001574471381	0.00000565544766	2.78399072214694	0.01549728508001**
SYN$_{2014}$	-0.03100270589219	0.01354973057839	-2.28806806990139	0.03952376697185**
SYN$_{2020}$	0.05943011298078	0.01825409057472	3.25571480745722	0.00625900920055***

Note: *, ** and *** denote significant at 10%, 5% and 1% respectively.

Table A-3. Error Correction Form: Short Run Equations

BEFORE AGREEMENT MODEL: ADL (4, 4, 2, 5, 5, 2)

Case 4: Constant Restricted with No Trend

Dependent Variable: ΔLNGDP$_t$

Variables	Coefficients	Std. Errors	T$_{STAT.}$	Prob.
ΔLNGDP$_{t-1}$	-0.06609286509699	0.10765952917075	-0.61390631749985	0.54912342042994
ΔLNGDP$_{t-2}$	-1.08482355531489	0.16276936304275	-6.66478958346726	0.00001070040052***
ΔLNGDP$_{t-3}$	-0.65753899252924	0.16084267646881	-4.08808785681186	0.00110760829876***
ΔLNEXPEU	-0.11858474213372	0.02504269930760	-4.73530192081691	0.00031917777122***
ΔLNEXPEU$_{t-1}$	0.17308486016813	0.03309728113593	5.22957941642599	0.00012750706807***
ΔLNEXPEU$_{t-2}$	0.12760820693904	0.03079862935953	4.14330798456641	0.00099445233994***
ΔLNEXPEU$_{t-3}$	0.07208514589966	0.01905545456044	3.78291400349461	0.00201776307702***
ΔLNIMPEU	0.11743089568502	0.03484260879346	3.37032443182249	0.00457516886438***
ΔLNIMPEU$_{t-1}$	-0.12928881750622	0.04968803749488	-2.60201094719290	0.02089538811068**
ΔLNIP	0.23373901454594	0.05546691652457	4.21402575069026	0.00086659562615***
ΔLNIP$_{t-1}$	0.01432119481578	0.06839863284292	0.20937837820055	0.83716898547742
ΔLNIP$_{t-2}$	0.21145861083050	0.06725349819822	3.14420240575835	0.00717383272934***
ΔLNIP$_{t-3}$	0.25129344182150	0.06466959756966	3.88580494181733	0.00164714766767***
ΔLNIP$_{t-4}$	0.17496471076952	0.07111624904809	2.46026348565156	0.02749526882367**
ΔLNGCF	0.15384186337980	0.02515545081723	6.11564724073424	0.00002670369877***
ΔLNGCF$_{t-1}$	-0.11419618532092	0.02246369179701	-5.08358939184397	0.00016665841393***
ΔLNGCF$_{t-2}$	-0.12164115193486	0.02856077669489	-4.25902815019165	0.00079412025198***
ΔLNGCF$_{t-3}$	-0.20022733264838	0.03085930438775	-6.48839423379461	0.00001428945271***
ΔLNGCF$_{t-4}$	-0.05541355401706	0.02850110761923	-1.94425966728625	0.07223817784621*
ΔLNFDI	0.00411635179734	0.00261585172059	1.57361816992068	0.13789707375179
ΔLNFDI$_{t-1}$	-0.00871205126505	0.00273536142358	-3.18497262919760	0.00661530850348***
SYN$_{2009}$	-0.06346759648844	0.01234444225313	-5.14139036717742	0.00014984396549***
ECT$_{t-1}$	-0.73018451653664	0.09035645956502	-8.08115457435777	0.00000121740807***

AFTER AGREEMENT MODEL: ADL (1, 5, 5, 3, 2, 5)				
Case 2: Constant Unrestricted with Trend Restricted				
Dependent Variable: $\Delta LNGDP_t$				
Variables	**Coefficients**	**Std. Errors**	**$T_{STAT.}$**	**Prob.**
C	2.75861340745543	0.35591797544801	7.75069987398942	0.00000315704121***
ΔLNEXPEU	-0.08694428627521	0.03031391462634	-2.86813126403849	0.01319031286353***
$\Delta LNEXPEU_{t-1}$	0.20934205983360	0.03165622236709	6.61298298344181	0.00001681302582***
$\Delta LNEXPEU_{t-2}$	0.08201430078690	0.03452595831650	2.37543879405344	0.03359298858808**
$\Delta LNEXPEU_{t-3}$	0.05072059042056	0.02781429901217	1.82354372469968	0.09128789354236*
$\Delta LNEXPEU_{t-4}$	0.06617752715258	0.02931545856584	2.25742766410936	0.04182960599998**
ΔLNIMPEU	0.28413483424133	0.02864035762173	9.92078513802402	0.00000019730181***
$\Delta LNIMPEU_{t-1}$	0.37348787613736	0.06271172734316	5.95563050103225	0.00004779855431***
$\Delta LNIMPEU_{t-2}$	0.43749005730749	0.05933398291036	7.37334720927874	0.00000539806537***
$\Delta LNIMPEU_{t-3}$	0.21217600950578	0.03656707189029	5.80237898572600	0.00006150952268***
$\Delta LNIMPEU_{t-4}$	0.15197279603853	0.03615927584670	4.20287166930093	0.00103401203912***
ΔLNIP	0.07269044046156	0.07353348689839	0.98853520385891	0.34093349694986
$\Delta LNIP_{t-1}$	-0.68655869276780	0.11014992864648	-6.23294723114420	0.00003053721353***
$\Delta LNIP_{t-2}$	-0.36599851348173	0.07051782017924	-5.19015636829711	0.00017404726853***
ΔLNGCF	0.05016811730176	0.00955362914985	5.25121045781160	0.00015653404638***
$\Delta LNGCF_{t-1}$	-0.03387468194207	0.01657062642845	-2.04426079414306	0.06173198396601*
ΔFDI	0.00000152531991	0.00000193062112	0.79006693193151	0.44366220548131
ΔFDI_{t-1}	0.00009464848325	0.00001147040054	8.25154125333324	0.00000159074411***
ΔFDI_{t-2}	0.00007499903599	0.00001044309761	7.18168485904553	0.00000713722501***
ΔFDI_{t-3}	0.00004044100193	0.00000722957651	5.59382722670270	0.00008715268802***
ΔFDI_{t-4}	0.00001574471381	0.00000362597985	4.34219561062766	0.00079842806632***
SYN_{2014}	-0.03100270588239	0.00857031707670	-3.61745144373553	0.00312579661823***
SYN_{2020}	0.05943011296987	0.01015395729287	5.85290160828234	0.00005658181843***
ECT_{t-1}	-0.74217484175788	0.09582666618070	-7.74497195131862	0.00000318243530***

Note: *, ** and *** denote significant at 10%, 5% and 1% respectively.

Table A-4. Detecting Cointegration through Bounds Test

BEFORE AGREEMENT MODEL: ADL (4, 4, 2, 5, 5, 2)				
Case 4: Constant Restricted with No Trend				
Nil Hypothesis: *There is no level relationship betwixt variables*				
Test Statistic	**Value**	**Significance**	**Lower Bound**	**Upper Bound**
$F_{STAT.}$	6.530505925	10%	2.276	3.297
		5%	2.694	3.829
		1%	3.674	5.019
Size of actual sample: 43 | Number of regressors lagged: 5				
AFTER AGREEMENT MODEL: ADL (1, 5, 5, 3, 2, 5)				
Case 2: Constant Unrestricted with Trend Restricted				
Nil Hypothesis: *There is no level relationship betwixt variables*				
Test Statistic	**Value**	**Significance**	**Lower Bound**	**Upper Bound**
$F_{STAT.}$	5.863155466	10%	2.750	3.739
		5%	3.211	4.309
		1%	4.251	5.596
Size of actual sample: 43 | Number of regressors lagged: 5				

Table A-5. Level Form: Long Run Equations

BEFORE AGREEMENT MODEL				
Case 4: Constant Restricted with No Trend				
Dependent Variable: $LNGDP_t$				
Variables	**Coefficients**	**Std. Errors**	**$T_{STAT.}$**	**Prob.**
$\mathbf{C_t}$	3.85111313779089	0.26961753985099	14.28361500486680	0.00000000097072***
$\mathbf{LNEXPEU_t}$	-0.30947114273536	0.05675141730374	-5.45309980681278	0.00008508678148***
$\mathbf{LNIMPEU_t}$	0.09093968575828	0.05988338879527	1.51861288393652	0.15111593259997
$\mathbf{LNIP_t}$	0.66401387158537	0.07003755635011	9.48082580531624	0.00000018005845***
$\mathbf{LNGCF_t}$	0.21803069090844	0.03812145617712	5.71936942532869	0.00005301938680***
$\mathbf{LNFDI_t}$	0.02932691987199	0.00901648205052	3.25259005759391	0.00578282816575***
$\mathbf{JB_{prob.}}$ = 0.893194 | $\mathbf{BG_X^2}$ = 0.0000(*) | $\mathbf{BPG_X^2}$ = 0.4835 | $\mathbf{RR_{Fprob.}}$ = 0.4487				
AFTER AGREEMENT MODEL				
Case 2: Constant Unrestricted with Trend Restricted				
Dependent Variable: $LNGDP_t$				
Variables	**Coefficients**	**Std. Errors**	**$T_{STAT.}$**	**Prob.**
$\mathbf{Trend_t}$	0.01018895185525	0.00110243482076	9.24222608303163	0.00000044534763***
$\mathbf{LNEXPEU_t}$	-0.36006400334301	0.04171269762364	-8.63199993900623	0.00000096344318***
$\mathbf{LNIMPEU_t}$	-0.26893677464162	0.11001621669847	-2.44451938734373	0.02951532852488**
$\mathbf{LNIP_t}$	1.13333950873715	0.07923584943244	14.30336794336390	0.00000000247859***
$\mathbf{LNGCF_t}$	0.17313804416568	0.03432880550951	5.04352078657994	0.00022500109951***
$\mathbf{LNFDI_t}$	-0.00012606134015	0.00001975536826	-6.38111820884857	0.00002414105251***
$\mathbf{JB_{prob.}}$ = 0.453572 | $\mathbf{BG_X^2}$ = 0.0000(*) | $\mathbf{BPG_X^2}$ = 0.7010 | $\mathbf{RR_{Fprob.}}$ = 0.7420				

Notes: ** and *** denote significant at 5% and 1% respectively. "$\mathbf{JB_{prob.}}$": Jarque & Bera normal distribution probability. "$\mathbf{BG_X^2}$": Breusch & Godfrey serial correlation LM test ChiSquare probability. "$\mathbf{BPG_X^2}$": Breusch & Pagan & Godfrey heteroskedasticity ChiSquare probability. "$\mathbf{RR_{Fprob.}}$": Ramsey Regression Equation Specification Error Test (RESET). (*) denotes that heteroskedasticity and autocorrelation consistent Newey-West estimator is carried out due to the presence of serial correlation in error terms.

