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Fenntartható Fejlesztés és Gazdálkodás Intézet

Hungarian University of Agriculture and Life Sciences, Institute of Rural Development and Sustainable Economy, Kaposvár Campus

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UNDERSTANDING RESILIENCE IN TOURISM AND HOSPITALITY

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ABSTRACT

The two years that have passed since the spring of 2020 have been an extremely unfavorable period for businesses in the tourism and hospitality sector. The coercive measures introduced due to Covid-19 led to adverse events, often crises in the operation of stores. The literature on resilience gives the most adequate answers to the question of how successfully a company resists or adapts to an unfavorable market situation. Resilience refers to the ability of the organization to continue to function during an adverse event by bouncing back or adapting to the circumstances in a new way. The purpose of this study is to summarize the concepts of resilience and present its aspects related to tourism and hospitality. The systematic processing of the results of resilience research found in the literature is not only useful for understanding the current situation but can also provide an effective coping strategy for another period of crisis. Since the research of corporate skills plays an important role in the post-Covid-19 recovery, the study proposes possible research methods for resilience and points out the challenges of business research.
Keywords: crisis, organizational resilience, systemic resilience, recovery

INTRODUCTION

In 2019, world tourism performed more than ever before. According to *Statista* (2020a), the contribution of tourism to the global economy was $2.9 trillion directly and $9.25 indirectly. The number of tourist arrivals increased to $1.46 billion. Since March 2020, tourism-related businesses have found themselves in one undesirable situation after another. The first wave of Covid-19 halved tourism: leisure spending fell by 50% (*Statista*, 2020b), while business spending dropped by more than 60% (*Statista*, 2020c). The emergency health measures have made the recovery for tourism difficult or limited for two years. As we can see from the industrial statistics of Hungary, the recovery is far from over, while new crises are threatening the sector: energy crisis, inflation, disposable income of target groups, or a drastic increase in facility operation costs. The ability of firms to survive and adapt can best be understood and examined in terms of resilience.

The relevance of resilience studies in tourism

The *Oxford Learner's Dictionary* (2022). reflects the original meaning of resilience as the ability of people and objects to recover from an unpleasant external impact such as

shock or injury. The Merriam-Webster Online Dictionary and Thesaurus introduces the phenomena of misfortune and changes alongside unpleasant external influences; therefore, resilience refers to the ability to recover from shocks or adapt easily to unpleasant situations (*Merriam-Webster*, 2022). The etymology of the word resilience is derived from the Latin resilire, meaning to bounce back, and is related to the Italian salire, meaning to leap. In the academic literature, it is worth starting from *Holling*'s (1973) definition of resilience as the ability of a system to maintain its identity and inherit its basic structure and characteristics in the event of malfunction (*Holling*, 1973).

When assessing resilience, it is primarily necessary to identify dysfunctions and adverse events. Although these can be diverse, they all have in common that they cause a state of imbalance in the functioning of the organization. According to *Faulkner* (2001), while disasters occur suddenly and the event that causes them is beyond the control of those involved, in a crisis, decisions may be made by those involved in several circumstances. Whichever the case, from the point of view of the organizations – or set of organizations – affected, adverse events typically have a determinate and negative impact on business, as usual. According to *Faulkner*'s (2001) synthesis, the defining characteristics of crisis and disaster situations are 1) a major trigger event that challenges the existing structure, the ability to carry out routine operations, and, indeed the survival of the organization, 2) a high threat characterized by surprise, urgency, and short decision times, 3) the perception of an inability to cope among the organizations directly affected, 4) a turning point or a decisive change that can move the organization in either a positive or a negative direction, and 5) flexible, unstable, dynamic situations.

When assessing the situation of tourism, the above indicates that a crisis can be identified for the coronavirus (hereafter: COVID-19). In Hungary, to control the COVID-19 outbreak, Government Decree 40/2020 (11.3.2020), which entered into force on 11 March 2020, first restricted the opening hours of restaurants, and a few weeks later it only allowed takeaway and home delivery. At the same time, the accommodation market faced a simultaneous drop in new bookings and the impossibility of receiving guests with reservations, while restrictions on entry and exit between countries were constantly changing. The situation was a combination of a major trigger event (regulation), short decision times (immediate restriction of service), and an inability to cope (operators had no experience in dealing with similar situations). The question is, however, how to characterize the situation in the tourism sector, and what to consider as a crisis based on the macro data for the sector?

Although tourism was considered a successful sector not only in Hungary but also worldwide before COVID-19, it is difficult to estimate the performance and output of the sector, and even more difficult to measure its true size and contribution to GDP. The reason is that tourism is not a productive or commercial activity, nor a consumer good, which has a well framed value-chain, but it is a set of 12 tourism products and economic activities. Although the Tourism Satellite Accounts (TSA) aim to estimate the output of the 12 products (Accommodation services for visitors, Food- and beverage-serving services, Railway passenger transport services, Road passenger transport services, Water passenger transport services, Air passenger transport services,

Transport equipment rental service, Travel agencies and other reservation services, Cultural services, Sports and recreational services, Spa services, Travel supporting services) as accurately as possible, *Hinek* (2020) points out the challenges of the TSA indicators. *Hinek* (2020) presents anomalies that can lead to misunderstandings and false conclusions. Indeed, only some of the products monitored by the TSA are purchased by tourists and travelers exclusively. A vast majority of hospitality services are used by local visitors, as well, as is the case for domestic passenger transport, which is predominantly used for commuting (to work, school, and intra- and inter-municipal destinations). Passenger transport infrastructure does not exclusively serve the needs of people far from home, either, but is rather a key element of a country's mobility. The case of spas is also typical, as a significant proportion of their volume is generated by residents.

Of tourism-specific products, this study focuses on accommodation services, food-and beverage service, travel agencies, and other reservation services. These three tourism-related products - also known as economic subsectors - were the most successful sectors of the years before the COVID-19 crisis. The industrial statistics of the companies producing the above-mentioned tourism products help to understand that the sector is still in the recovery phase. The evolution of the number of enterprises in the sub-sectors 55 Accommodation, 56 Food and beverage service activities, and 79 Travel agency, tour operator and other reservation service and related activities, the number of formations and terminations, the annual net turnover and the number of employees, according to NACE '08, are summarized in *Table 1*.

Table 1: Industrial statistics of tourism businesses in Hungary

	31 December 2019			31 December 2020			31 December 2021			31 December 2022		
	55	**56**	**79**	**55**	**56**	**79**	**55**	**56**	**79**	**55**	**56**	**79**
Number of enterprises (thousand)	4.9	21.3	1.9	4.9	20.8	1.8	4.9	20.8	1.7	5.0	20.9	1.7
Number of business formation (piecewise)	218	1.383	292	273	1.286	45	252	1.255	45	200	1.096	53
Number of business termination (piecewise)	234	1.785	332	190	1.231	105	133	758	75	179	1.195	84
Net revenue (million HUF)	524	1.084	374	280	837	374	355	1.088	88	-	-	125
Staff headcount (thousand people)	35.8	120.6	6.3	35.1	119.3	6.3	30.4	114.1	4.7	34.8	106.6	4.5
Average staff headcount (people)	7.3	5.7	3.3	7.2	5.7	3.5	6.2	5.5	2.8	7.0	5.1	2.6
55: Accommodation 56: Food and beverage service activities 79: Travel agency, tour operator and other reservation service and related activities												

Source: Based on *Nemzeti Cégtár*, 2023

Of the three priority sub-sectors, although food and beverage services have already realized pre-COVID-19 sales in 2021, accommodation and travel services were still far behind the record year of 2019. By the end of 2022, the sales revenue of accommodation and travel services may approach the pre-crisis level. To answer whether the increase in income is caused by sales prices or sales volume, it is worth

considering the industry indicators of accommodation and tourist arrivals. Since at the time of writing the study, the accommodation statistics of the Central Statistical Office (hereinafter: KSH) only date back to 2021 and previous annual summaries are not available, it is necessary to rely on the reports of the Hungarian Hotel and Restaurant Association (hereinafter: HAH).

Regarding the average number of staff headcount, the market of tourism-related businesses consists of micro and small-scale enterprises. Therefore, when analyzing market indicators, it is worth considering the research experience of *Csapai & Berke* (2020), according to which the strength of the market position and the market contest-power is positively related to the size of the enterprises.

Although the reports only summarize the performance of hotels, this can be considered relevant data as hotels accounted for 67% of all rentable rooms in 2021 (*KSH*, 2022a). Therefore, the data represent the dominant share of the sector. According to the report summarizing the year of 2021 (*HAH*, 2022a), the number of guest nights spent in accommodation in 2021 was only 44.8% of the value of 2019 (23,471 thousand guest nights). 2022 will probably be better than 2021, but lower performance is expected than the record year 2019. The number of guest nights between January and August 2022 (11,933 thousand total guest nights) corresponds to 74.8% of the same period in 2019 (*HAH*, 2022b). The dynamics of the accommodation market are slowly approaching pre-crisis (2019) levels for the time being, so it is worth examining the development of average prices. In August 2022, hotels nationwide showed an average gross rate of HUF 33,905 per room, which is a 37% increase compared to August 2019. The hotels at Lake Balaton showed the highest increase in room rates, an average of 67% (*HAH*, 2022b). The statistics of tourist arrivals also support the impact of average spending on the development of the tourism industry performance. Based on the KSH database, the volume of multi-day inbound trips to Hungary (239,357) in the first six months of 2022 was 28% below the volume of the same period in 2019, while the passenger spending exceeded that of the record year by 0.7% (*KSH*, 2022b).

In conclusion, while the market for the main tourism products reaches or has already exceeded the levels before COVID-19 in terms of average prices and revenue, the volume of tourism, based on accommodation statistics and travel statistics, is significantly lower than in 2019. However, another figure draws attention to a small crisis of tourism: the number of business formations in *Table 1*. This information may be relevant because in most sectors – especially in tourism and hospitality - new entrants and the market turbulence bring innovations, new business models and more efficient ways of operation, and force those on the market to change. In a concentrated and saturated market, the old methods are more likely to be conserved, obsolete falling behind in the global tourism competition.

The trends in tourism products after COVID-19 justify the relevance of examining the resilience of businesses and research on resistance capabilities. The present study aims to review the literature on resilience in the context of tourism businesses. The study summarizes the findings of the systematic processing of literature and reports the approaches and interpretation frameworks in which resilience could be studied further.

DISCUSSION ON LITERATURE REVIEW

From January 2021 to July 2022, 106 scientific publications on the relationship between tourism and resilience were identified using Google Scholar and ScienceDirect databases with the keywords: *resilience*, *tourism*, *hospitality*, and their combinations. After filtering the findings, 57 journal articles were selected for a more thorough review. These papers examined resilience in a tourism-related paradigm or theoretical framework. Except for 8 publications, every article was published in Q1-Q4 ranked journals such as the International Journal of Hospitality Management, Tourism Management, or Tourism and Hospitality Research.

Resilience is a flexible concept, the boundaries of which are defined by the context and research objectives; therefore, it is worthwhile to understand the typical approaches. In the literature reviewed, two major approaches can be identified: *systemic* and *organisational.* The former refers to the holistic analysis of a given sector, industry, or market, while the latter approach is the analysis of organizations performing a specific activity.

Systemic approaches

In a systemic approach to tourism research, the context of *destination resilience, economic resilience, community resilience, resilience cycles, the resilience of socio-ecological systems, multi-level perspectives, or disaster resilience framework* can be applied.

In terms of *destination resilience, Luthe & Wyss* (2014) have pointed out that a destination must continuously respond and adapt to increasingly complex and global changes. According to *Hall et al.* (2018), a destination is resilient if its stakeholders (1) are aware of vulnerabilities and the impacts of potential threats, (2) develop in ways that benefit the community as a whole, (3) plan for networking and collaboration, (4) redefine meta-governance of the destination as „soft" means of influence and control, (5) operate predominantly from local and regional resources, and (6) are reflexive, learning from past crises to reduce future vulnerabilities of the destination. *Cellini & Cuccia* (2015) published a study of Italy's tourism performance following the 2008 financial crisis and defined *economic resilience* as the ability of cities, regions, and countries to withstand and recover from negative shocks. In the approach to economic resilience, recovery is defined as the ability to bounce back to the level of output before the negative shock, restore previous growth performance, or develop a new and better growth strategy. The measure used to compare different cases and destinations is the time needed for recovery or bouncing back. According to *Brown et al.* (2017), *community resilience* is the prevalence of four attributes, such as (1) economic development, or more precisely, the equitable distribution of resources within a community, (2) social capital, or relationships as resources, (3) information and communication, which require shared meanings, interpretations, and information networks that can make communication during stressful situations more effectively, and (4) community competence, or the ability to make decisions and act together. The *resilience cycle,* also known as Holling's loop, was synthesized by *Cochrane* (2010). Holling was an ecologist and a pioneer of ecosystem dynamics, resilience and ecological economics. In *Holling*'s (1973) approach, resilience is the result of the interdependence of the economy, society and

environment. The loop named after Holling is a recursive formation, its starting point is *reorganization*, i.e., rapid change after a destabilizing event with the renewal of previous structures. The next stage is *exploitation*, which is the exploitation of the potential for reorganization by renewed structures. Exploitation is followed by *conservation*, which refers to the structures created in the reorganization and those that thrive in exploitation are combined, new ones are built on top of them, and the system becomes consolidated and flexible. Eventually, the system faces another destabilizing outcome, what it calls the *escape* stage. As a result, the structure breaks up again, becomes resilient, and tends to reorganize itself (*Cochrane*, 2010). The *resilience of socio-ecological systems (SES)* also returns to the ecological approach used since Holling. *Sheppard & Williams* (2016) identified four closely interacting factors in applying the SES approach in tourism research: (1) mastering the ability to cope with change and uncertainty, (2) maintaining diversity in reorganization and renewal, (3) combinatorial application of different knowledge elements, and (4) creating opportunities for self-organization. *Amore et al.* (2018) validated the *multi-level perspective (MLP)* model of destination resilience to support sustainability transitions, as proposed by *Geels* (2011). *Amore* and co-authors (2018) concluded that the four levels of the MLP: the *actor* (individual, personal decision-making level), the *niche* (resident population and travelers), the *regime* (organizational and institutional decision-making, tourism, and non-tourism operators), and the *landscape* (ecological and natural environment, biodiversity) form a complex adaptive system in terms of resilience. In this system, ecological, socio-ecological, socio-political, socio-economic, and socio-technological dynamics are at work and interact. According to *Amore et al.* (2018), the patterns of interaction, coordination, governance, risk management and cooperation within and between levels must be implemented to develop resilience in a destination.