Testing the Validity of Spatial Beta Convergence for the Countries of Southern Europe

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SUMMARY

Territorial economic and social disparities remain a major problem for the European Union today. No two regions have the same characteristics and starting conditions, resulting in significant disparities in their development path. The aim of this study is to analyse the impact of the economic and social shocks of the 2000s (economic and financial crisis of 2008-09 and COVID-19 pandemic) on the economies of four countries (Portugal, Spain, Italy and Greece) in Southern Europe by county-level gross value added. The methodology used is based on classical descriptive statistics, convergence analyses and spatial autocorrelation studies. The results show that the impact of the shocks of the 2000s varies across counties, with some areas being able to increase their gross value added even during the crisis period. In addition, the first and second waves of the economic and financial crisis and the pandemic had an uneven impact on the region's counties, which further increased territorial disparities.

Keywords: crises; gross value added; Southern Europe; spatial beta convergence; territorial inequalities.
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INTRODUCTION

Territorial economic and social disparities remain a major problem for the European Union. These differences are more critical in Southern Europe, where great dispersion is found not only in terms of GDP per capita but also in other economic and social indicators. Like other external shocks, crises tend to have a significant impact on the development of countries and regions and sometimes change their development paths. However, the effects can vary widely depending on the type of external shocks, and the resilience of regions in such circumstances is also not uniform.

The aim of this study is to analyse the impact of the economic and social shocks of the 2000s (the economic and financial crisis of 2008-09 and the COVID-19 pandemic) on the economies of the Southern European EU Member States. The study presents county-level differences in gross value added as a characteristic of development in the Southern European countries and their changes in response to external shocks. The methodology used is based on classical descriptive statistics, convergence analyses (sigma, beta, gamma) and spatial autocorrelation studies.

The structure of the article is as follows. The first section presents some theories of inequalities and the effects of crisis with special focus on the analysed area. The next section shows the methodology which can be adequate for checking the convergence processes of the South. The last section summarises the results of the study, while testing the extreme values, the different convergence processes across NUTS3 territorial units, and the role of space in connection with the convergence analysis.

THEORETICAL BACKGROUND

The study of convergence in economic growth theories is not a recent phenomenon; one of the main goals of the EU since the beginning of integration has been the convergence of peripheral regions. The importance of territorial cohesion was already mentioned in the preamble of the Treaty of Rome (1957), which laid the foundations for integration, and was formally confirmed

in the Single European Act of 1986, which elevated regional policy to the level of European Community policy as a top priority of integration (Soós, 2020).

The analysis of territorial inequalities is not a recent phenomenon; several researchers have already investigated the positive convergence prospects and catching-up of peripheral regions (e.g., the convergence process of nation states in Barro & Sala-i-Martin, 1992; Sala-i-Martin, 1995; Quah, 1996). In the relation of Southern Europe, the European Commission states that some of the EU regions, primarily in southern Member States (e.g., Calabria and Sicily in Italy or Ipeiros and Dytiki Elláda in Greece) accompanied by others from Europe, are in a "development trap" or at risk of falling into one, with low or negative growth, weak productivity and low employment creation (European Commission, 2023a). Thus, the analysis of their convergence processes is a timely issue.

According to the European Commission's 8th Cohesion Report, since 2000 the impact of substantial structural and territorial funding has reduced disparities between EU Member States (i.e., convergence has accelerated), but internal regional disparities between regions have increased (European Commission, 2022). In 2021, the highest GDP per capita among EU Member States at NUTS3 region (county) level was in Wolfsburg (GER) with €172,100, while the lowest was in Silistra (BG) with €4,200, a 40-fold difference (Eurostat, 2023). Data for Southern Europe (Portugal, Spain, Italy, and Greece) are as follows. The highest value is linked to Milano (ITA) with per capita values of €53,000 and the lowest to the county of Xanthi (GRE) with €8,900. Here there is a six-fold difference. This indicates a rather large disparity for the Southern European region. Besides the economic differences, there are huge problems in the unemployment rate (high in the whole region, especially in case of youth unemployment), wage levels, innovation and productivity. The European Regional Competitiveness Index of 2022 shows large differences also in regional competitiveness. The least competitive regions are in the eastern Member States, followed by southern Member States. The level of R&D expenditure in the EU is highest in the north-western regions and lowest in the East and South (European Commission, 2023a).

Crises can have a major impact on the development of regions. Diermeier et al. examined the impact of the 2008-09 economic and financial crisis on territorial processes from the aspect of convergence. Based on their results, the crisis slowed down the convergence of Europe, as in Central-Eastern Europe there was a low growth rate during that two years, while Southern Europe was stagnating (Diermeier et al., 2018). Another issue in these countries that the countries "have experienced two parallel crises of different types—an economic crisis and a political one" (Zamora-Kapoor & Coller, 2014, p. 1511). The crisis had such consequences in the region as the emergence of protest parties, and the growth of Euroscepticism and political instability besides the economic downturns (Morlino & Sottilotta, 2019). Studies have also revealed that once the EU managed to overcome the crisis, earlier β-convergence returned and there are positive tendencies in decreasing inequalities (Kuruczleki et al., 2022). Looking at a crisis of a different nature, the OECD (2020) study finds that the COVID-19 crisis highlighted the widening of regional differences in economic growth in Europe. Palomino et al. (2020) measured the impact on poverty and wage inequality in Europe from the aspect of policies that emphasised social distancing during the pandemic and found that poverty increased, and wage losses occurred during the pandemic. Abrhám & Vošta (2022) checked the effects of the COVID-19 pandemic from the unemployment point of view and has described that the negative impact on unemployment level from the crisis was not equal across Europe; Greece and Spain suffered most, while in Ireland there was only a slight increase in unemployment figures.

From the above it is clear that the region, there was a strong negative effect of the 2008-09 economic and financial crisis, which developed further in the first wave of COVID-19. The effects are not equal among the territories; their extent is different based on region-specific factors. Thus, a deeper analysis is justified.

METHODOLOGY AND DATA

Scope and time frame of the analysis

There are various suggestions for and approaches to the economic division of Europe by geographical region. In this study, I have relied primarily on the UN methodological guide (UNSTAT, 2023), refining it based on an article by Manic et al. (2017). Accordingly, Southern Europe is the composition of four countries in the Mediterranean region: Portugal, Spain, Italy and Greece.

The above division is supported not only by the UN and the above-mentioned study, but also by a study carried out by VÁTI (Urban Development Ltd.) in 2011, which defines the main European Geographical Zones with a similar classification.

A difference can be verified in the so-called Mediterranean 2.0 model, which defines a broader area, including also Cyprus, Malta and Slovenia, and the analysis notes that these are "joining the 'traditional' Mediterranean cohort" of Italy, Spain, Portugal, and Greece. In these countries, the low level of investments and exports is the most problematic dimension (Kuruczleki et al., 2022). I have decided rather to exclude them, as Malta and Cyprus would be outliers in a spatial regression analysis, having no neighbours, while Slovenia is also an outlier based on a different development path and economic history.

The area covered in my analysis contains a sum of 245 NUTS3 regions in the four-country group, from which 27 are neighbourless[i]. The connections among the territories with queen contiguity are shown in Figure 1. Queen contiguity means that spatial units share a common edge or a common vertex (Gerkman, 2010).

Source: Own compilation

Figure 1. The NUTS3 regions of the analysed area and the connections among them

The time frame of the analysis was 16 years, from 2005 until 2020, which is long enough to check the tendencies of the gross value added. To explore the impact of the crises, I have created three different shorter time periods to review the impact of the different shocks on the region. The first period covers the first wave of the economic and financial crisis from 2008 to 2009 ('Period A'), the second covers the second wave of the economic and financial crisis from 2011 to 2012 ('Period B'), and the third covers the first wave of the COVID-19 pandemic from 2019 to 2020 ('Period C'). In the first two periods, my assumption was that the crisis had a W-shape nature with bounces and drops in a sequence (Molnár et al., 2021).

Applied methods

In the literature, different types of convergence analyses are used to detect trends in differences (e.g., sigma, beta, and gamma tests), which try to explain the development trajectories of given regions.

Sigma convergence examines the dispersion of GDP between regions, i.e., whether the dispersion of incomes decreases over time (Kocziszky & Szendi, 2020). Thus, it measures the narrowing of the variation between different economic indicators (Kuruczleki et al., 2022).

Sigma convergence is usually measured by trends in the coefficient of variation (CV) indicator. If the relative dispersion of gross value added relative to the average decreases over time, then the phenomenon of sigma convergence is fulfilled (Szendi, 2016). The indicator can be calculated as the ratio of the dispersion to the average value.

$$CV = \frac{standard\ deviation}{average} \qquad (1)$$

The basic idea of beta-convergence is related to Solow's neoclassical model, which assumes that the rate of economic growth depends essentially on the growth rates of capital stock and labour (Andrei et al., 2023) and accounts for the change in average GDP relative to the base period. If the beta-coefficient is negative and significant, then beta-convergence is satisfied (Ferkelt, 2005; Stanišić, 2012). There are two trends in the literature on this method: absolute and conditional beta convergence. The absolute convergence theory states that less developed countries tend to grow faster in absolute terms towards a future steady state. In this theory, all regions converge to the same steady state. In contrast, conditional beta-convergence assumes that there are significant differences between regions in terms of initial conditions, available factors, and characteristics, so that there is no common steady state for each region, but each region converges towards its own development path (Mankiw et al., 1992; Eckey & Türck, 2007; Szendi, 2016).

The concept of gamma convergence was introduced by Boyle & McCarthy (1997) in the context of economic analysis. The index measures the change in ranking, expressing how the ranking of each area has changed compared to the base year:

$$\gamma = \left(\frac{\mathrm{var}(\mathrm{RGDPC_{ti}}+\mathrm{RGDPC_{t0}})}{\mathrm{var}(\mathrm{RGDPC_{t0}}*2)}\right) \quad (2)$$

where $var(RGVAC)$ is GVA per capita (gross value added)[ii] variance, while t_i is the examined year, t_0 the base year.

RESULTS

After making the analyses for the Southern European region, my results are detailed below. I present the results in four subsections, covering the distribution of values, the impact of crises on inequalities in the region, the results of convergence tests, and the importance of neighbourhood connections.

Variation and magnitude of extreme values

First, I examined the changes in the extreme values (maximum and minimum) of the four-country region as a response to the crises. In total, I examined six time periods, with 2005 indicating the starting year and the others showing the changes in response to Waves 1 and 2 of the economic crisis and the effects of Wave 1 of the COVID-19 pandemic. In the analysis, I wanted to find out how much the differences in the extreme values changed as a result of the shocks, which area was associated with the highest and lowest values in the periods under study, and how stable the position of these areas was (Table 1).

Table 1

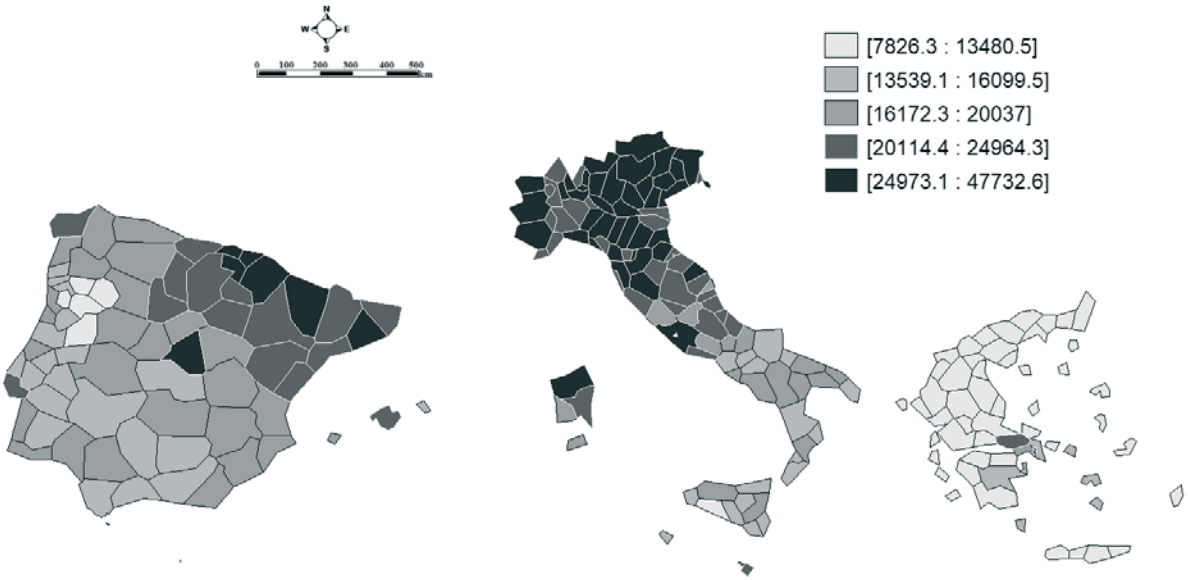
The variation of the extreme values in the GVA in Southern Europe

	Southern Europe			
	max	**region**	**min**	**region**
2005	39887.1	Milano (ITA)	7079.5	Tâmega e Sousa (POR)
2008	46379.2	Milano (ITA)	8374.6	Tâmega e Sousa (POR)
2010	47403.3	Milano (ITA)	8721.7	Tâmega e Sousa (POR)
2012	46853.9	Milano (ITA)	8402.6	Tâmega e Sousa (POR)
2019	50093.9	Milano (ITA)	8397.1	Xanthi (GRE)
2020	47732.5	Milano (ITA)	7826.2	Xanthi (GRE)

Source: Own compilation

There is a high degree of stability across the area in terms of the position of the best/worst areas, with few region swaps in the data. In Southern Europe, the maximum value is concentrated in the region of Milan in Northern Italy throughout the whole time frame, and the minimum value is driven by a Portuguese county until 2019, followed by a Greek region. In these regions the share of industrial GVA is quite low, mostly in the southern part of the area (in Southern Italy, Southern Spain, and almost the whole of Greece it is below 10%). Only some parts of Northern Italy and the Basque Country in Spain have high shares of industrial GVA (over 30%), which are in the top of the ranking (European Commission, 2023b). Differences in this geographical block increased from 5.6-fold to 6-fold, indicating divergence for the period.

When checking the dispersion of the GVA per capita in the Southern European region, we can see the lowest values concentrating in Greece and in some parts of Portugal, while the biggest hot spots are in Northern Italy (Lombardia, Veneto and Emilia-Romagna regions) and in the Basque Country and near Madrid (Figure 2).



Source: Own compilation

Figure 2. Dispersion of GVA in Southern Europe

These hot spots were also mentioned for the whole EU by Szendi (2022, p. 238), emphasising that central and north-eastern Spain (Segovia, Guadalajara, Toledo, Comunidad de Madrid, Avila, Cuenca, Girona and Tarragona), and northern and central Italy (in the larger area of Piemonte, Genova, Savona, Aosta and Rome) is one of the concentration areas, while Greece is a cold spot. For Europe as a whole, there is both an eastern-western and a northern-southern slope in the GVA distribution (similarly to GDP per capita), and the differences in the maximum values are the biggest in the western-eastern slope, while the minimum values appear in the northern-eastern relationship (European Commission, 2023b).

The country group has some other disadvantages compared to the western and northern part of the continent besides the economic data (GDP and GVA) and the previously mentioned unemployment rate. For example, if we check the latest edition of the Regional Innovation Scoreboard of the European Commission, low levels of competitiveness can also be verified. Only six NUTS2 regions of the countries examined have a higher competitiveness level than 100% of the EU average (Madrid, Catalonia, Comunidad Foral de Navarra in Spain, and Emilia-Romagna, Friuli-Venezia Giulia and Provincia Autonoma Trento in Italy). The most competitive, Madrid, is only 81st among the 239 regions covered. The worst positions are in the autonomous regions of Spain – Ceuta (231st of 239) and Melilla (223rd of 239 regions) – with 35% and 46%, respectively (European Commission, 2023c).

Impact of crises

The above results show that the four countries have followed a sometimes similar and sometimes very differentiated path during each of the crises studied. The different types of shocks have affected the areas differently (Table 2).

Table 2

Effects of the crisis periods on the NUTS3 areas by the degree of increase/decrease

%	2009	2012	2020
Above 0	15.9	13.5	1.6
Between the two thresholds (2009: 0 to -10; 2012, 2020: 0 to -5)	82.0	64.5	26.5
Below -10 (2009); below -5 (2012, 2020)	2.0	22.0	71.8

Source: Own compilation

When checking the three periods of the analysis (first wave of the economic and financial crisis from 2008 to 2009, second wave of the economic and financial crisis from 2011 to 2012, first wave of the COVID-19 pandemic from 2019 to 2020), the following can be verified. From 2008 to 2009, during the first wave of the economic and financial crisis, Southern and Western Europe showed significant similarities at the level of each NUTS3 territorial unit based on the extent of the downturns (World Bank, 2019). Their economies suffered the largest decreases in this period, although the recovery time in Southern Europe was much longer. Some regions in this geographical area reached the pre-crisis GDP level only in 2016 or 2017 (mainly in Southern Italy and Greece), while a huge part of the EU in 2010 or 2011 (Eurostat, 2019).