A more specific approach to the above is the *Disaster Resilience Framework for Hotels (DRFH)*, which is based on the work of *Brown et al.* (2018). The DRFH identifies variables whose performance and condition can predict the resilience of a hotel or the accommodation service to a disaster or shock. These variables are, with the phenomena to be assessed in brackets, *economic capital* (access to resources, diversity of income sources, financial background, financial state of the staff), *social capital* (social network, cohesion, ability to work together, business confidence), *human capital* (health of staff, skills, adaptability, skills), *physical capital* (safe environment, business continuity), *natural capital* (natural and environmental risks of the location, impact of the activity on the environment) and *cultural capital* (cultural impact of the activity on society, accumulated cultural knowledge and value). Although *Brown et al.* (2018) have formulated the elements of the framework specifically for hotels, the approach can be adapted to different activities and areas exposed to crisis situations.

Organizational approaches

Systemic approaches are abstract, generalizable theoretical relationships that are difficult to implement in concrete cases. These approaches focus on a specific part of the internal functioning of organizations, enterprises and institutions through which the organization's flexible ability to resist can be developed. The most typical

ones include the *resilience of the workers*, the *ability to recover*, *resilient management*, and *planned* and *adaptive resilience*.

The *resilience of workers* is a dispositional factor related to the human ability to return to its original state after crises and traumatic situations, and on the other hand, it is a process aimed at the development of endurance, coping and innovation capacity of individuals as workers. (*Kuntz et al.* 2016). *Saad & Elshaer* (2020) examined the employees of the sales and marketing departments of five-star hotels and the employees of travel agencies specialized in luxury travel in Egypt that were directly or indirectly affected by a terrorist attack. According to the responses of 960 employees, if workers' resilience is stronger, job insecurity (fear of losing one's job) is lower, and creative performance is higher. Path analysis confirmed that distributive justice (equal share of the organization's performance) and trust play a mediator role between employee resilience and workplace insecurity.

According to *Dartey-Baah* (2015), *resilient leadership* is the integration of transformational (aiming to transform the system) and transactional (promoting and requesting tasks). This management style and ability are necessary to be able to implement changes affecting the organization. *Suryaningtyas et al.* (2019) interviewed directors and human resource managers of three-star hotels in Indonesia in their research. According to their findings, organizational resilience positively affects resilient leadership, and resilient leadership leads to better organizational performance.

In the research of *Prayag et al.* (2018), organizational resilience was identified as *planned* and *adaptive resilience*. Regarding planned resilience, the organization already has an emergency plan and priorities before a crisis or disaster, or at least has an idea of how it would react to undesirable events and tries to predict the occurrence of events by continuously monitoring the natural and economic environment. On the other hand, adaptive resilience is developed after a disaster event or because of a crisis. It requires appropriate leadership, external relations, internal cooperation, and the learning ability from past crises. *Prayag et al.* (2018) involved 84 New Zealand tourism businesses (accommodation services, passenger transport specialized in tourism, and attraction management) and concluded that if planned resilience has a significant and positive effect on adaptive resilience, the financial performance of businesses is not affected. On the other hand, adaptive resilience has a positive effect on the financial performance of enterprises.

Empirical experiences of resilience in tourism research

The summary of some empirical research helps to understand the validity and the explanatory power of the system and organizational level. It is worth dividing the results into groups: before the COVID-19 pandemic and during the COVID-19 pandemic. Long before COVID-19, *Sheppard & Williams* (2016), based on a qualitative study of Whistler, British Columbia, stated that socio-ecological features (see Chapter 3.1) enhance the resilience of tourism-focused communities.

To understand the context of organizational resilience, *Melián-Alzola*, *Fernández-Monroy, & Hidalgo-Peñate* (2017) conducted research in the Canary Islands in 2017, involving 72 hotels. They chose strategy and change management as antecedent

variables of organizational resilience, and variables such as competitors (appearance of new hotels, changes in competitors' offers), guests (changes in guest composition, changes in demand) or the economic context (exchange rates) were used as changes or threats (unfavorable change, downturn). According to their research results (*Melián-Alzola et al.* 2020), the two antecedent variables individually and together positively influence the resilience of the hotel as an organization.

BREXIT was the reason for the 2018 research conducted by *Burnett & Johnston* (2020) in Ireland, involving a total of 27 senior managers, industry association members and policy makers. Although the analysis (*Burnett & Johnston*, 2020) revealed that at the time of the survey, tourism representatives praised the performance of the industry and were not particularly prepared for BREXIT, but they recognized innovation and the development of new markets as the way to better resilience.

Based on their research in New Zealand, *Tibay et al.* (2019) concluded that the most important indicators of the resilience of tourism enterprises are the quality of management, the core competencies of the staff, planning and preparedness, market sensitivity and regulatory compliance.

The role played by resilience in vulnerability was investigated in Turkey by *Doğantan & Kozak* (2019). Based on their sample of more than 400 respondents, including hotel managers, representatives of travel agencies and private airlines, they proved (*Doğantan & Kozak*, 2019) that the effect of flexible resilience on vulnerability is significant and negative; in terms of planning and proactivity in the face of crises, there is no difference between the examined stakeholders in tourism, and managerial resilience is significantly higher in the case of travel agencies.

Senbeto & Hon (2019) investigated the relationship between hotel staff and organizational resilience by asking nearly 300 subordinates and nearly 80 managers in Ethiopia. According to their results (*Senbeto & Hon*, 2019), market turbulence has a negative relationship with employee resilience, while employee resilience has a positive relationship with service innovation and mediates the relationship between market turbulence and service innovation.

Hallak, Assaker, O'Connor, & Lee (2018) investigated the correlations of creative self-efficacy, innovation, and industry experience with resilience concerning upscale restaurants in Australia long before COVID-19. They interviewed more than 180 restaurant managers or owners. In the research design they used, creative self-efficacy refers to an individual's belief and confidence in his or her abilities to perform creatively (*Tierney & Farmer*, 2002). *Hallak et al.* (2018) have proven that the operator's ability to resist (leadership resilience) has a positive effect on creative self-efficacy and innovation but does not affect the performance of the restaurant while time, creative self-efficacy, and the commitment of the restaurant to innovations had a positive effect on the restaurant manager's perceived performance. An important finding of the study is that the role of resilience as a mediator between creative self-efficacy, innovation and performance increases with the number of years spent in the sector.

Ivkov et al. (2019) examined the resilience of hotels in Europe involving hotels from 12 countries affected by natural disasters. At the time of the research, the countries most affected by natural disasters were Russia, France, and Italy. According

to the results based on the answers of 60 hotels in total, the hotel managers who have already experienced a natural disaster as managers or individuals, or who have been working as managers for a longer period, rate their ability to resist natural disasters better. In addition, the size of the organization and the quality of the hotel positively influence resilience against natural disasters.

Jia, *Chowdhury*, *Prayag & Chowdhury* (2020) examined the relationship between proactive and reactive organizational resilience and various capital factors of organizations among a total of 65 enterprises affected by the 2008 Sichuan earthquake. Of capital factors, structural, relational and cognitive capital was used in the research. Structural capital refers to the efficiency and speed of information flow between people involved in the operation of the organization (*Burt*, 1992); cognitive capital includes the similar ambitions, visions, goals, and cultural values of the organization's actors (*Nahapiet & Ghoshal*, 1998); and relational capital refers to the relationships of the organization that are characterized by trust, friendship, respect, and reciprocity and develop through the organization's stakeholder relationships (*Li et al.* 2016). Based on the experiences of the 2008 natural disaster, it was established that stronger structural capital increases proactive resilience and stronger relational capital increases reactive resilience, while cognitive capital has no significant effect (*Jia et al.* 2020).

Romão (2020) examined the growth capacity, vulnerability, absorptive capacity and recovery of tourism from the 2008-2012 crisis in 55 NUTS2 European regions. Based on *Romão*'s (2020) statistical analysis, gross added value of tourism, guest nights, the situation of the agriculture and food industry, environmental technology, mobility and transport, culture and creative industry, as well as maritime and biotechnology increase the absorption capacity of an area. However, guest nights and environmental technology do not contribute to the recovery from the crisis.

During the COVID-19 pandemic, *Filimonau*, *Derqui & Matute* examined the impact of senior hotel directors' and managers' organizational commitment to coping with the COVID-19 crisis in Spain. According to the study based on 244 valid questionnaires (*Filimonau et al.* 2020), resilient hotels responded more effectively to the crisis. During the pandemic situation, the workplace insecurity felt by interviewed managers depended on the strength of organizational resilience but after the pandemic situation there was a significant and positive relationship between insecurity and organizational resilience. Interestingly in large hotels, not only the manager's commitment to the organization was lower but also the ability of the organization to resist.

Neise, *Verfürth & Franz* (2021) investigated the resilience of restaurant hospitality under COVID-19 in Germany through their large-scale survey of more than six hundred restaurant owners and managers. Of their results (*Neise et al.* 2021), it is worth noting that the better financial and economic situation of the restaurants, as well as the value of the tangible and intangible assets available, did not affect their ability to resist flexibly. On the other hand, the ability to respond quickly and in the short term, the experience of the owner and manager in the industry, and the fact that the owner is involved in the management of the restaurant, increase the resilience of businesses.

Sobaih, *Elshaer*, *Hasanein*, *&Abdelaziz* demonstrated in their large-scale research on small hotels and restaurants from Egypt (*Sobaih et al.* 2021) that both planned and adaptive resilience positively affect the performance of enterprises, and that adaptive resilience contributes to sustainable tourism development.

CONCLUSION

The review and processing of the literature examining the resistance capacity of tourism enterprises led to both a more effective planning of resilience research, an understanding of the capabilities of the enterprises and the formulation of proposals for them. Studies using systemic approaches have confirmed that the ability to resist adverse events does not only depend on a number of environmental variables but is also a consequence of the social, economic and cultural environment of a given destination, sector or enterprise. The resilience-enhancing concepts and variables listed among systemic approaches reflect values, attitudes, and, as one might say, mentality which is more deeply rooted in the sociocultural environment than we might think at first. In the strict sense of the word, their development is difficult or impossible, but the recognition of the need for development and the effort may improve the flexible resistance capacity of those involved.

The organizational-level approaches point to the generalized resilience concepts that can be well specified for each organization, destination, and activity. It is worth observing how much of a role is assigned to the staff involved in the activity and the community they form in this approach. Concepts and conditions that can be read in systemic approaches can presumably be easily identified in a specific organization, and initiatives aimed at its development can nevertheless facilitate the path to development.

Empirical research results are already extremely specific for each case or for a well-defined group of stakeholders. Here, the question may arise as to what further possibilities lie in resilience research. Although the limitations of the scope of this study do not allow us to get to know the methodology of the cited research in more detail, the experiences of the literature review provide several consequences. In general, it can be said that quantitative research methods are overrepresented in the reviewed studies. In these cases, validated organizational and entrepreneurial attitude scales were typically used with methodologically appropriate results. Still, it is important to note that when filling out a questionnaire containing scale variables, it can easily suggest self-evaluation for an owner, organization or department manager, and therefore, the socially expected answer is a real risk of measurement. Another difficulty – also arising from our own research experience – is the separation of the characteristics of business and enterprise in the case of a specific business activity. It may easily be that the company, especially its organizational culture, behavior, and practices, does not strengthen resilience, however, the financial and influence opportunities of the operating enterprise still make the business resilient.

Finally, it is worth looking briefly at the uniformity of qualitative research since in-depth interviews are exclusively used when the qualitative methodology is conducted. In this field, there are many research opportunities with the innovative

use of participant observation, ethnographic methods, action research and other alternative research methods. The application of non-conventional research methods not only makes the final study interesting and instructive for the readers of the literature but can also provide real, in-depth results and feasible practical suggestions for the examined sector.

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THE LINK BETWEEN RETURN AND RISK IN THE CASE OF BITCOIN

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ABSTRACT

Over time, cryptocurrencies have experienced a widespread adoption, with bitcoin emerging as the most prominent example. In an increasingly uncertain world, the significance of possessing a stable store of value, traditionally fulfilled by gold, has escalated. Bitcoin has been often referred to as a digital equivalent of gold. Hence, this study primarily focuses on analyzing the price dynamics of this particular cryptocurrency. A comprehensive literature review will be employed to examine the regulatory obstacles encountered within the cryptocurrency market. Additionally, considering the contentious nature of this field, special attention will be devoted to the clash of perspectives surrounding this innovation. Subsequently, concentrating on the period 2016-2021, this paper will investigate the factors that define a risk-weighted investment, utilizing the Sharpe ratio and Sortino ratio. However, there has been significant volatility in the price of Bitcoin in 2020-2021, and our research fills a gap in the relationship between Bitcoin returns and risk in the post-2016 period. Overall, the analysis concludes that bitcoin exhibits highly turbulent investment characteristics. Despite its substantial price appreciation, the findings indicate that bitcoin displays significant volatility. Consequently, selecting this investment alternative entails considerable risks. Based on our results, there were years between 2016-2021 when bitcoin was a good investment, but in most cases its returns were associated with excessive volatility and risk. For this reason, it is not recommended for risk-averse rational investors.
Keywords: Bitcoin, return, risk, cryptocurrency

INTRODUCTION

Bitcoin is a digital currency that operates on a decentralized network called the blockchain. It was created in 2009 by an anonymous person or group of people using the pseudonym Satoshi Nakamoto. Bitcoin is often referred to as a cryptocurrency because it uses cryptographic techniques to secure transactions and control the creation of new units. (*Nakamoto*, 2008). It is not governed by central authorities, such as governments or central banks, and intermediaries for currency issuance or settlement and validation of transactions, and can provide lower transaction fees for payments (*Ali et al.*, 2014) In Hungary, cash payments are dominant, although digital solutions are gaining ground (*Pintér et al.*, 2021, 2022; *Menrad & Varga,* 2020). Cryptocurrency payments are negligible.

There are multiple perspectives regarding bitcoin. Devoted proponents assert that it possesses the potential to supplant the role traditionally held by gold as an investment. Conversely, critics contend that bitcoin lacks intrinsic value, its source code is replicable, and it is unable to fulfill the functions of a currency, although electronic money is also able to fulfill all money functions. (*Gál & Gáspárné*, 2013)

Bitcoin currently holds a substantial portion of market capitalization within the realm of cryptocurrencies. Consequently, fluctuations in its price exert a noteworthy influence on the prices of other cryptocurrencies. Hence, the present study aims to analyze and compare the returns and risks associated with bitcoin. In pursuit of this objective, the research employs the Sharpe ratio and Sortino ratio to examine the investment viability of bitcoin, alongside tracing the evolution of its price.

Within the realm of cryptocurrencies, a significant aspect of concern pertains to the regulatory challenges associated with criminal activities. The presence of anonymity renders the market substantially appealing to illicit actors. Regrettably, within the dark web, operators cannot ascertain the precise identities of participants with 100% certainty. Nonetheless, a positive consequence emerges whereby investigators and agents can assume undercover roles, thereby bolstering the likelihood of apprehending criminals. Furthermore, by employing adequate expertise to scrutinize the transaction chain of the blockchain, comparable insights into the criminal network can be obtained, akin to examining traditional financial data.

However, these favourable attributes solely apply to the initial generation of cryptocurrencies, namely Bitcoin. Subsequent generations such as Monero and Zcash have been developed, which possess the capability to obfuscate the transaction chain through various means, rendering it untraceable.

Overall, the European Union (EU) encounters a dearth of regulatory measures in this domain. Anonymity and decentralization serve as impediments to facilitating effective regulation (*Teleki*, 2020).

The cryptocurrency market is additionally characterized by its illiquidity and extreme volatility. (*Wang et al.*, 2016; *Ciaian et al.*, 2018; *Corbet et al.*, 2019; *Gil-Alana et al.*, 2020; *Mba & Mwambi*, 2020; *Fang et al.*, 2021). The pronounced market volatility exposes investors to elevated risk levels, which may engender significant profits or substantial losses. Consequently, investors necessitate the requisite tools to effectively manage and incorporate these dynamic volatility dynamics. (*Mba et al.*, 2018; *Mba & Mwambi*, 2020).

Liu et al. (2022) results show that the cross-section of cryptocurrencies can be meaningfully analyzed using standard asset pricing tools. Moreover, a parsimonious three-factor model that can be constructed using the market information is successful in pricing the strategies in the cryptocurrency market.

Interestingly, the cryptocurrency market appeared as a risk management tool for the domestic and international investors of stock and commodity markets around the globe, particularly during the period of higher uncertain events (*Al Mamun et al.*, 2020; *Ariefianto*, 2020; *Bouri and Gupta*, 2019; *Cheema et al.*, 2020; *Colon et al.*, 2021; *Lucey et al.*, 2021; *Matkovskyy et al.*, 2020)

There are varying perspectives on the perception of bitcoin. With its increasing popularity, more investment funds are venturing into the development of crypto-

asset-based products, a financial activity that necessitates regulation. Consequently, it is likely that the freedom characterizing the cryptocurrency market will undergo changes in the near future. However, bitcoin mining represents a significant waste of energy (*Vranken*, 2017)

György Matolcsy, President of the Hungarian Central Bank, advocates for the prohibition of cryptocurrency mining and trading within the European Union (EU). This aligns with the viewpoint of the EU's primary financial regulator, who contends that is susceptible to numerous abuses, and its proliferation necessitates regulation. The prominent issue at hand is the substantial energy wastage associated with mining, a concern that the world has been endeavoring to mitigate for years due to climate protection reasons. In the midst of the ongoing energy crisis, mining exacerbates the situation. To alleviate the burden on the public, the government is temporarily reducing electricity prices, which can be exploited by bitcoin miners. In the absence of the cost of mining exceeding the value of bitcoin, the market itself cannot rectify this problem. Consequently, Matolcsy finds it entirely comprehensible to restrict or even ban such activities.

The Hungarian National Bank also states in its article that many individuals perceive cryptocurrencies as pyramid schemes, an issue that Matolcsy believes should be preempted to prevent potential economic problems and general social discontent resulting from individuals losing their money. Furthermore, he highlights two additional concerns: the absence of investor protection and the potential for criminals to exploit cryptocurrencies for extortion and money laundering purposes. For instance, criminals may demand bitcoins in exchange for the return of stolen data. Hence, regulating this market becomes crucial both in terms of energy consumption and in order to prevent individual and economic complications (*baon.hu*, 2022).

Géza Sebestyén's blog discusses the „Snapchats of the financial sector." In 2016-2021 years, numerous innovators, including bitcoin and thousands of other cryptocurrencies, have emerged within the financial market. Sebestyén identifies several issues associated with these innovations, such as fraudulence, unviability, and their limited suitability for large-scale financial transactions in urban settings. Moreover, he notes that during the time of the Crown Tax, anonymity, while considered a positive feature, tended to aid fraudsters. Sebestyén acknowledges one aspect of bitcoin that its proponents have rightly emphasized, namely its transfer speed. Indeed, cryptocurrencies have enabled faster money transfers compared to traditional monetary systems. However, traditional operators have incorporated this feature into their own systems. Hence, it can be inferred that central banks have responded to the challenges posed by virtual currencies (*Sebestyén*, 2021).

On the other hand, billionaire founder and chief investment officer of investment firm Miller Value Partners, Bill Miller regards bitcoin as „insurance against financial disaster", and has allocated 50% of his wealth to cryptocurrency. Miller believes that its decentralization represents its greatest advantage, safeguarding against hyperinflation and nationalization in unstable economies. In a podcast episode titled "Richer, Wiser, Happier" on May 24, 2021, Miller cited the collapse of the financial system in Afghanistan as an illustrative example. When the United States withdrew from Afghanistan in August 2021, it became impossible to

transact between the two countries using Western Union, while individuals with bitcoin retained the ability to send money globally. Miller contends that bitcoin can serve as effective insurance, citing its resilience during the initial stages of the pandemic when the Federal Reserve intervened and bailed out mortgage rates. He observed that bitcoin faced no issues during that period and experienced a significant increase in value as its owners recognized the impending inflation. In his view, it functions as an insurance policy (*kriptoworld*, 2022).

There are also differing views among researchers on the risk-weighted returns of investing in bitcoin. *Qin et al.* (2022) analyzed the impact of Bitcoin on stock portfolio's risk and return with Markowitz's investment theory and Monte Carlo simulation to find the optimal investment portfolio. Their results show that the return performance of the investment portfolio with Bitcoin is better than that of the traditional investment portfolio. *Henriques & Sadorsky* (2018) investigated the implications of replacing gold in an investment portfolio with bitcoin ("digital gold"). Their approach is to use several different multivariate GARCH models (dynamic conditional correlation (DCC), asymmetric DCC (ADCC), generalized orthogonal GARCH (GO-GARCH)) to estimate minimum variance equity portfolios. They find that it is possible for an investor to substitute bitcoin for gold in an investment portfolio and achieve a higher risk-adjusted return. This conclusion was reached by *Gangwal* (2017) too when analyzing the effects of adding Bitcoin to a portfolio (stocks, bonds, Baltic index, MXEF, gold, real estate and crude oil) from 2nd of July, 2010 to 2nd of August, 2016. He concludes that adding Bitcoin to a portfolio, over the course of the considered period, always yielded a higher Sharpe ratio. This means that Bitcoin's returns offset its high volatility. However, there has been significant volatility in the price of Bitcoin in 2016-2021 years and our research fills a gap in the relationship between Bitcoin returns and risk in the post-2016 period.

MATERIALS AND METHODS

Given the limited extent to which bitcoin can fulfill the functions of money, the subsequent chapter aims to derive conclusions about its potential as an investment through analysis. When evaluating an investment, solely examining the return on investment is inadequate as it fails to account for the associated risks. Various types of risks exist, including default risk, counterparty risk, and notably, exchange rate risk, which remains a constant concern for investors. Therefore, it is essential to consider this factor to obtain a clearer assessment of an investment. Given its substantial volatility, this study utilizes the Sharpe ratio and Sortino ratio to evaluate the performance of bitcoin as an investment vehicle.

The Sharpe ratio and Sortino ratio utilize stock price data from Yahoo Finance spanning from 01.01.2016 to 31.12.2021. We chose this period because crypto-market was much less developed before 2016, but post-2020 shocks could distort the results. The short-term stock market crash in 2020 significantly increased the global stock market risk (*Vancsura & Bareith*, 2023).

To calculate these ratios, daily returns were computed by taking the difference between daily closing prices. As a risk measure, the standard deviation of returns

was chosen, derived from the time series of daily returns for each year by dividing the average of daily returns by the standard deviation of daily returns. Furthermore, the returns were adjusted by the risk-free rate of return, achieved by subtracting the daily 0.0136% RWA+ return from the daily return. For the examined period, the risk-free rate of return was set at 4.95% per annum.

The Sharpe ratio assesses the risk associated with the achieved return. Its formula incorporates the risk-free rate of return, representing the excess return earned by the investment per unit of risk taken (*Sharpe*, 1994).

Calculation:

Sharpe ratio = (annualized return on investment asset - annualized risk-free rate of return) / standard deviation of return on investment asset

Example of use: Consider two investments, „A" and „B". We know that investment A has a return of 11% and investment B has a return of 16%. This obviously makes investment B the more attractive investment, but if we add that investment A had a spread of 3%, while investment B had a spread of 6% and the risk-free annual return was 2%, then if we plug the data into the Sharpe ratio formula, we get the following result.

- The Sharpe ratio of investment A is (11-2)/3= 3, so for 1% extra risk, we can get 3% extra return.
- Sharpe ratio of investment B: (16-2)/6= 2.33

This makes investment A the better choice.

An inherent limitation of this indicator is its assumption of a normal distribution of returns, penalizing positive-skewed price movements. To address this, investment funds such as hedge funds employing volatile exchange rates utilize the Sortino ratio, which exclusively considers the standard deviation of negative price movements.

The formula for the Sortino ratio is akin to the Sharpe ratio, incorporating the standard deviation attributable to price declines of the investment asset (*Sortino & Meer*, 1991).

Calculation:

Sortino ratio = (annualized return on investment asset - annualized return available without risk) / standard deviation of price decline of the investment asset

Example of use: „A" mutual fund return 16%, risk free return 3%, negative return, standard deviation 12%.

„Mutual fund B return 13%, risk free return 3%, variance 7%.

- The Sortino rate of investment A: (16-3)/12= 1.083, so 1% negative downside is associated with a return of 1.083%.
- Sortino rate for investment B: (13-3)/7= 1.428, i.e. 1% negative return associated with a return of 1.428% (*Sortino & Meer*, 1991)

Although past returns are not an accurate predictor of future expected returns, they provide investors with a point of reference for fund performance. The indicators mentioned above allow investors to consider the risks they are taking and provide an overview of the differences between portfolio managers.

RESULTS AND DISCUSSION

Bitcoin accounts for almost half of the market capitalisation of cryptocurrencies, which means that changes in its exchange rate have a significant impact on the exchange rate of other cryptocurrencies. To illustrate this, the correlation between bitcoin (btc) and three major cryptocurrencies (Ethereum = eth, ripple = xrp, litecoin = ltc) is shown in *Table 1*. As ethereum and ripple are newer cryptocurrencies, the reference period for the calculation of the correlation is 09.11.2017 to 31.12.2021.

Table 1: Correlation between bitcoin, ethereum, ripple and litecoin exchange rate movements from 09.11.2017 to 31.12.2017

	btc	eth	xrp	ltc
btc	1			
eth	0.919925	1		
xrp	0.556861	0.661923	1	
ltc	0.735614	0.723008	0.811749	1

Source: Based on Yahoo Finance data

The values show that the currencies under study show a positive, strong correlation with the price of bitcoin, especially in the case of ethereum, with a correlation value of 0.92, which indicates a close relationship in the fluctuations of the two cryptocurrencies' exchange rates.

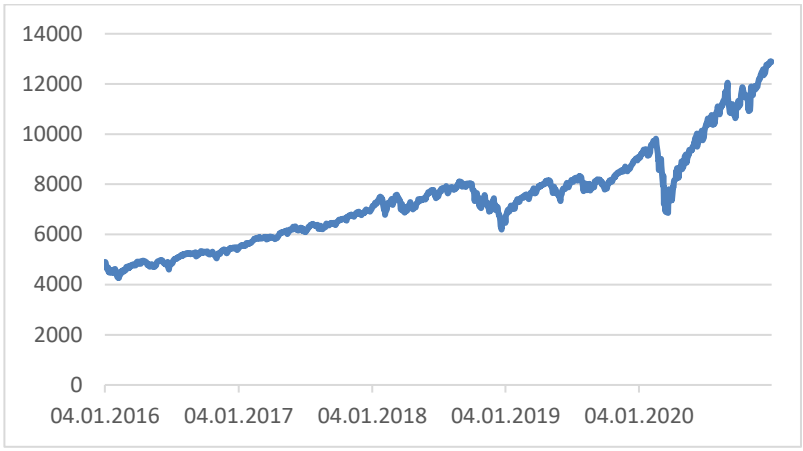
This dominant role makes it worth analysing the bitcoin exchange rate if you are interested in the cryptocurrency market over a given period.