The share of regions with an increase in per capita value added was around 15%. Counties that showed a fall in value added of over 10% because of the crisis made up 2% of the 245 territories. At the same time, a continuous examination of the data shows that in Southern Europe this crisis was noticeable only one year later than in the rest of the continent (Zamora-Kapoor & Coller, 2014; the analysis of raw data). A further analysis of the consequences of the economic and financial crisis also shows the extent to which the W-shaped crisis curve (Molnár et al., 2021) can be supported. In the second wave of the crisis (2012), more serious problems are to be found in Southern Europe, where the later onset of the above-mentioned crisis, and the second fallback due to the W-nature caused serious problems. Only 13.5% of the counties managed to grow, while the remaining counties experienced a decline of varying degrees (most of them between 0 and 5%). The tendencies showed quite similar tendencies to Western Europe, as mentioned also above, as the GDP per capita relative to EU average changed similarly over the period between 2007 and 2011; in both areas there was a decrease (Southern Europe: GRE, ITA, ESP, POR; Western Europe NED, LUX, IRL, FRA) to a similar extent (Kolev, 2012). By 2020, the effects of the first wave of the COVID-19 pandemic were being felt in Europe. The trends of different economic data reflect the different ways in which the crisis has been handled (closures, restrictions, the resilience of the health system, more liberal solutions and their impact on economic growth). Southern Europe, perhaps one of the worst hit by the first and second waves of the epidemic, saw one of the largest declines in the EU, with more than 70% of counties showing a decline of more than 5%. The automotive sector was especially hard hit, where based on the data of the ACEA (European Automobile Manufacturers' Association), in 2020 22.9% of the total EU production was lost. In the EU, Southern Europe suffered the longest closures (in days), which resulted in a significant lack of vehicles, working days and employees (ITA: 41 days, 157,933 vehicle loss, 69,382 employees affected; ESP: 34 days, 452,155 vehicle loss, 60,000 employees affected; POR: 35 days, 41,525 vehicle loss, 20,000 employees affected). The biggest decline in employees took place in Portugal with 1.92 employees per 1000 inhabitants (this was 1.26 in Spain, and 1.17 in Italy) (ACEA, 2020).

Convergence analysis

Sigma convergence – Change in the value of the CV indicator

As mentioned in the methodological chapter, the analysis of sigma convergence examines whether the dispersion of gross value added (measured by the CV indicator) is decreasing over time, i.e., whether regional differences are narrowing. In examining this in the geographical area concerned, I have come to the following conclusions. Over the whole period, we find a non-balanced picture between territorial units showing both convergence and divergence. In total, one country's NUTS 3 regions converged (Portugal), while the three other countries' counties showed diverging trends (Table 3). Although in the whole period some countries behave similarly, there are some differences among the given countries from year to year. For instance, in Greece there was a sigma convergence in 2006-2010, and a stronger divergence from 2015 until 2020. In contrast, in Italy until 2018 the whole period was characterised by divergence, followed by a slight narrowing after it, while in Spain there was a slight divergence in the whole-time frame with some stagnating phases. The situation in Portugal was the most promising; until 2014 there was strong and rapid narrowing of the inequalities, and the same after 2018. However, it is also worth noting that in Portugal the sigma convergence was predominantly the effect of a negative catch-up, as the more developed regions showed bigger drops in their values, compared to the less developed ones in the different crisis periods.

Table 3

Summary of the sigma convergence analysis results

convergence	**divergence**
Portugal (0.24-0.15)	Greece (0.28-0.32)
	Italy (0.24-0.27)
	Spain (0.19-0.21)
	Southern Europe as a whole (0.32-0.35)

Note: value of CV indicator in the brackets
Source: own compilation

Southern Europe shows overall divergence. Of course, the overall picture over the whole period is nuanced by the differences and changes in each crisis period and it is worth running deeper analyses to test the validity of the analyses. Until 2010 the four-country area experienced sigma convergence, while after that a strong divergence happened, mainly due to the results of Greece and Italy.

Looking at the impact of crises in more detail, in Southern Europe, the 1st wave of the economic and financial crisis brought the sigma divergence a year later, yet the 2nd wave arrived at the expected time, here the COVID-19 crisis also indicated a slight divergence of the values.

Beta and gamma convergence

Sigma convergence alone is not sufficient to map convergence processes, because when it occurs, we can speak of convergence in both positive and negative senses. In other words, it also indicates convergence if the values of the initially more developed regions decrease and thus the overall regional differences decrease (negative convergence). It is therefore worthwhile to investigate convergence processes using additional methods. In the present study I have analysed both beta and gamma convergence to obtain a more complete picture of the changes in the differences. First, I review the results of beta convergence, which measures the regression of the initial GVA on the average annual growth rate of value added.

The results suggest that, in contrast to the sigma convergence examined earlier, several countries show convergent trends, and three of them achieved beta convergence of gross value added over the whole period (Table 4). One country in Southern Europe where convergence has not been achieved was Italy. Here, basically three counties have affected the divergent tendencies for the country, as Trieste, Bolzano and Milano are quasi-outliers, both in their initial GVA level, and because the growth rate is higher than the average.

The gamma convergence, which quantifies the positive changes in the ranking of regions, shows much more favourable results than before. Over the period, it shows convergence in all the countries and the geographical block studied, i.e., a positive shift in the ranking of the NUTS3 counties.

Table 4

Summary of the beta and gamma convergence analysis results

country/region	Beta convergence		Gamma convergence	
Portugal	✓	y = -0.0003x + 5.2001 R^2 = 0.7953	✓	2.23 – 2.14
Greece	✓	y = -2E-05x - 1.3291 R^2 = 0.0083	✓	2.22 – 2.10
Italy	×	y = 1E-05x + 0.1329 R^2 = 0.0195	✓	2.24 – 2.21
Spain	✓	y = -6E-05x + 1.7082 R^2 = 0.0546	✓	2.24 – 1.94
Southern Europe	✓	**y = -1E-05x + 0.5105 R^2 = 0.0038**	✓	**2.24 – 2.13**

Source: Own compilation

The gamma convergence' results highlight that the biggest position changes can be observed in Spain, while Italy showed the smallest ranking shifts. From a deeper analysis of the data, we can state that in Spain, compared to the base year, Huesca has improved by 12 positions, A Coruña by 13, and Ourense by 29 (these are tourism and trade centres of the country). Of course, huge negative change also took place in the country (e.g., the island region of Fuerteventura has lost 47 positions, while Menorca went down by 33 positions), but their extent (the number of affected territories) was smaller than that of the positive shifts. The changes in Italy were about maximum 20 positions in both directions (Trieste was positive, and Prato, among others, was negative).

Spatial autocorrelation analysis

The role of space in the analysis of spatial inequalities is significant based on the first law of geography: "Everything is connected to everything else. But near things are more connected than distant things" (Tobler, 1970, p. 236). Spatial autocorrelation is a method of studying spatial interactions by examining whether the spatial distribution of individual values of gross value added is random or follows some regular pattern (Dusek, 2004). Autocorrelation can be measured globally (using the Moran I index) and locally.

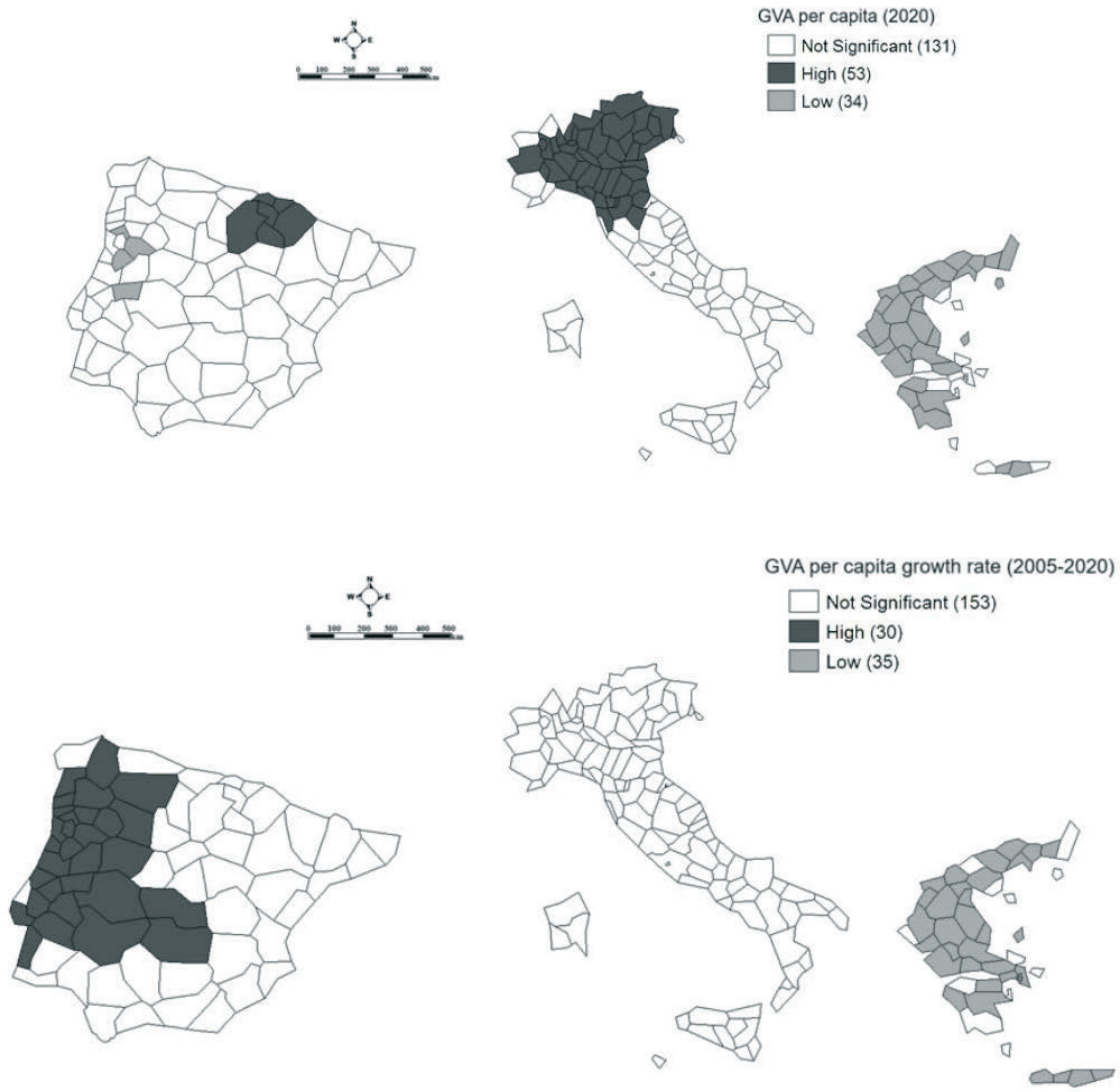
Among the tools of the local spatial econometric methods (LISA indicators such as Local Moran I, Local Geary C, Local G indicator), I chose the Local G_i^* indicator, which is an indicator of the local spatial autocorrelation of each data point. The indicator is not sensitive to spatial outliers and can be calculated using the following equation:

$$G_i^*(d) = \frac{\sum_{j=1}^{n} w_{ij} x_j}{\sum_{j=1}^{n} x_j}, \qquad (3)$$

where d is the neighbourhood distance and w_{ij} is the weight matrix, which is a queen neighbourhood matrix (with symmetric distribution). Positive G_i^* represents local clustering of high values (hot spots), while negative G_i^* represents local clustering of low values (cold spots).