In addition, the correlation with the stock market was examined and compared with the NASDAQ price, the evolution of which is illustrated in *Figure 1*.

The result was surprising, as the expected result was that bitcoin is a good alternative for portfolio diversification, but the correlation result of 0.62 shows the opposite, as the result shows that it falls along with the big tech companies' stocks due to a medium-strong correlation. So overall, bitcoin is becoming less and less of an alternative to stocks.

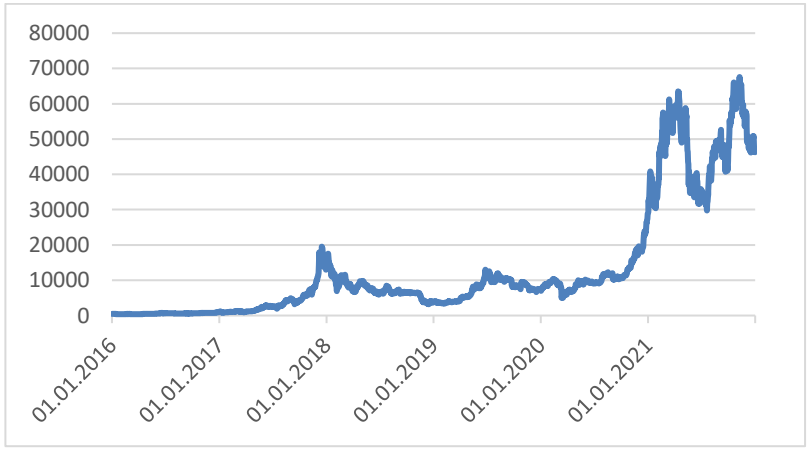
Figure 2 shows a simple line graph of the price movements over the reference period. An upward trend can be seen, with the daily value of bitcoin rising from $430 to $46 300 over the period, i.e. roughly 107 times. It should be borne in mind, however, that this extraordinary increase has been accompanied by extremely high volatility, i.e. extremely high risk. The graph shows that the growth in the value of bitcoin really took off at the end of 2020, when it went from USD 11 000 to USD 65 000. After that, the exchange rate started to fall sharply, but after hitting a low of around USD 30 000, the exchange rate started to rise again, reaching a value of over USD 65 000 again. The rise in 2020 is different from that of 2017, as in 2020 large corporate players (Grayscale, Tesla) have already increased their bitcoin buying base.

Figure 1: NASDAQ share price evolution (USD)



Source: Based on Yahoo Finance data

Figure 2: Bitcoin exchange rate evolution (USD)



Source: Based on Yahoo Finance data

The period from 31.08.2021 to 31.08.2022 is a good counterpoint to the growth period, as this is when the market is experiencing a big decline. From a value of almost $70 000, it has fallen to $20 000, which is shown in *Figure 3*. There are several reasons for this downward trend.

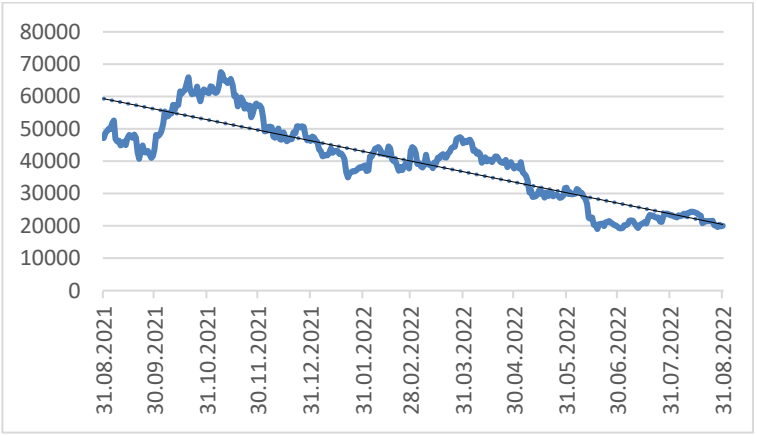
Firstly, the riots and protests that broke out in Kazakhstan did not help the bitcoin price. After China banned mining, many people settled here due to cheap electricity. However, the protests have restricted internet access, making the miners' activities unfeasible. This in turn is causing the bitcoin's exchange rate to fall.

On the other hand, the interest rate hike announced by the Federal Reserve has also had a negative impact on the exchange rate due to rising inflation. As bitcoin is

considered a risky form of investment, the interest rate hike has had a significant negative impact.

It was also impacted by the emergence of the omicron variant of the coronavirus, which introduced a significant uncertainty. There was no way of knowing what measures would be taken or what the impact would be on the global economy as a whole. In such situations, investor confidence is also shaken.

Figure 3: Bitcoin trend and exchange rate development (US dollar)



Source: Based on Yahoo Finance data

Its investment assessment may be based on a combined analysis of its profitability and risk profile. For this purpose, the study uses the exchange rate data from Yahoo Finance for the period 01.01.2016 to 31.12.2022.

Risk-free interest rates are provided by risk-free return investments. Examples include government bonds and treasury bills. A nominal value that protects the investor against expected inflation, thus providing a positive real return to the investor.

Although other risk-free investments with dynamically changing daily returns may be a realistic choice, we believe that the daily return of the government bonds MÁP+, which is available to Hungarian retail investors and is very popular during the period under review, is the best choice as a risk-free alternative.

The returns were then adjusted by the risk-free rate of return, whereby the daily return was adjusted by 0.0136% MÁP+ government bonds return per day. This was set at 4.95% per annum as the risk-free rate of return over the period under review. In this case, if we compare only the risk premium to the risk (standard deviation, since the standard deviation/risk of the government bond yield is 0) for the return, we have a Sharpe ratio of bitcoin of only 0.95, as shown in *Table 2*. So although there have been high returns over the period 2016-2021, it has a value below 1 based on the risk due to yield volatility, which means that it is not a good investment.

First, a daily return is defined as the difference between the daily closing prices. As a risk measure, the standard deviation of returns is chosen, which is obtained by using the time series of daily returns for each year by dividing the average of daily

returns by the standard deviation of daily returns. The Sharpe ratio is 1.02 for the entire period under consideration, which means that for a unit (one percent) of risk, we get almost exactly one unit of return premium.

Table 2: Sharpe ratio of Bitcoin 2016-2021

	Bitcoin daily average return	Bitcoin return standard deviation	Alternative yield 4,95%	Sortino	Sharpe adjusted for alternative yield
Total	0.0021	0.0399	0.000136	**1.02**	**0.95**
2016	0.0022	0.0253	0.000136	1.65	1.55
2017	0.0074	0.0493	0.000136	2.85	2.80
2018	-0.0036	0.0429	0.000136	-1.62	-1.68
2019	0.0018	0.0353	0.000136	0.97	0.89
2020	0.0038	0.0401	0.000136	1.82	1.75
2021	0.0013	0.0420	0.000136	0.58	0.52

Source: based on Yahoo Finance data

A value between 0 and 1: Indicates that, compared to a risk-free asset fund, the hedge fund under study can only generate less than one unit of return for every unit of risk taken.

A value between 1 and 2: The risk/return ratio is reversed, i.e. higher risk is associated with higher return.

Between 2 and 3: These are asset funds that promise at least two or more times the return for each unit of risk (*Sharpe*, 1994).

The Sortino indicator is more suitable for testing assets that have high volatility. As can be seen in *Table 3*, it achieves better values than the Sharpe ratio presented above. The reason for this is that the Sortino ratio does not take into account the variance due to positive volatility. In this case, the result is that since we have not defined volatility as a risk, but only exchange rate movements, it is worth buying bitcoins, as the Sortino rate will be high.

Table 3: Bitcoin Sortino rate 2016-2021

	Bitcoin daily average return	Bitcoin return standard deviation*	Alternative yield 4,95%	Sortino	Sortino adjusted for alternative yield
Total	0.0021	0.0326	0.000136	**1.25**	**1.168**
2016	0.0022	0.0224	0.000136	1.86	1.743
2017	0.0074	0.0365	0.000136	3.85	3.780
2018	-0.0036	0.0339	0.000136	-2.05	-2.129
2019	0.0018	0.0256	0.000136	1.34	1.234
2020	0.0038	0.0407	0.000136	1.79	1.724
2021	0.0013	0.0287	0.000136	0.85	0.763

* only due to negative volatility

Source: Based on Yahoo Finance data

The results show that it was mostly worth investing in bitcoin in 2017, with those who invested in this year making big gains. Conversely, the same cannot be said for those who entered in 2018, as we can see that both rates were negative. The year 2021 was not the year of bitcoin either, as both the Sharpe and Sortino ratios were below 1, which makes it a bad investment, and the Sharpe ratio also shows that the same can be said for 2019, although it is only slightly below 0.97. In 2016, 2019 and 2020, it scored between 1 and 2, meaning that higher risk was associated with higher returns.

It can also be seen from the results that bitcoin is a very hectic investment, but those who were risk takers and got in at the right time profited from it, as opposed to those who chose the wrong time to buy.

CONCLUSIONS

Analyzing and researching the risk associated with cryptocurrencies is of paramount importance for several reasons. For individuals and institutional investors, cryptocurrencies represent an increasingly attractive investment option. Understanding the risks allows investors to make informed decisions about allocating their capital. Without adequate analysis, investors may be unaware of the potential downsides and might face unexpected financial losses. By identifying and assessing risks, investors can implement strategies to mitigate them. Failing to research and understand the legal and regulatory risks can result in non-compliance, legal issues, and potential financial penalties. Staying informed about regulatory changes is crucial for cryptocurrency businesses and users. Cryptocurrency markets are notoriously volatile. In-depth analysis can help investors anticipate and respond to market fluctuations. This knowledge can be especially valuable when making trading decisions, as timing can significantly impact profitability.

As the world becomes more uncertain, the more important it becomes to have a stable store of value, traditionally gold. Many people refer to bitcoin as digital gold. However, it is difficult to verify this claim on the basis of the period under review (2016-2021). Although it has risen significantly, it has a very high volatility, as the results show. It is therefore a significant risk to take if you choose this investment alternative. It can be seen that there have been some outlier years, such as 2017, when a very good return was achieved, but the opposite happened in the following year, when both the Sharpe ratio and the Sortino ratio turned negative.

It also moved with the price of risky tech stocks, as shown by the NASDAQ correlation of 0.62. This is significant because when risk aversion appears in the market, the share price weakens, while gold rises on historical data. And over the past year, we can see that the price of bitcoin has fallen significantly during the period of crisis.

It is advisable to gather information from as many sources as possible to make the right decision. All in all, the future of the cryptocurrency market is full of uncertainties. The year 2021 was not the year of bitcoin either, as both the Sharpe and Sortino ratios were below 1, which makes it a bad investment, and the Sharpe ratio also shows that the same can be said for 2019, although it is only slightly

below 0.97. In 2016, 2019 and 2020, it scored between 1 and 2, meaning that higher risk was associated with higher returns.

It can also be seen from the results that bitcoin is a very hectic investment, but those who are risk takers and got in at the right time could profit from it, as opposed to those who chose the wrong time to buy. Based on our results, there were years between 2016-2021 when bitcoin was a good investment, but in most cases its returns were associated with excessive volatility and risk. For this reason, it is not recommended for risk-averse rational investors.

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INVESTIGATING PROFIT PERSISTENCE AMONG HUNGARIAN PLASTIC MANUFACTURING COMPANIES

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ABSTRACT

This study examines the competitive nature of the Hungarian plastics industry sector based on 2010-2019 data from the Crefoport database.. The aim of the study is to examine that how close the market of plastic industry companies is to perfect competition. Market efficiency was investigated using a Markov chain and profit persistence estimation (Arellano & Bond, 1991). Corporate profitability was measured using the ROA indicator. Variables reflecting industry and market effects are also included in the analysis as controls. Based on the Markov transition probability matrix, market competition is harmed. Based on the panel model estimation, the profit persistence value shows a low value (0.129) compared to the existing literature. The profitability of plastic companies can be statistically proven to be affected by company size (p=-0.046), short (p=0.016) and long risk (p=-0.093), and the volatility of profitability (p=0.633). Among the exogenous variables, industry income (p=0.081) and market concentration (p=0.974) have a significant effect on the profitability of companies. Limited market competition reduces overall social benefit and efficiency in several ways: it reduces price competition, quality orientation, and the pursuit of innovations. Therefore, from the point of view of economic policy , it is definitely justified that the sector receives subsidies in an appropriate amount that improves the efficiency and productivity of small and medium-sized enterprises, as well as encourage technological development and innovation.
Keywords: market competition, profitability, dynamic panel, Markov chains

INTRODUCTION

One of the foundations of economics is that, in the case of perfect competition, no company can realize a profit above the market average in the long run. If, however, we find that a significant proportion of companies are able to achieve (abnormal) profits higher than the market average in the long term, then market competition is harmed, thereby reducing the consumer surplus (and, with it, the overall social benefit). In a short time, even in the case of perfect competition, it is possible to achieve an abnormal profit, but in the long term, thanks to competition, prices adjust to the market norm. The "perfection" of market competition, i.e. its efficiency, can be measured by profit persistence, which shows how quickly profit realizing

abnormal profits converge (return) to the equilibrium level, i.e. how fast the correction is. Since the 1970s, scholars working in the fields of economics and strategic management have conducted extensive research on profit persistence (*Mueller,* 1977*; Roquebert et al.* 1996*; McGahan & Porter,* 2003*; Gschwandtner,* 2005, 2012; *Gschwandtner & Hirsch,* 2017*; Sanderson et al.* 2018*; Hirsch et al.* 2020), which form the backbone of the theoretical background of our research.

Due to its nature, market efficiency and profit persistence can be analysed at the meso level for a specific industry. In this case, our choice fell on the plastics industry, which is also significant from an economic and sustainability point of view. The world's plastic production has grown continuously over the past seventy years. The amount of plastic produced in the 1950s increased from 1.5 million tons to 367 million tons by 2020 (*Plastics Europe,* 2021).

This global growth is, of course, not evenly distributed worldwide. Therefore, the availability of plastic-containing products has increased, the commercial drivers being durability, cost-effectiveness, versatility, flexibility and long lifetime (*Brahney et al.* 2020*; MacArthur,* 2017). Plastics are used in many fields, including construction, transportation, packaging, electronics, automotive or agriculture (*Plastics Europe,* 2021*; Wang et al.* 2019). While the social benefits of using plastics are extensive and inexhaustibly applicable (*Andrady & Neal,* 2009), plastics as commodities are the subject of increasing environ-mental concerns (*Cole et al.* 2011). Thanks to this, the sector has undergone significant changes recently. Companies invest significant capital, development and expertise to sustainably achieve their 2050 net zero emissions and circular economy goals. With their investments, they intend to develop their technological base, which provides innovative solutions to answer questions such as the problem of plastic waste and climate change (*Lehoczki,* 2020).

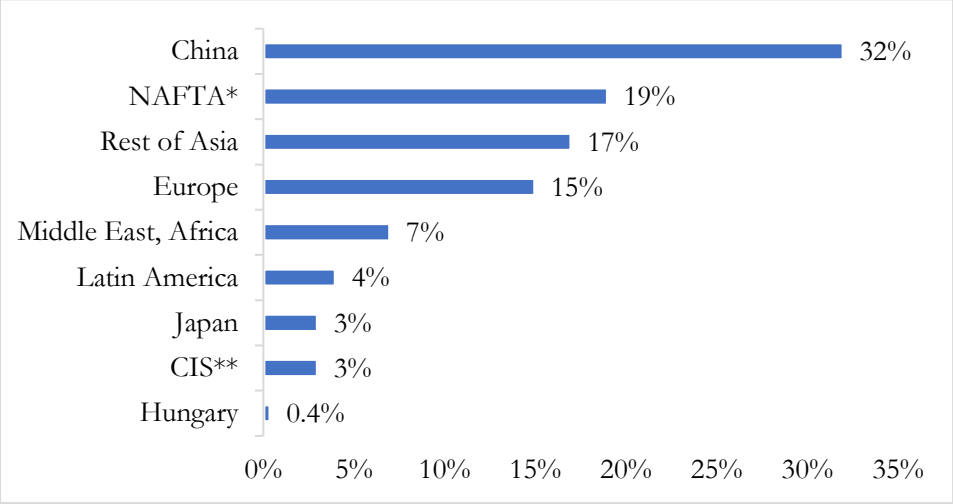
Figure 1 clearly illustrates that Asia is the world's major power of plastics production. It accounts for 50% of the total volume. Among the economic entities, China is at the forefront, covering 32% of the entire portfolio internationally. With its production of 55.5 million tons, Europe ranks fourth in the ranking. The figure also shows Hungary, which is in the focus of our study, where the production volume of the plastics industry was 1.6 million tons, which covers 3% of European production.

It is essential to highlight that European plastic production differs slightly from global trends (*Figure 2*). In the four years before the coronavirus, European production decreased. Germany is at the top of European plastic production, and Romania is at the bottom of the ranking. According to 2020 data, the six largest European countries (Germany, Italy, France, Poland, Spain, and England) cover 70% of market demand. Regarding the industrial use of plastics, the packaging and construction industry represents the largest end-user markets, with the two sectors representing 60% of the total European volume (*Plastics Europe,* 2021).

From Hungary's internal economic performance point of view, the plastics industry is also of considerable importance. Hungary's manufacturing industry contributes around 20-21% to the GDP. This value is higher than the European Union average. The production of rubber, plastic and non-metallic mineral products is one of the defining branches of the domestic manufacturing industry, contributing

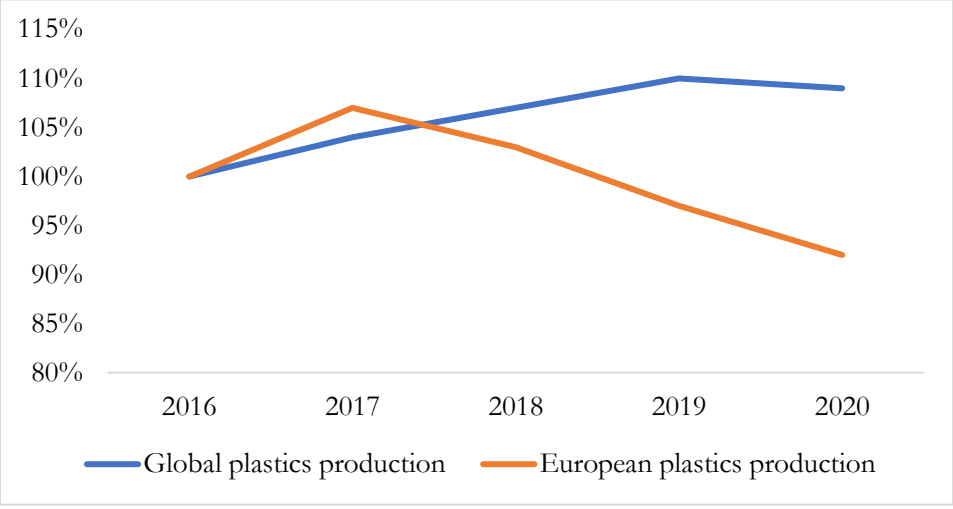
an average of 9% to the production value of the manufacturing industry in the last ten years, which also exceeds the EU average (*KSH*, 2021b). The Hungarian volume index increased between 2016 and 2019, but the pandemic broke this growth and even caused a downturn in the sector's output (*Figure 3*).

Figure 1: Territorial distribution of global plastics production by production volume (2016-2020)



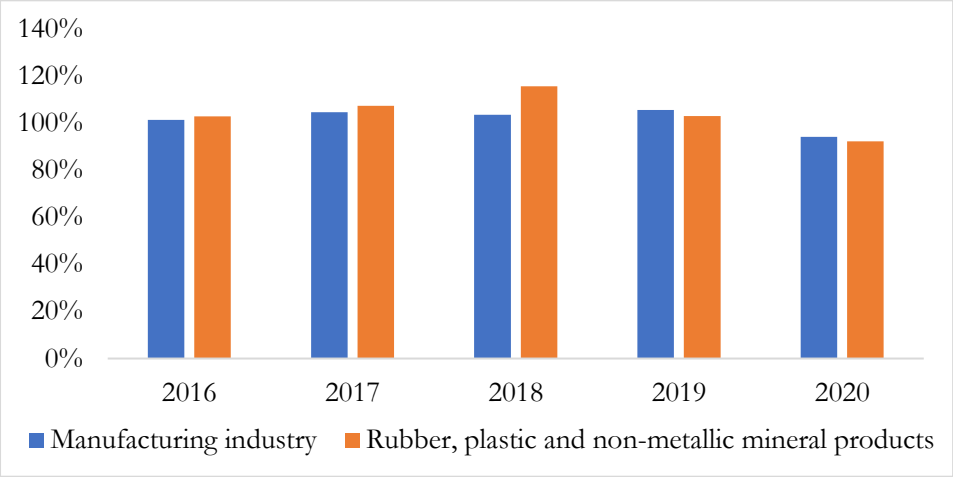
Source: Based on *Plastics Europe* (2021)
(* North American Free Trade Agreement, ** Commonwealth of Independent States)

Figure 2: Development of global and European plastics production [not including the production of recycled plastics] (2016-2020)



Source: Based on *Plastics Europe* (2021).

Figure 3: Volume indices of the sales of the manufacturing industry and the production of rubber, plastic and non-metallic mineral products [the previous year = 100.0%] (2016-2020)



Source: *KSH*, 2022

Nothing shows the importance of the sector better than the fact that at domestic level, the fourth largest activity of the manufacturing industry is the plastic production. At the same time, among the EU27 countries, in terms of the industry's share of the country's gross added value, Hungary ranks fourth, therefore taking all this into account, it is worth conducting in-depth research on the sector itself (*KSH*, 2021a). As a Hungarian case study, our research can be the first to contribute to a better understanding of the competition within the EU plastics industry and explore the nature of sectoral efficiency and profitability. Our research can convey additional information to our knowledge about profit persistence while also leading to valuable recommendations from a sectoral development point of view.

Theoretical background

During the analysis of profit persistence, we determine how long companies are able to maintain profits above the equilibrium level (abnormal profit), i.e. how quickly they return to the equilibrium level, which we call correction. The higher the value of profit persistence, the farther the market is from perfect competition, and thus the correction process is slower. The methodological basis of profit persistence studies is the estimation of the auto-regressive (AR) process, through which we measure the extent to which the profit rate in period t depends on the profit of the previous period(s). The tests can be carried out at the plant or industry level, and accordingly, the results are prepared using time series models or panel models. Abnormal profit was first studied in an article by *Dennis C. Mueller* (1977), and later he first used an autoregressive model to study profit persistence (*Mueller,* 1986). Recently, studies with panel models have been in the foreground, with more modern estimation procedures available (*Hirsch,* 2017; *Iskenderoglu & Haykir*, 2018).

The results of *Mueller's* (1977) study are consistent with *Shepherd's* (1975) findings that corporate profit rates are related to market shares. The author argued that high market shares are relatively stable over time. *McGahan & Porter* (1999) used data from a sample of US firms to examine the persistence of incremental industry, firm-parent, and store-specific effects on profitability. The authors conclude that the incremental effects on industry profitability last longer than the growth effects of the corporate parent and the specific line of business. Changes in industry structure affect profitability more permanently than changes in company structure. In their 2003 research, the authors also found that the industry and company-parent company effects of well-performing companies are more sustainable than their business-specific advantages. *Schumacher & Boland* (2005) conducted an in-depth study of companies' profitability in different food industry sectors. Their findings show that profits are more persistent within an industry than within any specific company. *Chen & Lin* (2010) investigated the profit persistence of the IT industry in Taiwan, concluding that the effect of companies on profitability lasts longer than the effect of the industry. A major shortcoming of the profit persistence literature is that it only considers surviving firms. In his study, *Gschwandtner* (2005) uses a unique database to examine the persistence of profits to examine surviving and bankrupt companies. The results for survivors are consistent with the existing literature: profits converge on average to the market norm, but profit stickiness is also significant. The results show that the competition between exiters is higher (lower profit persistence) than the survivors. However, there are also companies among them that do not fully converge to the market norm. Recent developments in econometrics are discussed by *Goddard et al.* (2005) and used to examine the determinants of profitability for manufacturing and service sector firms in Belgium, France, Italy and the United Kingdom. The study synthesizes the empirical models researchers use in industrial economics, strategic management, accounting, and finance. Despite the formation of the single goods and services market of the European Union, the above-average profit continues to be significantly maintained year after year. Overall, the structural time series analysis (STS) detected a more frequent occurrence of profit persistence: nearly 70% of the companies did not converge to zero, compared to barely half of the AR1 estimate. STS outperformed AR1 in predictive performance comparisons regarding prediction error rates at conventional significance levels. In his research, *Resende* (2006) examined the profit persistence of Brazilian industrial companies over a relatively short period. The obtained results show that the existence of the unit root is mostly preferred for the two different profitability measures. Therefore, extremely durable profits can still be observed despite the apparently more competitive environment of the Brazilian economy. *Guan et al.* (2015) analyse and compare industry and company effects on profitability using a sample of Chinese machinery manufacturing companies listed on the Shanghai and Shenzhen stock markets. The results show that company effects persist longer than industry effects, thus supporting the hypotheses of the resource-based approach. Studies in this area have used different research subjects, backgrounds, study periods, and profit-sharing criteria, contributing to differences in research findings. *Tsoulfidis et al.* (2015), in their study, test the classical hypothesis

of whether the profit rate between industries tends to approach the average profit rate of the economy. Their research applied individual and panel unit root tests to a sample of 52 Japanese manufacturing industries from 1974–2008. In the study, two different estimation methods of profitability were used, a standard based on the average capital associated with AROP (Average rate of profit) and a new standard based on regulatory capital associated with IROP (Incremental rate of profit) - in a certain sense marginal capital. The authors concluded that the two profitability measures are uncorrelated and move in an intertwined manner. The main difference is that IROP exhibits a much larger oscillatory behaviour, crossing the zero line multiple times. *Zeren & Öztürk* (2015) analysed whether the profits of these companies are sustainable or not by using the return on assets (ROA) and return on equity (ROE) indicators of the manufacturing companies listed on the Istanbul Stock Exchange, for which the Hadri-Kurozumi panel unit root test was applied. As a result of their research, they determined that profit is x permanent in sectors operating in manufacturing areas such as paper, packaging, and printing, as well as stone, soil, and cement. However, they experienced the opposite effect in chemistry, petroleum, plastic, metal industry machinery, major metal, and the clothing sector. *Puziak* (2017) examined the persistence of Polish manufacturing companies' abnormal profit (the part above average profit). He investigated profit persistence using a dynamic panel model with generalized moment estimates (GMM). He applied the method to a panel database of 5 303 Polish manufacturing companies between 2006 and 2014. Puziak was able to draw three main conclusions: within the same industry, there are significant differences between profit rates at the division level, the estimated persistence of ab-normal profit coefficients is at a moderate level, and there are significant differences between the estimated persistence of profit coefficients of businesses operating in the same industry. In their research, *Isik & Tasgin* (2017) empirically analysed the factors determining the profitability of 120 manufacturing companies listed on the Borsa Istanbul Stock Exchange from 2005-2012. The estimates from the dynamic panel model, which considers the endogeneity of variables, show that lagged profitability, company size, financial risk, R&D costs, net working capital and economic growth are the most important variables affecting the company's profitability. Specifically, profit persistence (past, company size, net working capital, and economic growth positively and significantly affect profitability. On the other hand, R&D costs and financial risks reduce profitability. In their exploratory study, *Gschwandtner & Hirsch* (2017) used GMM estimation to analyse the factors affecting the profitability of the American and European manufacturing industries. The results show that, in the examined period, the food industry produced lower profit persistence than the other processing industry sectors. Company-specific drivers of profitability are company size and financial risk. Regarding industry characteristics, industry concentration and growth rate significantly affect profitability. In addition, the results provide insight into the management of food processing companies in the United States and Europe, which aims to increase their competitiveness. *Sanderson et al.* (2018) investigated the profit persistence of the Zimbabwean banking industry. The study revealed that profitability is not permanent. That is, banks realize abnormal profits over the years.