In Southern Europe the Moran I results suggest medium strong, positive spatial autocorrelation among the territories (0.5360 by significant pseudo-p value), which indicates that the neighbouring territories have similar values, so the high and low values of the GVA cluster together. That is why it is worth analysing the local clustering tendencies.

I checked the Local G_i^* indicator for the geographical area covered and observed the following. Based on the values of the GVA in 2020, Northern Italy (from Torino to Udine (west-east) and from Bolzano to Arezzo (north-south) containing also the Milan – Turin – Genova triangle) and the Basque Country are hot spots with continuous high levels of value added (Figure 3). The cold spots (with continuous lower GVA levels) can be found mainly in Greece (12 of the 52 territories are lower outliers) and some parts of Portugal (Ave, Douro, Viseu Dao Lafoes or Beira Baixa). In the case of hot and cold spots, the forming clusters underline the hypothesis stated by the dispersion of the specific GVA across the Southern European countries, as almost the whole Northern Italian region and some parts of Northern Spain are also mentioned here, while the concentration area of lower-value-added regions verifies the previously mentioned territories of Greece and Portugal.



Source: Own editing

Figure 3. Local G_i^* clusters of GVA per capita (above) and GVA per capita growth rate (below) in Southern Europe

The growth rate of GVA (checked along with the initial values) also indicates divergent processes, as Greece is a cold spot in both indicators, so a further widening of inequalities is expected. Based on the GVA growth rate from 2005–2020, a huge section of Portugal and Spain shows hot spot areas (76% of the Portugal areas and some Spanish territories like Lugo, León, Zamora, Salmanca, Caceres, Badajoz, Toledo or Ciudad Real). The South of Italy cannot be classified into a single cold spot cluster (although the initial values suggested that), as some NUTS3 regions from the Basilicata or Calabria region act as outliers.

As the spatial autocorrelation analysis suggests significant neighbourhood effects, it is worth expanding the analysis with spatial effects. I checked the validity of spatially lagged models in the β-convergence analysis, with the following results. In Southern Europe, the explanatory power of the OLS (Ordinary Least Squares) model is quite low, with the linear equation explaining only 0.37% of the dispersion of units, while the value and significance of the F statistic suggest that this model does not best explain the distribution of value added in the region (Table 5). The Jarque-Bera test for normality also rejects the null hypothesis at 1%.

However, as seen above, the spatial autocorrelation tests for Southern Europe, with a Moran I (0.5360), indicate a positive, moderately strong, and significant autocorrelation. In other words, in this case it is justified to extend the analysis to include neighbourhood effects. It also implies that gross value added of the Southern European counties is positively related to its neighbours. Therefore, I tested whether the spatial lag or the spatial error autocorrelation model seems to be correct for the region.

Table 5

OLS regression results for the GVA in Southern Europe

REGRESSION OLS METHOD **(SOUTH)**			
	Coefficient	Std. error	Prob.
Constant	0.510485	0.286499	0.07603**
Log of „base year"	-0.000144	0.000150	0.33822
R-squared		0.003775	
F-statistic		0.92079	
Prob(F-statistic)		0.33822	
Multicollinearity Condition Number		6.350066	
Jarque-Bera test		9.7353	0.00769
Breusch-Pagan test		45.0880	0.00000
Koenker-Bassett test		30.4667	0.00000
Log likelihood		-425.23	
Akaike info criterion		854.46	
Schwarz criterion		861.463	
	Moran I/ Degrees of Freedom	Value	Prob
Moran I (error)	0.5360	12.7042	0.00000
Lagrange Multiplier (lag)	1	157.4413	0.00000
Robust LM (lag)	**1**	**6.1161**	**0.01340**
Lagrange Multiplier (error)	1	152.8476	0.00000
Robust LM (error)	1	1.5224	0.21726
Lagrange Multiplier (SARMA)	2	158.9637	0.00000

Source: Own compilation

Two of the most common methods for econometric modelling of spatial autocorrelation are the spatial lag model and the spatial error model (Varga, 2002). The spatial lag is the weighted average of the neighbouring values of a given observation unit. The spatial error model (SEM) assumes that only the error terms are correlated in the regression, while the spatial lag model (SLM) examines how the GVA growth rate of regions depends on their own initial value-added level and how this is affected by the growth rates of neighbouring regions (Gerkman & Ahlgren, 2011; Andrei et al., 2023).

To select the appropriate spatial autocorrelation model, I used the classical procedure presented by Anselin (2005), which allows the user to decide between the SLM model and the SEM model based on Lagrange Multiplier tests.

Since both the LM-lag and the LM-error models are significant (p value 0.0000), robustness tests should be considered. As the significance of the lag model is lower among the robust tests, I decided to use it. This assumes that there is autocorrelation between different levels of the dependent variable.

Since the analysis of R^2 is not relevant in spatial regression models (Anselin, 2005), I considered the values of the Log- Likelihood, the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC). By comparing the Log-Likelihood values of OLS (-425.23) and SLM (-360.671), a higher value is observed for SLM, i.e. the lag model fit is better. This is also supported by the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC), which have lower values for the lag model.

The model estimates the spatial autoregressive coefficient to be 0.71, which is significant (0.0000) based on the p-value (Table 6). The spatial lag model and the classical OLS model of GVA differ slightly. However, the spatial lag model suggests a faster catch-up than the OLS estimate (based on the constant and log base values).

Table 6

Spatial lag model results for the GVA in Southern Europe

	Value
Mean dependent var	0.248872
S.D. dependent var	1.37518
Lag coeff. (Rho)	**0.712743**
R-squared	0.494473
Sigma-square	0.956015
Standard Error of regression	0.97776
Log likelihood	-360.671
Akaike information criterion	727.341
Schwarz criterion	737.845
W_log yearly average growth rate	0.712743
	(0.0000)
Constant	0.261355
	(0.20317)
Log of „base year”	-0,0001401
	(0.19551)

Source: Own compilation

CONCLUSION

The aim of the study was to test the convergence and autocorrelation of gross value added in Southern Europe. The results show that the impact of the shocks of the 2000s varies from one region to another, with some areas being able to increase their level of value added even in times of crisis. Almost all areas were deeply affected by the first wave of the economic and financial crisis, but the second wave and the first wave of the pandemic had stronger impact for some areas. In general, Greece and Spain experienced the strongest downturns (with -1.8; -5.6; -8.9% and -3.3; -3.6, respectively, and a -10.5% average decrease in GVA in the different periods), followed by Italy (-4.2; -1.3; -6.1%) and Portugal (0.3; -3.4; -4.8%). Analyses of convergence at the intra- and inter-country level show that between 2005 and 2020, sigma convergence was only achieved in Portugal and in the other three countries and within the four-country region sigma divergence took place, while beta convergence was achieved in Portugal, Spain and Greece, and in an interregional context. This indicates that the ranking of areas within countries has also changed, as evidenced by the gamma convergence of values. The spatial autocorrelation is significant in the area, but there is no significant change in the pattern of hot and cold spots, indicating that the spatial patterns are not very sensitive to external shocks. The different nature of the areas and their initial conditions suggest that they have followed recovery paths of different intensities from crises. Thus, the first and second waves of the economic and financial crisis and the pandemic have had an uneven impact on the region's development path, which has widened spatial disparities. The Southern European NUTS3 regions' convergence is best described by a spatial lag model.

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[i] Similarly to Malta and Cyprus, these territories are island areas, where neighbourhood connections cannot be interpreted.

[ii] Most researchers choose value added as the measure of economic activity. This has the advantage of including the contribution of capital and labour as well as changes in productivity, but is not sensitive to, for example, price levels between regions within Member States (Gorter - Van der Horst, 2005).

Economic Growth and Firm Size Dynamics: Evidence from Romania's Development Regions

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SUMMARY

The relationship between firms and economic growth is an intensely debated topic in the literature, emphasizing the impact of large businesses or small and medium-sized enterprises (SMEs) in ensuring growth, innovation and employment, as well as the role of support measures or social benefits. Although there is no consensus on the importance of each category in growth and development, there is tacit recognition that each size-class of firms has a series of specific characteristics that can more strongly influence certain aspects of development. A better understanding of these factors could help in adapting and calibrating measures and policies according to specific objectives, stages or geographical areas. In this paper, we propose an econometric approach to the relationship between economic growth (by GDP evolution) and the dynamics of firm sectors, by size class, at the level of the development regions of Romania. We found that the effect of the number of enterprises in each size class influences the GDP to a similar degree, regardless of the region, with a more pronounced positive impact in the case of micro- and small enterprises and ambiguous in the case of medium-sized enterprises.