The results also show that market power, cost efficiency, credit and liquidity risk and the size of banks significantly affect profitability. Furthermore, the results conclude thatthe ' profitability of banks is determined by the strategies used by the bank management.

Considering the number of foreign publications dealing with profit persistence, the profitability of the domestic plastics industry has not been researched before, so in our study, we would like to fill this gap by examining the Hungarian economy. Based on the above, our research aims to examine the competitiveness and profitability of the Hungarian plastics industry through profit persistence.

MATERIALS AND METHODS

The research examines market efficiency through the profitability of Hungarian plastic manufacturing companies. In the definition of the plastics industry sector, we considered companies that, based on TEÁOR, belong to the plastic product manufacturing (222) classification. A unique feature of the study is that no profit persistence study has yet been prepared for domestic plastic companies.

When examining profit persistence, the generally accepted profitability measure is the return on assets (ROA). To measure profit persistence, we use the *Blundell & Bond* (1998) dynamic panel model, during which the company's profit (ROA) is explained by the profit of the previous period, taking into account the company. These macroeconomic and regional factors are considered a novelty in this topic.

The Crefoport Scholar[1] database provides the data required for the analysis. The MATE Kaposvár Campus has a subscription to the database.

Profit persistence studies are often based on some econometric estimation, and profit is measured by a continuous variable (usually ROA). However, the Markov chain (following *Stephan & Tsapin,* 2008) used in this research approaches the measurement from another point of view, with the help of which it is possible to examine how likely a company is to be transferred to a more profitable or less profitable group. The Markov chain is an appropriate starting point, and based on the obtained results, expectations regarding the competition dynamics can also be derived. Profit (ROA) was divided into groups of five or ten equal elements based on the size of the examined sample and sorted according to profitability. The groups were defined from 1 to (5) 10, where 1 is the least profitable and (5) 10 is the group of companies with the highest profitability. The purpose of the breakdown into 10 profitability groups is to check the robustness of our results. In terms of profit persistence, the values in the diagonal are relevant. The closer these values are to 1, the higher the profit persistence, from which we can conclude that the profits of companies are "sticky". That is, they cannot move from their current profitability group.

The dynamic panel model will give a more accurate picture than the Markov chain analysis (*Hirsch,* 2017) thanks to the time invariance and controllability of the different effects. In our case, we used relevant variables (*Gschwandtner and Hirsch*, 2017*; Puziak*, 2017; *Isik & Tasgin*, 2017) such as sales revenue, short (current assets

[1] www.crefoport.hu

divided by short-term liabilities) and long-term risk (proportion of long-term liabilities within re-sources), export activity (value 1 if the company has export revenue in the given year, otherwise 0), market share based on sales revenue, industry revenue, market share of top 10 companies, and the 3-year rolling ROA standard deviation, which we assume have an impact on profitability.

Table 1 contains the descriptive statistics of the variables. based on which the average ROA was 0.116 in the examined period. In case of the sales revenue, the median value was 18.693. Furthermore, the short risk shows even higher average value than long risk. The median long risk is about 0, i.e. slightly more than half of the companies have long-term liabilities. Regarding export dummy variable, the median value is 0, based on the average, 19.2% of companies also produce for export. In terms of industry revenue, there was no significant increase during the period under examination. Market share resulted the lowest mean value, and at the same time the share of the top 10 companies became significantly higher. Finally, the ROA_sd3 variable resulted 0.117 average value.

Table 1: Descriptive statistics of the variables

Variable	N	Mean	p50	SD	Min	Max
ROA	8469	0.116	0.060	0.231	-0.383	1.360
ln_sales_revenue	8472	18.776	18.693	2.182	7.601	25.859
short_risk	8462	0.778	0.537	1.017	0.002	7.395
long_risk	8469	0.092	0.004	0.163	0	0.874
export_dummy	8472	0.192	0	0.394	0	1
ln_industry_revenue	8472	27.469	27.486	0.279	27.006	27.926
market_share	8472	0.001	0	0.006	0	0.141
top10_share	8472	0.349	0.343	0.020	0.326	0.393
ROA_sd3	7765	0.117	0.058	0.188	0.001	1.279

RESULTS AND DISCUSSION

Table 2 contains the transition probability matrices estimated for the five profitability categories.

Table 2: Transition probability matrix (five profitability categories)

ROA	(1)	(2)	(3)	(4)	(5)	Pi
(1)	**48,48**	19,84	12,49	7,65	11,54	100
(2)	19,15	**40,89**	19,58	11,24	9,14	100
(3)	12,52	19,78	**34,23**	20,42	13,04	100
(4)	6,46	9,53	20,30	**41,45**	22,26	100
(5)	6,87	7,31	12,81	22,94	**50,07**	100
Pj	19,45	19,95	19,93	20,35	20,31	100

Source: Based on *STATA* results

The higher the probabilities in the crossover, the greater the profit persistence. In the case of the database divided into five income groups, the diagonal values are between 34 and 50%. In the case of perfect competition, these values would be around 20%, so in our case, a strong profit persistence can be observed among Hungarian plastic manufacturing companies, which indicates that previous years' performance has spillover effects for the current year. It can be observed that the probabilities are the highest for groups (1) and (5). In the case of poorly performing companies, there is a high probability that they will not be able to enter a more profitable group. In contrast, well-performing companies have a good chance of remaining in the more profitable group. Profit stickiness appears among the examined companies, i.e. the current year's profit is also determined by the previous year's profit. The profit rates are not independent of each other. Markov chain results suggest that the market is not perfect, and it results provide indirect evidence of distortion of market competition.

Table 3 shows the estimation results of the dynamic panel models of the Hungarian plastics industry sector. Based on the panel model estimation, the profit persistence value is low (0.129) compared to the values measured in similar international research (*Isik & Tasgin,* 2017; *Pervan et al.* 2019; *Isık et al.*, 2017). Contrary to our expectations, in-creasing sales revenue reduces profitability. An increase in short risk (which is essentially a liquidity indicator) increases that company's profit rate. Here, it is worth mentioning the study by *Borszéki* (2008), according to whom the increase in trade payables does not mean an improvement in the market financing position but rather the presence of debt chains, which is a sign of a sector problem. On the other hand, in the analysed industry, the opposite appears to be the case: an increase in the liquidity position increases profitability. The long-term risk reduces profitability, based on which the cost of attracting foreign capital exceeds the benefits of the development. As a result, the sector's prospects deteriorate significantly in the medium to long term. This can lead to the postponement or non-implementation of significant investments. The coefficients of the export dummy and the market share variables did not become significant. That is, the export activity of the companies, as well as the position within the industry, basically do not affect the profit relative to assets. The 3-year rolling ROA standard deviation is significant, which means if companies take on more risk, it positively affects profitability. This confirms the basic assumption of classic economics about the direction of the relationship between returns and risks. The industry sales revenue and the market share of the top 10 companies should be analysed together. Based on the results, the industry sales revenue increases the profitability of the companies, which at first contradicts what was learned from microeconomics since, in a growing market, the competition also increases, and it is more difficult to achieve an outstanding profit. This effect is complemented by the effect of the share of the top 10 companies, based on which profitability decreases as market con-centration increases. Growing industry revenues increase profitability if the companies' market share does not change significantly, i.e. everyone can grow - approximately - equally.

Table 3: Results of the dynamic panel estimation

Variables	ROA	
L.ROA	0.129***	(0.036)
ln_sales_revenue	-0.046***	(0.010)
short_risk	0.016**	(0.007)
long_risk	-0.093**	(0.041)
export_dummy	0.017	(0.021)
market_share	0.974	(1.484)
ROA_sd3	0.633***	(0.057)
ln_industry_revenue	0.081***	(0.014)
top10_share	-0.693***	(0.164)
Constant	-1.106***	(0.357)
Observations	7.752	
Number of IDs	706	
AR(2) p-value	0.059	

Note: Standard errors are in parentheses; *** p<0.01; **p<0.05; *p<0.1

CONCLUSION

The plastics industry underwent significant changes during the examined period. Based on the investigation, it can be said that profit persistence is significant in the plastics industry. This phenomenon can undermine but limits the efficiency-enhancing effect of market competition. Based on the Markov chain analysis we found emipirical evidencies that the least profitable companies find developing challenging, while companies with high profits can easily maintain their position. In such a market environment, it is easier for larger companies to maintain their market position, and it is more difficult for new competitors to enter the market.

Based on the dynamic panel model, it can be said that the profitability of plastic manufacturing companies can be statistically proven to be influenced by company size (sales), short and long risk, and the volatility of profitability. Among the exogenous variables, industry income and market concentration significantly affect companies' profitability. It also gives companies with smaller sizes or profitability less chance to improve their position with adequate market performance.

From the point of view of the sector, the decrease in income caused by long-term indebtedness is a significant limitation. In such an environment, the investments will not pay off. The lack of investments will put these companies at a competitive disadvantage in the international market, increasing their exit from the sector and limiting their entry. These processes worsen market competition and result in competitive takeovers and incapacitation, which cause damage to the level of society as a whole.

To sum up, our results confirm limited competition in the investigated market. .According to the basic principles of economics, limited market competition reduces overall social benefit and efficiency in several ways: it reduces price competition, quality orientation, and the pursuit of innovations.

Taking an economic perspective, it may be beneficial to implement public interventions that improve the market efficiency of the plastics industry without disrupting competition. These interventions can comprise subsidies for investments in productivity and efficiency for small and medium-sized enterprises, as well as financial support programs that promote technological advancements and innovation in the industry.

A further policy implementation of our results could be public intervention to reduce market concentration. It is advisable to support new entrants or existing small-scale firms with high growth potential, through tax incentives or targeted investment credits to increase production capacity. The latter should be complemented by green financing schemes, given the high environmental impact of the industry.

The investment credit schemes proposed here should be complemented by an appropriate security rating system, as long-term indebtedness is already a competitiveness problem in the group of companies under study. The development of such a complex rating and credit system could be the subject of a future research project.

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SPATIAL ANALYSIS OF GAME DAMAGE IN THE SETTLEMENT OF CSERÉNFA AT THE KAPOSVÁR FORESTRY OF SEFAG

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ABSTRACT

Reducing game damage is the essential interest of both farmers and hunters. A former paper on statistical analysis of game damage is complemented with spatial analysis in the recent paper. Authors examined the forest cover at Kaposvár Forestry of SEFAG, and also the location, the topography, the land cover of Cserénfa, and their relationship with the location of the game damage events. The maps clearly show that in the forested, hilly Zselic landscape, the island-like agricultural areas are inherently exposed to game damage. Only 3.77% of the total area of the Kaposvár Forestry is located further than 300 m distance of the forest, in Cserénfa, this is only 1.59%. Considering the topography of Cserénfa, it was found that only 39% of the agricultural area has a slope of less than 5%. Due to the steep slopes and the exposure to game damage, an alternative form of farming is proposed.

Keywords: forest covering, edge effect, topography, Zselic, game damage reduction

INTRODUCTION

Game damage is one of the biggest problems in agriculture. The legal regulation and the level of compensation vary from country to country (*Bleier*, 2014). In Hungary, the Act on the Protection of Game, Game Management and Hunting of 1996 (Act LV of 1996) sets the rules for the prevention of and compensation for game damage.

Preventing and mitigating game damage is in the interest and responsibility of both farmers and hunting clubs. Farmers use various methods to prevent their fields from wild game damage: fencing, guarding, electric fencing, ultrasonic alarms, or game alarms. Game alarms, although expensive, provide effective protection (*Kovács et al.*, 2014). Hunters can protect against game damage by alarms, prevention hunting, or by cultivating game land.

Managing nearly 80 000 hectares of forest, SEFAG is the largest wildlife management company in County Somogy. *Király et al.* (2020) analysed game damage at Kaposvár Forestry of SEFAG. The research covered the period from 1998 to 2017. The basic data came from the data of hand-recorded game damage information, which was later recorded on a computer. The dataset was then subjected to statistical tests.

The records contain the name of the settlement affected by game damage, the species of wildlife causing the damage, the amount of compensation, and the topographical lot number as a parcel identification. Unfortunately, we had found a large number of missing data and inaccuracies in the records.

In the examined period, most of the game damage and the largest amount paid out were also connected to Cserénfa. In the period under study, the highest number of incidents of game damage occurred in Cserénfa, and the amount paid out was also the largest here in the examined period. The settlement is located in the Zselic, so it is characterized by a variety of topography. Farming can be done most effectively on flat or low-sloping areas, where the risk of erosion is low. In Cserénfa, only one fifth of the total area, approximately 1,775 hectares is under agricultural use. In the small amount of arable crop land, another disadvantageous factor is the risk of significant game damage.

As a supplement to the previous statistical analysis, we analysed game damage by using GIS methods.