Keywords: economic growth, firm-size class, GDP, Romania's regions
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INTRODUCTION

In present times there is much diversity in GDP per capita levels in the world, with the differences between the richest and poorest economies being both striking and worrying, as these differences mean very different standards of living, opportunities and sometimes profound deprivation and inequality. Seeking to find out why economies perform so differently, numerous researchers have tried to understand to what extent certain characteristics of firms and their dynamics are related to the dimensions of the economy in which they are part.

The size of firms and the contrast between large businesses – few in number, but with considerable shares in employment, value added or geographical expansion – and the huge number of small businesses have led many researchers and policy makers to support a certain category of firms, invoking either the contribution in employment, in innovations' generation and diffusion, or the contribution to the reduction of inequalities and the rebirth of the entrepreneurial spirit. Nor have social or political arguments been forgotten, such as vulnerability and dependence on public support,

their role in social and community capital or political influence.

However, statistical data and various study results are quite contradictory in determining whether there are differences between small and large enterprises in terms of their impact on overall economic growth, employment, poverty reduction or boosting entrepreneurship. Some research shows that small companies make the most important contribution to new job creation (European Commission, 2023; Komarek & Loveridge, 2015; Shaffer, 2006), others put large companies in the foreground, especially through job stability and qualifications (Beck et al., 2005; Haltiwanger et al., 2010). Certain researchers support the viewpoint that the influence of the activity sector is decisive, for example in the services sector SMEs are much better represented and, implicitly, have a higher share of employment, but most of them offer jobs with low qualifications (Deller, 2010; Mansury & Love, 2008; Carneiro et al., 2020). In geographical and administrative contexts, it seems that small firms have greater importance in local development and the reduction of poverty and inequalities, stimulating cohesion and local initiatives (Badulescu et al., 2024; Gubik, 2020), while large firms have a more relevant contribution at the national level, through contributions to employment, income to the state budget, spreading technology and supporting research and development activities.

This paper aims to fill a gap in the national and European academic literature, analysing the relationship between business size and regional economic development in a European Union member country, namely Romania. Thus, the structure of the article is as follows: after this introduction, the literature review section follows, and the subsequent sections (third and fourth) are for the methodology and for the analysis of the results and discussion, respectively. Finally, the main conclusions and policy recommendations are presented.

THE LITERATURE

The main literature on firm size and its impact on the uneven development of economies suggest that disparities in business size, organizational structure, and workforce qualifications contribute to economic differences between rich and poor countries. In the next subsections we will present a review on this topic, but also on the role of small and large firms in economic growth, examining how the distribution of firm sizes influences overall economic performance.

Firm size and the uneven development of economies

An important part of the literature explores the uneven level of development of the world's economies by the large differences in the size of businesses, organization and qualifications of the employed labour force. First of all, firms in poor countries tend to be, as a rule, much smaller than those in rich countries. Bento and Restuccia (2021), analysing the complete distribution of firm sizes in several countries, found that a 10% increase in GDP means, on average, an increase of about 3% in the size of firms (as number of employees). Second, not only the number but also the form of organization can explain these differences - firms in poor countries often tend to be sole proprietorships or family firms, while in rich countries the percentage of firms organized as joint stock companies is substantially higher, and this percentage gradually increases with the increase in GDP per capita (Majerovitz, 2023). Finally, not only the number of employees, but also their qualifications and education matter: the average share of workers who have graduated from high school or higher education varies by GDP per capita, showing considerable differences. According to Majerovitz (2023), companies in the manufacturing sector in developed European countries have, on average, more than 80% of employees with at least a high school education, compared to only 55% of workers in companies in African developing countries.

A less friendly business environment, various pressures and reduced security mean that many firms in developing countries avoid registration or declare turnover figures that are much lower than reality. According to La Porta and Shleifer (2014) the informal nature of economic activity is very widespread in less developed economies: in poor countries around 35% of GDP comes from informal firms, while in richer countries (i.e. those in the first quarter of the group of countries ordered by GDP) the percentage is below 17% (La Porta & Shleifer, 2014; Majerovitz, 2023).

We must note that these differences show the state of affairs, but the explanations of the differences and links with economic development are still quite complicated. The fact that less developed countries are characterized by a business sector dominated by small business sizes, an informal sector, basic organization structures and low employee qualifications may reflect deeper problems.

Bento and Restuccia (2017) connect the small size of firms in poor countries to a lack of interest in investment and technology, fuelled by the uncertain economic environment that threatens their expectations of the profitability of such investments. Akcigit et al. (2021) find that individual and family firms, although suited for survival and resilience in uncertain or hostile economic and political environments, cannot grow because their managers are not selected on the basis of competence but on the basis of family ties.

The effect of firm size distribution on economic growth

In general, the relationships between economic growth and firm size have been widely discussed in the literature, but most papers have focused on specific parts of the distribution, either micro- and small firms, or large firms, and quite a few have addressed the particularities of the entire distribution of firms by size class. Much of the literature has also argued that explanations have to consider, in the same models, other important factors of economic growth.

The first approaches to the relationship between economic growth and the size distribution of firms can be found in Schumpeter's 1934 *Theory of Economic Development* (1961), which describes the small innovative entrepreneur as the driving force of economic development, competing with existing firms by introducing new innovations, thereby making current technologies, goods or services obsolete. The importance of small firms over large companies, which are consolidated but often lacking in flexibility and willingness to renew, is described in the well-known expression "creative destruction". Later in Schumpeter's work, in *Capitalism, Socialism, and Democracy* (Schumpeter, 1942), he describes the dominance of large firms over small firms, advantaged by their considerable financial and human resources and the ability to use the innovations resulting from the activity of research and development, the so-called "creative allocation" process, specific to the first half of the 20th century. Interestingly, economic growth at the end of the 20th century in developed countries according to many researchers and statistical findings, was closer to the first Schumpeter's model (Carree et al., 2002), as the share of small enterprises in production industrial, trade, creation of added value, employment, but also in innovation and research and development was increasing (Acs & Audretsch, 1987). Since then, numerous studies argue that an economy with a higher proportion of SMEs is more efficient, or, reciprocally, that a poorly developed SME sector (quantitatively, but also qualitatively) would explain the poor performance and reduced dynamism of many world economies (Carree & Thurik, 1998; Audretsch et al., 2000).

There are, however, numerous contributions based on more recent data that support the importance of large firms in generating economic growth in modern-day economies. For example, Lee et al. (2013) showed that a 1% increase in the number of top firms led to a significant increase in growth rates in most developed and developing countries. According to their research, large enterprises, which are much smaller in number but with a greater contribution to the creation of added value, have a clearer and stronger effect on economic growth compared to SMEs. The relatively large number of employees compared to turnover and the volume of investments and non-existent budgets for research, development and innovation in the vast majority of SMEs indicate a limited possibility for influencing GDP growth (Dianu et al., 2019). Autor et al. (2020) advance a theoretical model of "superstar firms", starting from the premise that tougher competition increases the advantages of more innovative and productive firms, which become dominant "superstars" over time. The increase in competition has gone hand in hand with the increase in concentration in certain industries, which have become relatively more productive and innovative, with significant decreases in labour costs in total expenses. According to Poschke (2018), economic development also generates significant changes in the size distribution of firms, and the average size of large firms in rich countries has increased simultaneously with their size dispersion. The growth of entrepreneurial firms is strongly conditioned by the adoption of technical progress and the development of entrepreneurial skills.

Starting from the fact that the size of the firm is relevant and can be considered as a relevant factor for the growth and development of a region, Shaffer (2006) recommends that political decision-makers understand these relationships to influence regional development according to the most favourable effect of each size category on growth and, of course, on the strategic objectives of each stage.

However, certain researchers and studies assert that, while in developed countries SMEs are associated with faster income growth (Amaghouss & Ibourk, 2013; Audretsch & Thurik, 2001; European Commission, 2023; Shaffer, 2002), in developing countries and regions with weak institutions, the role of small businesses is ambiguous (Acs & Audretsch, 1987; Carree et al., 2002; Carree & Thurik, 1998; Dejardin & Fritsch, 2011; Deller, 2010). In developed countries SMEs are considered to be the most important factor of regional GDP growth (Komarek & Loveridge, 2015), a key factor in explaining variations in output across region (Gubik, 2020), but also a precondition for regional economic progress in developing countries (Glonti et al., 2021), while Yang (2019) considers that the level of regional development is important for the growth and performance of companies, but it is overshadowed by the role of investors and managers.

Cravo et al. (2012) show that although firm size plays an important role in regional economic development, the results are uneven, depending on the sector, time frame and methods of measurement. Carneiro et al. (2020) find that industrial sectors display a strong relationship between firm size and regional economic growth, while the relationship is statistically significant and negative for service sectors. All categories of companies (by number and global size) negatively influence poverty indicators. Interestingly, small firms and especially microenterprises in the tertiary sector have a negative effect on income growth, but a positive effect on regional employment.

Regarding the recent literature on this topic in the case of Romania, although we find numerous studies on the relationship between the dynamics of SMEs and GDP growth (Armeanu et al., 2015; Simut et al., 2021; Stelea & Calefariu, 2022), the regional perspective and, in particular, the structure by size classes of firms related to economic growth has been analysed (Badulescu et al., 2024; Druica et al., 2017; Gavrilut et al., 2022; Goschin, 2014). In a sectoral approach to this relationship, Stancu et al. (2021) determined that for the period 2007–2015 the influence of firm size on growth was negative and significant, which would suggest that small firms grow faster than large firms, and other variables (such as the level of taxation) also have a significant influence on the growth of firms, but not investments in research and development (especially in the case of small and medium-sized firms).

Of course, the international literature on the topic of economic growth states there are other important variables that influence economic growth, beyond the distribution of firm size, including the dimensions, dynamics and liberalization of the financial sector (Levchenko et al., 2007), participation in international trade, innovation (Piguillem & Rubini, 2012) and the regulatory environment associated with the labour market (Loayza et al., 2005). In addition, tax burden, trade barriers, bankruptcy and contract enforcement are undoubtedly important factors in the growth (or stagnation) of an economy.

METHODOLOGY

Based on the previous literature, in the present work we started from the hypothesis that the dynamics and performance of an economy are determined, among other factors, by the number of companies active in that economy, and we propose to test this hypothesis by analysing the existence of links between the evolution of the number of registered companies (by size class) and change in GDP, at the level of the development regions of Romania (NUTS2), a European Union member state. The data were obtained from the National Institute of Statistics of Romania (NIS Romania) and from Eurostat.

Romania consists of eight development regions (NUTS2 level, see Figure 1), ordered according to GDP/capita as follows: the capital region, namely the Bucharest–Ilfov Region, with over 28,400 EUR/capita, West Region (12,200 EUR/capita), Centre Region (11,600 EUR/capita) North-West Region (10,500 EUR/capita), South-East Region (10100 EUR/capita), South-West–Oltenia Region (9400 EUR/capita), South–Muntenia Region (9390 EUR/capita) and North-East Region (7900 EUR/capita) (NIS Romania, 2024; Badulescu et al., 2024).

As for the number of enterprises, it grew constantly, but quite slowly during the analysed period (2008 to 2021), from around 555,000 in the years 2008–2010 to around 671,900 in 2022. Almost a quarter of the total number of companies registered in Romania (24.1%) are in the Capital Region, Bucharest-Ilfov, followed by the North-West Region (15%), Centre, North-East, South-East, South-Muntenia (between 11% and 12%, each), while the South-West and North-East regions have the lowest percentages, between 7% and 9% each. By size class, the figures are quite similar across regions; however, the situation of large enterprises (with over 250 employees) is worth noting: the capital region holds over a third (36.2%) of the total number, while the next two regions (Centre and North-West) each contain about 11% of the total (NIS Romania, 2024).

Source: Popescu & Popescu (2011)

Figure 1. The development regions of Romania

In this paper, we aim to take an econometric approach to examine the relationship between economic development (reflected by GDP growth) and the dynamics of the business sector from a regional perspective.

To begin with, we build a multiple linear regression to investigate the relationship between the GDP evolution and the structure of companies, categorized by size, for each development region of Romania and at the national level. More precisely, we intend to find out which categories of company size influence (and to what extent) the economic development of a region. At the level of the European Union, the structure of the company sector (by size class) is strongly unbalanced: there is an overwhelming share of micro-enterprises (92-93% is the EU average, 88-89% for Romania) (Eurostat, 2024) and relatively insignificant percentages of medium and large companies. On the other hand, in all EU countries, including Romania, the contribution of large companies is considerable, both in quantitative terms – gross added value (over 48%), employment (35.6%), and turnovers – but also qualitative (European Commission, 2023).

Thus, we considered GDP (in million RON) as the dependent variable and independent variables were MICRO (Micro-enterprises, firms with 0 to 9 employees), SMALL (small enterprises, with 10 to 49 employees) and MEDIUM (medium-sized enterprises, between 50 and 249 employees) (European Commission, 2003; OECD, 2020). The analysis covers the period from 2008 to 2021, during which comprehensive data for all indicators and regions were available (Eurostat, 2024; NIS Romania, 2024).

The augmented Dickey-Fuller (ADF) test, regarded as the least affected by insufficient data among common unit root tests such as ADF, PP, and KPSS (Choi, 2001; Im et al, 2003) was initially applied to the original series. If no significant results were obtained, the test was then performed on the first differenced series to determine the order of integration: I(0), I(1), or other. The test was not applied after the second differencing due to the low statistical power of such tests, which would be further compromised by the reduction in series size.

The test was performed with lags between 0 and 4 (larger lags decrease the power of the test). Also, the ADF test can be performed according to 3 methods: without deviation (drift) and without linear trend (trend), with deviation but without linear trend, with deviation and linear trend. Thus, the first model corresponds to an equation of the form $y_t = \rho \cdot y_{t-1} + \varepsilon_t$ (stationary with mean 0), the second to an equation $y_t = \alpha + \rho \cdot y_{t-1} + \varepsilon_t$ (stationary with non-zero mean/stationary at level), and the last method corresponds to $y_t = \alpha + \beta \cdot t + \rho \cdot y_{t-1} + \varepsilon_t$ (stationary around a straight line/trend-stationary).

RESULTS AND DISCUSSION

These results are summarized in Table 1 for the model yielding the most significant results (the most negative ADF).

Table 1

Augmented Dickey-Fuller test results for GDP, MICRO, SMALL and MEDIUM time series

	GDP			MICRO			SMALL			MEDIUM		
	Order/ Method	**ADF**	**P**	**Order/ Method**	**ADF**	**P**	**Order /Method**	**ADF**	**p**	**Order/ Method**	**ADF**	**P**
National	1 (D+T)	-3.61	0.04	0 (D+T)	-5.01	<0.01	0 (D+T)	-16.82	<0.01	0 (D+T)	-6.20	<0.01
North-West	N/A	-2.98	0.20		-4.55	<0.01	0 (D)	-6.65	<0.01	0 (D+T)	-11.94	<0.01
Center	N/A	-1.86	0.61		-4.10	0.019	0 (D+T)	-5.04	<0.01	0 (D+T)	-6.79	<0.01
North-East	N/A	-2.62	0.32		-4.20	0.016	0 (D+T)	-3.79	0.03	0 (D+T)	-5.24	<0.01
South-East	N/A	-2.5	0.15		-4.87	<0.01	0 (D)	-10.74	<0.01	0 (D+T)	-5.26	<0.01
South - Muntenia	N/A	-3.21	0.11		-3.60	0.049	0 (D+T)	-8.52	<0.01	0 (D)	-4.58	<0.01
Bucharest–Ilfov	N/A	-3.13	0.13		-8.56	<0.01	0 (D+T)	-4.41	<0.01	1 (D+T)	-6.82	<0.01
South-West Oltenia	N/A	-1.19	>0.87		-3.99	0.023	0 (D)	-4.45	<0.01	0 (D+T)	-10.1	<0.01
West	N/A	-1.73	0.66		-4.41	<0.01	0 (D+T)	-4.36	0.01	1 (D+T)	-4.17	0.01

Notes: Order – Order of differencing, ADF – Augmented Dickey-Fuller test statistic, N/A – stationarity is not obtained even after the first difference (the lowest ADF and p value obtained for the differenced series are mentioned). The methods are: D (with deviation, no linear trend), D+T (with deviation and linear trend).

Source: our calculations

The results for the MICRO series are relatively consistent across regions, as the series are all trend stationary. However, the SMALL series shows less consistency, displaying a mix of trend- stationary and level-stationary patterns. For the MEDIUM series, the results vary: in the Bucharest–Ilfov and West regions, the series exhibit a unit root and become trend-stationary after the first differencing; in the South–Muntenia region, the original series is level-stationary, while in the remaining regions, it is trend-stationary.

At the national level, the GDP series is not stationary at level but becomes stationary after the first differencing, indicating an integrated process of order 1 (I(1)). However, at the regional level, the series remains non-stationary even after the first differencing, regardless of the method applied, suggesting a more complex structure or a higher order of integration. Considering this fact, we tried to repeat the tests on the logarithmic lnPIB series. Some series appear to be trend-stationary after the first difference at a confidence level of 0.05 (North-East and Bucharest–Ilfov), others only at a confidence level of 0.10 (national, Centre, South–Muntenia), the series South-East is trend-stationary as such, and the rest (North-West, South-West Oltenia and West) are not stationary even after the first difference, according to any method. Thus, we conclude that, at a confidence level of 0.1, the Total (national), Centre, North-East, South–Muntenia and Bucharest–Ilfov series are I(1), the South-East series is I(0), and the others are integrated to a higher order.

Given the heterogeneity of these results, which are likely affected by the application of low-power tests to small series, we chose to build a multiple linear regression model, restricting ourselves to the original, non-log and undifferentiated series in the first place due to the simplicity and ease of application of diagnostic tests. For example, the existence of a spurious regression phenomenon, although it is expected in the case of non-stationary series with similar evolution, can be identified post hoc by a significant result of the Durbin-Watson test for the autocorrelation of the residual variable (Granger & Newbold, 1974).

Thus, we applied the following model to each region:

$$GDP_t = \beta_0 + +\beta_1 \cdot MICRO_t + \beta_2 \cdot SMALL_t + \beta_3 \cdot MEDIUM_t + \varepsilon_t \quad (1)$$

The results are presented in Table 2 in the following format: independent variable (p-value for t-test), adjusted R-squared, F-statistic for OLS model (p-value).