LOCATION OF GAME DAMAGE

Among several other data the records contain the name of the settlement affected by game damage, the species of wildlife that caused the damage, and the amount of compensation. The area affected by the damage could be identified on the basis of the topographical lot number. Unfortunately, the lot number was missing in many cases. Furthermore, in the case of garden plots, often only 'GP' was recorded.

Several topographical lot numbers are divided into up to 20 subsections (e.g., 029/1 – 29/20), but in the protocol only the single summary number (029) is included. In the case of such fragmented areas, it is likely that game damage occurs in several parts, but it is not possible to decide which parts.

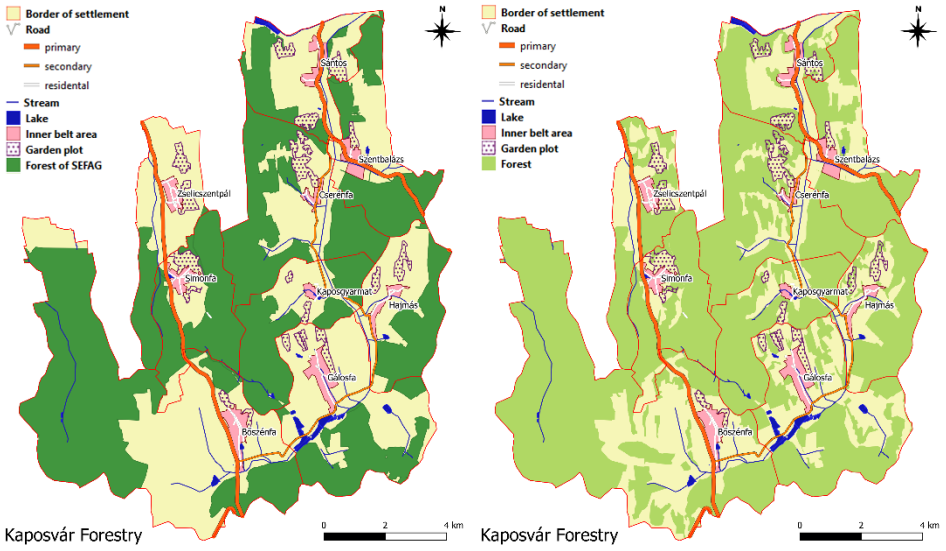
In order to solve the above mentioned problems, i.e., the missing topographical lot number in the inner belt area for the registered game damage, we took the location of the damage to be in the central part of the inner belt area, in this way, we „placed" the location of the damage into an area not affected by game damage in the middle of the garden plots. For fragmented areas, we used two methods, in one case all sub-parts were designated as damage sites, and in the other case only one. Whatever the case may be, this naturally distorted reality.

Agricultural game damage is most likely to occur in fields close to forests. *Barna et al.* (2007) say that wild animals do most of the damage within a distance of 300 metres from the forest. In addition, settlements also have the effect of attracting game damage, the number and amount of reported game damage is greater on the lots close to the inner belt areas (<300 m). Forests and settlements have an edge effect.

The research area is located in Zselic, so it is typically covered with forest. The largest forest manager is SEFAG, but there are also private forests, either individually or communally owned. SEFAG provided us with a map of the area it manages. Other forests could be identified from satellite images, but due to the size of the area, this would be a lot of work. Instead, the former FÖMI (today Lechner Knowledge

Center) prepared the improved land cover map called CLC-50 from the Corine Land Cover database created by the European Union. The forests were selected from the CLC database in the research area. *Figure 1* shows the area of the SEFAG forests in the study area and the forests on the CLC-50 map. Of course, there is a lot of overlapping between the two.

Figure 1: Forest areas of SEFAG (left) and the forest areas of CLC-50 (right)



The total forest area accounts for 65% of the outer belt area of the settlements (*Table 1*). Adding the inland areas and the area of the lakes to this number, we get nearly 70% of the total area, which is covered by forest and therefore not suitable for agricultural cultivation.

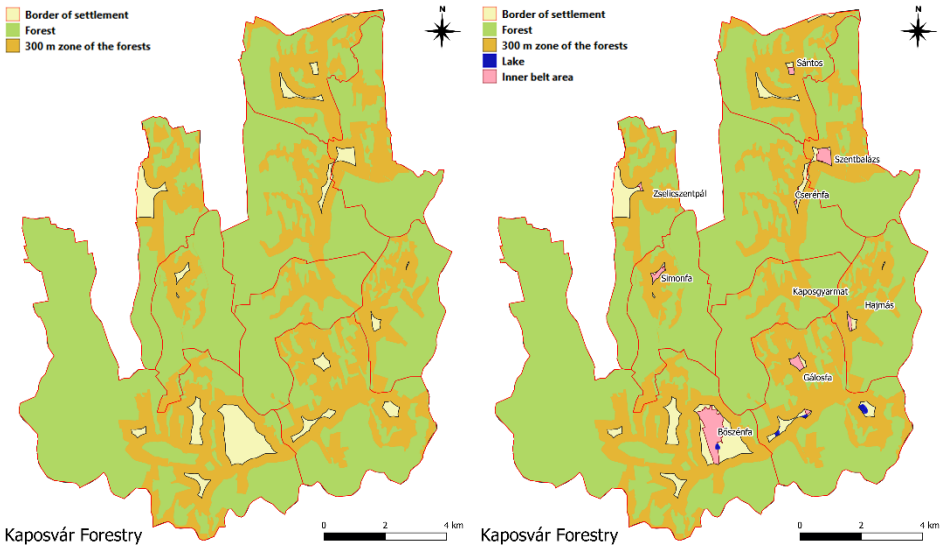
Table 1: Territorial distribution of settlements

	Area (ha)	%
Total area	14749.28	100.00%
Including:		
Forest	9660.20	65.50%
Inner belt area	519.91	3.52%
Lakes	72.86	0.49%
Total:	10252.97	69.52%

Due to the edge effect, areas close to forests are the most exposed to the risk of game damage, so it is advisable to consider whether it would be worthwhile to switch to some other cultivation practice there, for example, agroforestry solutions can be

recommended. *Figure 2* clearly shows that adding the 300-meter edge zones to the forest areas almost closes the open-field agricultural areas due to territorial characteristics. If we take out the inner belt areas and fishponds from the remaining parts, there is hardly any part left suitable for agriculture.

Figure 2: The 300 m zone of the forests (left) and the inner belt areas and fishponds in them (right)



Quantifying the map data from *Table 2*, it can be seen that if the 300-meter zone is added to the forest areas, only 3.77% of the total area is suitable for arable cultivation. If inner belt areas and fishponds are subtracted from this, only 2.66% remains as agricultural land. If we also take into account the edge effect of interior areas, only 1.69% of arable crop land remains, the rest is explicitly exposed to game damage.

Table 2: Territorial distribution of settlements

	Area (ha)	**Remaining area (ha)**	**%**
Total area	14749.28	-	-
Including:			
Forests	9660.20	5089.08	34.50%
300 m zone of forests	14193.20	556.08	3.77%
300 m zone of forests + Inner belt area + Lakes	14371.94	377.34	2.56%
300 m zone of forests + 300 m zone of Inner belt area + Lakes	14499.98	249.30	1.69%

In the settlements, all the points shown in the map are either topographical lot numbers, garden plots or inner belt points (*Table 3*). All missing topographical lot numbers listed as inner belt areas, but there are actually inner belt incidences, e.g., wild game animal damage on the football field as well.

Table 3: The number of places of game damage by settlements

Settlement	Topographical lot number	Inner belt area	Garden plot	Total
Bőszénfa	74	100	15	189
Cserénfa	384	65	39	488
Gálosfa	229	110	4	343
Hajmás	81	43	22	146
Kaposgyarmat	185	45	8	238
Sántos	3	6	1	10
Simonfa	23	74	89	186
Szentbalázs	143	57	6	206
Zselicszentpál	4	15	9	28
Total:	1126	515	193	1834

There were several game damage events where several smaller parts of a topographical lot number were affected, for example 029/1, 029/4 and 029/7. These parts can be "merged", for example, instead of three small parts, the entire area marked with a single topographical lot number 029 can be considered as affected by game damage. The merge of fragmented lots would decrease the number of lots by 382.

In the centre of the areas identified from the records, the location of game damage is shown by a red dot (*Figure 3*). When evaluating the map, the distorting effects described earlier must be taken into account. The map shows the proximity of the forest and the location of the game damage events. Out of the 1,834 game damage points, 1,503 (82%) are within the 300-meter zone of the forests and only 331 points (18%) are outside of the zone. The area of the settlements is not shown in the map.

LOCATION OF CSERÉNFA

In the area of the Kaposvár Forestry, Cserénfa was the settlement most exposed to game damage. The forest map of the settlement (*Figure 4*) was provided by SEFAG. The other forests were identified in MEPAR's browser. The remaining areas are agricultural fields. In one case, according to MEPAR, the area marked with a topographical lot number contains both forest and agricultural land.

The map shows the predominance of forests in the outskirts of the settlement. Much smaller agricultural areas are wedged between forests or found next to forests, and the same can be said about garden plots. Wild game does not even have to move as much as half a kilometre between forests, it crosses an agricultural land.

Figure 3: Location of game damage events without (left) and with the edge zones of forest (right)

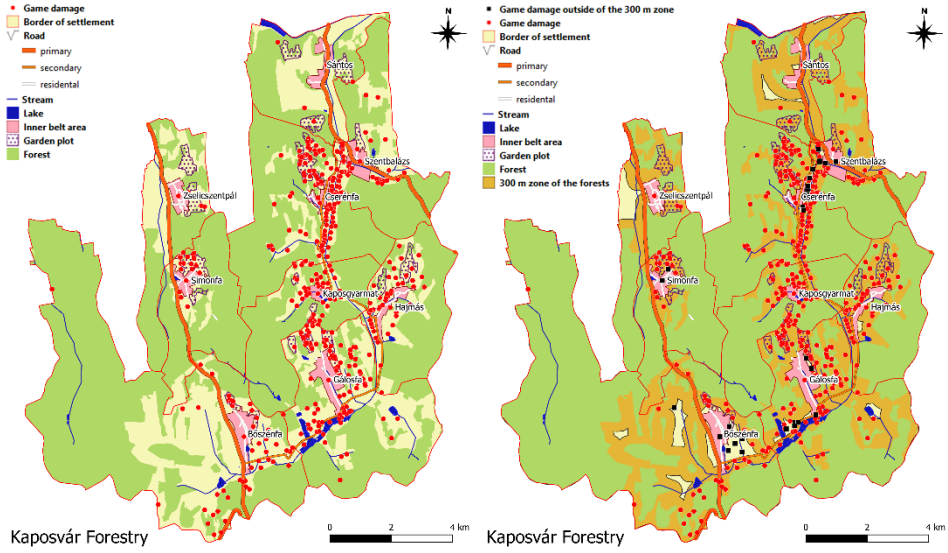
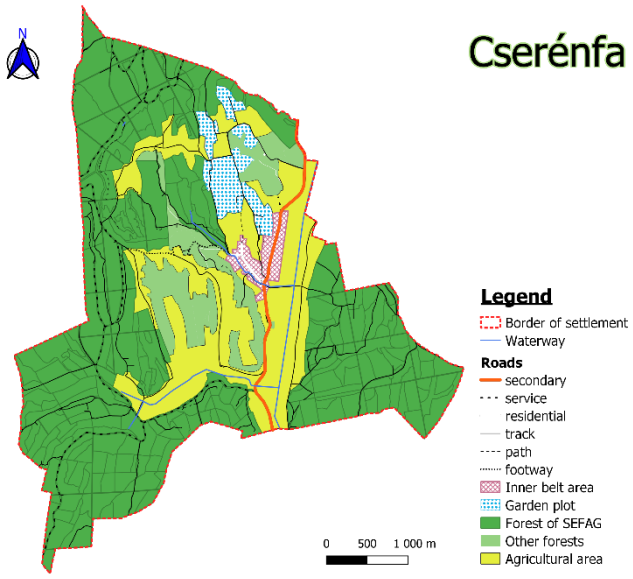


Figure 4: Settlement boundary map of Cserénfa



The forestry area of SEFAG accounts for the largest part of the settlement boundary of Cserénfa (*Table 4*), which is almost two-thirds of the total area (64%). Due to topographical conditions, agricultural areas occupy a total of 22%, according to the MEPAR browser, a large part of this is grassland.

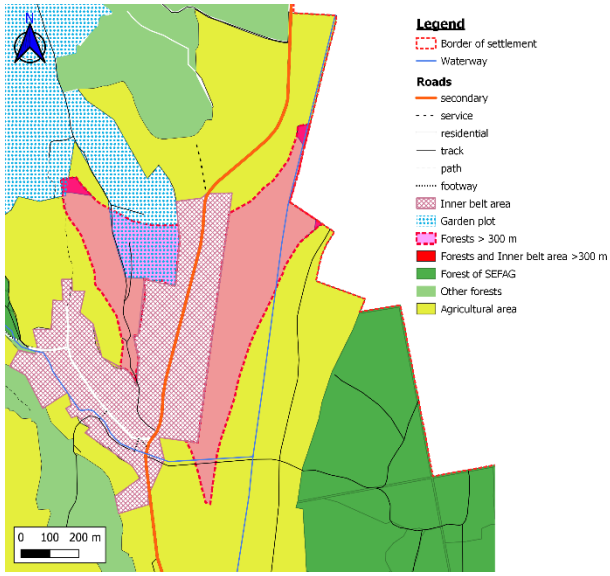
Table 4: The distribution of the different types of cultivation

Cserénfa	Area in ha	Percentage
Inner belt area	33.04	2%
Garden plot	65.41	4%
Agricultural	393.09	22%
Forest of SEFAG	1137.05	64%
Other forests	147.24	8%
Total:	1774.87	100%

RESEARCH OF THE EDGE EFFECT IN CSERÉNFA

In order to examine the edge effect of forests, we created a 300-meter zone of forest areas (SEFAG and other forests together) in QGIS, and then subtracted the entire interior area, as well as the part of garden plots and agricultural areas falling within the zone. In this way we got an area of 28.2 ha constituting agricultural fields and garden plots (*Figure 5*), which is more than 300 meters away from the forests and is therefore less exposed to wild game damage. Due to the edge effect of the settlements, we subtracted the areas that are closer than 300 meters to the inner area from the 28.2 hectares calculated above. As a result, we got an area far enough from the forest and the settlement and is consisting of two parts, totalling only 0.0846 hectares. It means that substantially there is no agricultural area in Cserénfa that is far enough from places where game damage is a threat, so the occurrence of game damage is very much likely, almost surely expected in those fields.

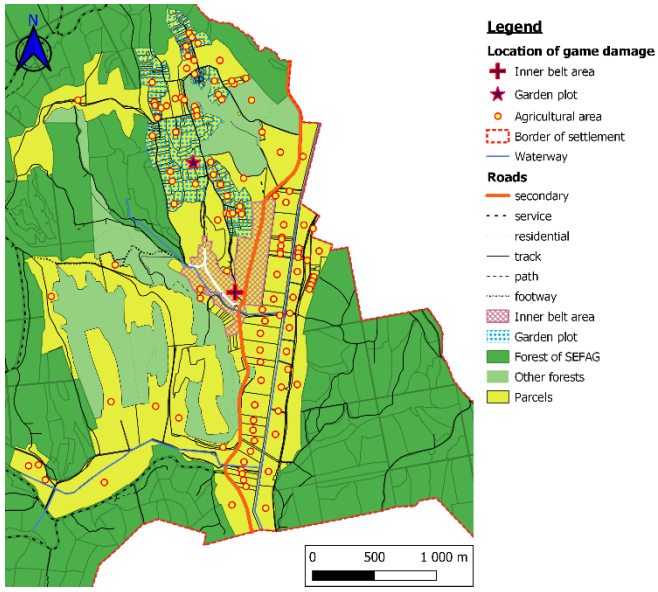
Figure 5: Areas in distance of more than 300 meters from forests and from forests and settlements



LOCATION OF GAME DAMAGE IN CSERÉNFA

The location of all game damage is shown in the map *Figure 6*. To mark the location of game damage, we used the recorded topographical lot number to identify of the parcel of the area affected by game damage. As a result of the divisions, the topographical lot number originally marked with the single number 123 was given the numbers 123/1, 123/2 and 123/3. Later new divisions or mergers further complicated the numbering. Among such areas, there are many really small parcels, which today are typically cultivated jointly, even by the same owner.

Figure 6: Location of all game damage



Unfortunately, topographical lot numbers were not always indicated and sometimes the lot number recorded was not existing in the settlement. We treated these cases as if they were in the inner belt area. Although there have been incidents of game damage both in the inner belt area and on the football field of Cserénfa.

In many cases, the damage to garden plots did not include an entry for the topographic lot number, only a text indicated that it was a garden plot or gp. abbreviation was found in the record. For the purposes of map representation, these were uniformly assigned to the centroid of the garden plot area of the settlement.

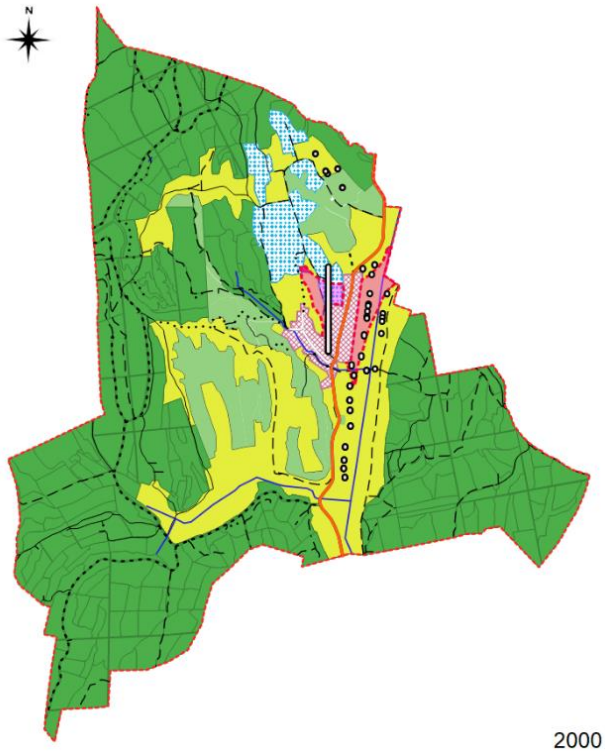
In several cases, because of extensive wild damage, several parcels were indicated in one report, while the area affected by wild damage and the amount paid were not broken down to parcels. In order to produce a map, such multiple entries had to be broken down into as many parcels as the number of parcels indicated and the amount divided between them proportionally. The fractional number of parcels was also shown separately.

Maps can also be used to illustrate the extent of wildlife damage. It is possible to map each year separately. These can then be converted into time-sharing videos to track the change in wildlife damage between years.

THE AMOUNT OF GAME DAMAGE IN EACH YEAR

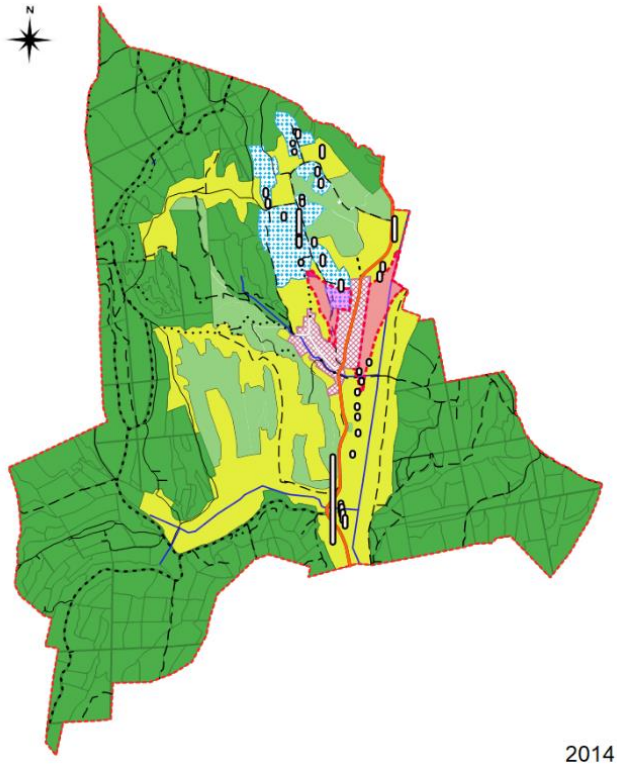
Figure 7 shows not only the location of the game damage but also the amount of game damage on the map. The location of the game damage is represented by the bottom of the rounded-end columns, and the amount of game damage is symbolized by the length of the column. It can be seen that in 2000 a large amount of damage was recorded for the inland area, but this was due to the fact that the topographical lot number was missing in many cases from the records. No wildlife damage was reported in the garden plot. The many small circles in the arable lands show that a single game damage affected several parcel numbers, but the amount of shared game damage was not large.

Figure 7: The amount and location of game damage in 2000



In 2014, however, the game damage did not „reach" the inner belt areas, but there were more of them in garden plots than in agricultural areas (*Figure 8*). The amount of game damage is also higher than in 2000, and even in one case it is exceptionally large.

Figure 8: The amount and location of game damage in 2014



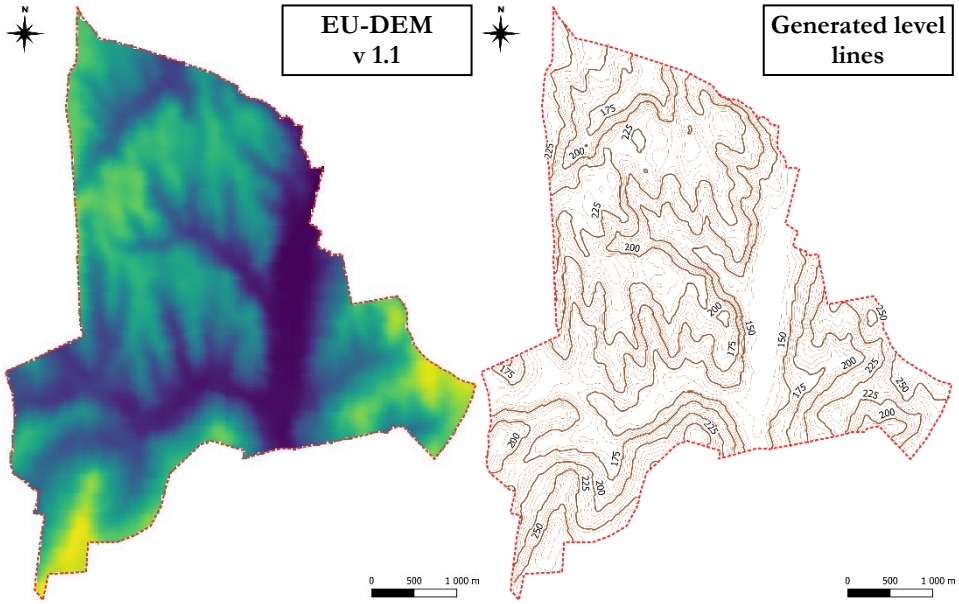
TOPOGRAPHY ANALYSIS IN CSERÉNFA

The European Union's Copernicus Programme made the EU-DEM topography model freely available. *Figure 9* shows the topography cut in the Cserénfa area and the contour line drawn from it in the QGIS program. The varied topography could be clearly seen, marked by intersections, with a large difference in level.

In order to be able to quantify the slopes, a slope map must be created (Figure 10), which shows the percentage values of the slopes. The red colour dominates, which indicates places with a slope greater than 15%. The steepest parts are located outside the agricultural area marked in blue and have forestry cultivation. The agricultural areas are in the areas with a smaller slope, but even so, the slope is greater than 15% in many places.

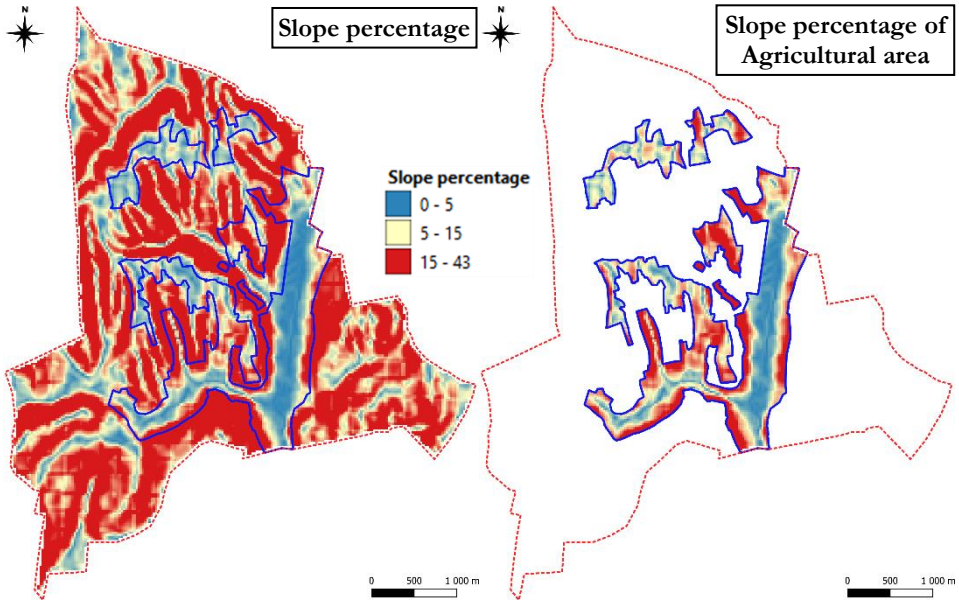
In the entire area, the number of slopes with an 5-15 % is the largest, but there are also a significant number of areas with a slope of more than 20 %, but the average is 12.5%. In agricultural areas, the slope percentages are smaller, but the average here is also 8.7%, which is quite high. In addition, there are many areas with slopes greater than 20%.

Figure 9: Topography of Cserénfa



130 m 270 m	Minimum=130.28 Maximum=267.20	Mean=189.90 StdDev=32.03

Figure 10: Slope percentage map of Cserénfa



Minimum=0.01 Maximum=50.22	Average=12.95 StdDev=7.83	Minimum=0.01 Maximum=44.70	Average=8.73 StdDev=7.61

The figure clearly illustrates the ratio of each slope percentage. For a more accurate picture, we calculated the total area of the raster regions (*Table 5*).

Table 5: Raster statistics

Scale	Total Area ha	%	Agricultural Area ha	%
Under 5%	281.81	17%	154.66	39%
Between 5% and 15%	800.26	47%	175.77	44%
Greater than 15%	619.84	36%	69.10	17%
Total:	1701.92	100%	399.53	100%

There are about 70 hectares of agricultural land with a slope of more than 15%. In these areas, it should be considered to switch from traditional agricultural cultivation to one of the agroforestry solutions, which are also less exposed to game damage.

CONCLUSION

Game damage is certain in the examined area because there are very few agricultural areas that are more than 300 meters away from the forest. The case would be even worse if the edge effect of the settlements were included.

A significant part of the agricultural land is located on steep fields where cultivation costs are much higher, and the risk of erosion is greater.

It would be advisable for farmers to consider switching to agroforestry solutions that require less machine work and are subject to less game damage.

Identifying game damage with topographical lot numbers is difficult, and data processing and representation are also complicated. Manual data recording is also an obsolete technique. It would be advisable to record the game damage records with a computer and determine the affected area with GPS measurements. As a result, the application of modern statistical, IT and geospatial solutions becomes available in data processing and display, as well.

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