Table 2

Analysis of GDP using firm size distribution by region

	Intercept (p)	**MICRO (p)**	**SMALL (p)**	**MEDIUM (p)**	**R^2**	**F statistics (p)**
National	$-2.06*10^6$ (0.008)	2.46 (0.017)	68.96 (<0.001)	-194.7 (0.003)	0.849	19.8 (<0.001)
North-West	$-3.94*10^5$ (<0.001)	2.52 (<0.001)	73.08 (0.001)	-176.1 (0.0095)	0.871	23.51 (<0.001)
Centre	$-2.27*10^5$ (0.042)	1.95 (0.019)	70.16 (0.0035)	-200 (0.0034)	0.745	10.74 (0.005)
North-East	$-1.88*10^5$ (0.0018)	2.19 (<0.001)	48.67 (<0.001)	-125.7 (0.00115)	0.885	26.62 (<0.001)
South-East	$-1.13*10^5$ (0.046)	1.82 (0.003)	47.19 (<0.001)	-179.4 (<0.001)	0.893	28.86 (<0.001)
South–Muntenia	$-1.042*10^5$ (0.064)	1.24 (0.033)	60.44 (<0.001)	-203.1 (0.0043)	0.866	22.59 (<0.001)
Bucharest – Ilfov	$-7.02*10^5$ (0.041)	2.85 (0.020)	75.30 (0.027)	-115.7 (NS)	0.685	8.24 (0.011)
South-West Oltenia	$-1.056*10^5$ (0.053)	2.66 (0.004)	42.35 (0.006)	-139 (0.007)	0.7969	14.08 (0.002)
West	$1.36*10^5$ (NS)	2.16 (0.046)	26.53 (NS)	-157 (0.030)	0.4258	3.47 (0.079)

Source: our calculations

It can be seen that the model poorly performs for the West region (the F-test result is not significant at the 0.05 confidence level), but for all other regions and at the national level, the results are acceptable and comparable. The most notable and challenging finding to explain is the negative correlation between the number of medium-sized firms and GDP across all regions. In other words, in all regions (with the

exception of the West Region, where the model lacks statistical significance), an increase in the number of medium-sized enterprises is associated with a decrease in GDP.

Regarding the effect of the number of micro-enterprises (MICRO), it is more significant in the Bucharest–Ilfov Region, and the weakest in the South–Muntenia Region. Regarding the effect of small firms (SMALL) on GDP, we note again the maximum value for the Bucharest–Ilfov region, and the weakest effect in the West Region (but here the coefficient is not statistically significant), and respectively in the South-West Oltenia Region. In the case of medium-sized companies (MEDIUM), first of all, we note that their effect is negative, and the strongest effect (in absolute value) is registered in the South–Muntenia and Centre Regions, and the weakest in the Bucharest–Ilfov Region.

Regarding the value of R2, very high values are generally recorded (except for the West Region), which, on the one hand, can be interpreted as a large part of the GDP variation being due to the variation in the number of companies, but, at the same time, it is more likely a consequence of ignoring the trend of the time series (i.e. during the analysed period, the GDP value and the number of companies had a similar evolution, of relatively continuous growth).

To confirm that the model, despite neglecting the assumptions characteristic of time series regression, is nevertheless useful for forecasting, a series of diagnostics were performed: autocorrelation of the residual variable, heteroscedasticity, normal distribution of the residual variable, and variance-inflation factor (for multicollinearity). Results are presented in Table 3.

Heteroscedasticity was tested using the White test, normality of residuals using the Shapiro-Wilk test (which is considered appropriate for short series), and finally autocorrelation of residuals using the Durbin-Watson test. Multicollinearity was estimated using the variance-inflation factor (VIF).

We can conclude that the models are generally suitable for making predictions. No model shows residual heteroscedasticity, the residuals are normally distributed (with the possible exception of the model for the Southeast Region), and the predictor terms (the independent variables) do not appear to depend on each other, with the possible exception of the model for the North-West, in which case the number of medium enterprises is somewhat correlated with the other predictor variables.

The main problem is the positive serial autocorrelation of the errors, evidenced by a Durbin-Watson statistic below 2 and a significant p-value, in the case of the Centre, Bucharest–Ilfov and West Regions. However, the small sample size and the decision to neglect non-stationarity in the original time series indicate that the problem may also apply to the model calculated for the other regions. At the same time, the DW statistic is never less than R2, an empirical "test" for severe spurious regression situations mentioned by Granger and Newbold (1974).

Table 3

Diagnostic regression tests for linear models

				VIF		
	Homoscedasticity of the residual variable - White statistic (p)	**Normality of residuals: Shapiro-Wilk statistic s(p)**	**Autocorrelation of residuals - DW statistic (p)**	**MICRO**	**SMALL**	**MEDIUM**
National	9.234 (0.161)	0.938 (>0.1)	1.871 (>0.1)	1.200	1.183	1.350
North-West	8.496 (0.204)	0.893 (>0.1)	1.786 (>0.1)	2.034	2.316	3.788
Centre	6.324 (0.388)	0.962 (>0.1)	1.479 (0.043)	1.261	1.211	1.440
North-East	8.568 (0.199)	0.907 (>0.1)	2.131 (>0.1)	1.276	1.109	1.364
South-East	10.449 (0.103)	0.869 (0.075)	2.772 (>0.1)	1.197	1.047	1.202
South–Muntenia	3.569 (0.735)	0.947 (>0.1)	1.617 (0.058)	1.134	1.598	1.444
Bucharest–Ilfov	4.409 (0.621)	0.935 (>0.1)	1.3375 (0.028)	1.576	1.243	1.578
South-West Oltenia	2.814 (0.832)	0.963 (>0.1)	1.684 (0.095)	1.007	1.003	1.005
West	5.376 (0.496)	0.922 (>0.1)	1.375 (0.023)	1.110	1.287	1.359

Source: our calculations

In Table 2, the value of the regression coefficients, although of the same order of magnitude, tends to differ somewhat between regions. In an attempt to identify whether regions can be clustered according to the impact of a certain number of firms on GDP, k-means clustering was performed for the MICRO, SMALL and MEDIUM coefficients after normalization. All significant models were analysed (less for the West Region), grouping the regions into three clusters (groups), calculated by the silhouette method, the average of each cluster being interpreted below:

a. The moderate impact of micro-enterprises, the low impact of small companies, the moderate impact of medium-sized companies on GDP in the following Development Regions: North-East and South-West Oltenia;

b. The high impact of micro-enterprises and small companies, and respectively the moderate impact of medium-sized companies in the North-West and Bucharest–Ilfov Development Regions;

c. The low impact of micro-enterprises, the moderate impact of small companies, and, respectively, the low impact of medium-sized companies in the Centre, South-East and South–Muntenia Development Regions.

It can be concluded that, in certain regions, such as the South-East and South–Muntenia, GDP is less influenced by the number of small firms and micro-enterprises, while the negative impact of medium-sized firms on GDP is also less significant. Conversely, in the North-West and Bucharest–Ilfov regions, the number of small and micro-enterprises exerts a stronger influence on GDP growth, whereas the effect of medium-sized firms presents a more modest negative impact on GDP dynamics.

CONCLUSIONS

The literature has intensively analysed the relation between economic development and systematic changes in the firms' size distribution. Several contributions assert that in rich countries the average dimensions and dispersion of firms are larger than in developing countries, but also that the internal (organizational forms, staff qualifications) or external characteristics, such as the quality of the regulatory environment, matter a a great deal in the relationship between firm size and the growth of national economies. However, most of the studies focused on certain components of the structure of firms by size class – favouring either micro-enterprises, or the whole SME group, or large firms. Numerous researchers have shown that focusing on identifying relationships between size class structure and GDP growth is rather unproductive, as long as other economic, social, political or cultural factors are proven to matter for economic growth.

In our analysis on Romania development regions, we found that, in general, the effect of the number of enterprises in a particular category similarly influences GDP, regardless of region, at the 0.1 confidence level. It is observed that the number of micro-enterprises and small enterprises positively influences GDP; the number of small enterprises, however, has a greater effect by an order of magnitude (10 times higher) than micro-enterprises, while the number of medium-sized enterprises has an effect even stronger, but negative, except for the Bucharest–Ilfov region, where the number of medium-sized companies does not significantly influence GDP.

Although the assumptions of the linear model were ignored, the testing of the residual variables for homoscedasticity, normality and autocorrelation do not indicate significant deviations, except for the Centre, Bucharest–Ilfov and West regions. As for multicollinearity, measured as variance inflation factor, we consider that it is not severe in any region, but it should be remembered that for this parameter (VIF) there is no threshold value. Applying a clustering algorithm (k-means clustering) to the coefficients of the MICRO, SMALL and MEDIUM explanatory variables in the case of the seven regions that have significant patterns (so not including the West Region), we can cluster the regions into three categories:

a. GDP less influenced by the structure according to the size class of the companies, in the Centre, South-East and South–Muntenia Development Regions;

b. GDP influenced mainly by the number of micro-enterprises (in a positive sense), but, simultaneously, also by the number of medium-sized companies (in a negative sense), in the North-East and South-West Oltenia Regions;

c. GDP influenced especially by the number of micro and small companies, in the North-West and Bucharest–Ilfov Regions.

However, although the effect of the number of firms on GDP seems more favourable in the case of the Bucharest–Ilfov and North-West Regions, the coefficients have similar values in all regions (a positive but relatively small effect for the number of micro-enterprises and small firms, respectively a larger but negative effect for the number of medium-sized firms), suggesting that the differences, even if they exist, are not strong.

Current models and research also have a number of limitations. Thus, due to a limited number of values, it was not possible to test the premises of the regression applied to time series (especially the stationarity of the GDP series). Also, the GDP series is not stationary at the level, nor does applying the 1st or 2nd order difference achieve stationarity. Also, for this reason, it is possible that the diagnostic tests that should have signalled the consequences of ignoring these deviations (especially the Durbin-Watson test for the autocorrelation of the

residuals) did not have sufficient power, i.e., generated false negative results, the models being in reality unusable for predictions.

On the other hand, we started from the premise of a linear model (1), but a nonlinear model, such as a quadratic or logistic regression model, could have better represented the involved phenomenon. We note, however, that even in the case of log(GDP), the series does not become stationary after the first and second differences.

Further understanding of the differences between firms, as well as the causal links between their size structure and economic development, can help to underpin economic policies by contributing to the increase of firms' performance, supporting those characteristics specific to each class of firms by size in order to enhance more accelerated and comprehensive growth in certain periods of time, economic sectors or regions.

Author's contribution

The authors declare they equally contributed to this article: conceiving and designing the study; collecting the data; performing the analysis; writing and reviewing the paper

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