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Driving economic inclusion: Analyzing the participation of individuals with disabilities

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Abstract: The population with disabilities constitutes the largest minority group in the labour market, facing social and organizational barriers. The ambiguous nature of employment support provisions and the lack of unified vocational activation systems hinder their economic participation. This study reviews existing literature and examines the effectiveness of support programmes, and discusses the employment challenges faced by disabled individuals. The research emphasizes the need for coordinated national guidelines and highlights disparities across Central and Eastern European countries. The objective of this study was to analyze the economic activity of individuals with disabilities in micro, small, medium, and large enterprises in Poland. The study was conducted using the CAWI method (computer assisted web interview). The questionnaires were sent and completed online. The study found that individuals with severe disabilities may face greater challenges in accessing resources to support their own sole proprietorship (8.33%) in the labour market, compared to entrepreneurs with moderate (66.67%) and light (25%) disabilities. Furthermore, only 2.56% of individuals with physical disabilities are employed in micro-enterprises, with 32.08% being professionally inactive. This study identifies significant factors that contribute to the active participation of disabled individuals in the workforce, particularly in the Wielkopolska region, which was chosen as a case study. The results of the survey indicate a preference for enterprises without a high proportion of disabled employees. The factors influencing disabled individuals' participation in the workforce include age, education, and professional activity. The improvement of the system should take into account company size, disability level, job assessment tools, and the use of job coaches. Incentives should not be based on disability status. The findings from this study have the capacity to inform about changes in SME job creation and enhance professional activity for people with disabilities.

Keywords: Activity instruments, disabled people, labour market, work environment, workplaces.

JEL Classification: L26, M54, J14, J24.

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Introduction

Disability has been identified as an economic, social, global and contemporary problem of the 21st century, affecting all continents and countries of the world, developed, developing and poor. Ambiguous and inconsistent provisions on employment support and the lack of a unified system of vocational activation adapted to the needs of people with disabilities, who report low social support, loneliness, economical inactiveness and lower educational qualifications (Emerson et al., 2021).

People with disabilities are the largest minority group in the labour market, with one in six requiring special care or special conditions (WHO, 2023). This group is also very diverse in terms of its members, who are easily discriminated against by social and organizational barriers in the workplace or by the lack of conditions in the workplace (Bonaccio et al., 2020; Martel et al., 2021). Examples of barriers, based on field studies, are lower productivity, increased labour and training costs, risk of social exclusion, feeling socially stigmatized and discriminated against (Birau et al., 2019). All the national support comes from the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) to set the rules for the national guidelines to support the integration of people with disabilities in the labour market (Grabowska et al., 2022). The gradual subjectivity of disability in social life and the existence of instruments to improve the economic activity of disabled people have been noted in the literature. However, there is a lack of research on the effectiveness of supporting activities and supporting programmes implemented in this regard. A number of studies from CEE countries show how important the issue of employment of people with disabilities is. Starek (2022) explains that in the Czech Republic, 10.2% of the total population is made up of people with health disabilities, and almost all of them are economically inactive. Holubová et al. (2024) add that in Slovakia, in contrast to Norway, there is no political coordination of work with disabled people. It opened the discussion of whether the situation in another member of Visegrad Four (V4) – Poland – would be different, when Kuklek et al. (2021) mentioned that the situation in the labour market and regulation is quite the same.

This article is structured as follows: section 1 presents a literature review, section 2

outlines the research methodology, and section 3 presents the paper's results. Section 4 discusses related studies and proposes an alternative problem-solving approach that involves changes to the current process, organizational structure, and human resource allocation. Finally, the paper concludes and presents its limitations in the last section.

1. Theoretical background

The social movements and legislative changes that have taken place over the last few decades are at the heart of the history of state policy for people with disabilities in micro, small and medium-sized enterprises (SMEs). In the 1960s and 1970s, organizations advocating for the rights and opportunities of people with disabilities began to put pressure on governments and institutions to remove social barriers and promote equality (Bartkowiak, 2019; Garbat, 2013; Mihailović et al., 2011; Pedracki, 1997).

A number of key moments in the history of the policy for the development of disabled people can be identified. During the era of the German politician Otto von Bismarck, who served as prime minister and foreign minister of Prussia from 1862 and as the first chancellor of the German Reich from 1871 to 1890, Germany introduced its first social insurance programme, which provided material compensation for accidents in industrial plants and on the railways. Germany became a world power with a growing economy, population and technology under Bismarck's leadership. It has been argued that although Otto von Bismarck achieved one of the greatest achievements in German history by unifying the country, his social policies need to be questioned (Kasson, 1886; Steinberg, 2011; Stone, 1985; Wolfensberger, 1981).

Subsequently, legal acts appeared prohibiting discrimination against people with disabilities in all areas of public life accessible to the public, as well as in the workplace, requiring to make reasonable adjustments and accommodations by a public or private entity at the request of the applicant. It has been noted that the Americans with Disabilities Act (ADA) that passed in the United States in 1990, is an example of the content of the described act. On the other hand, the European Union adopted the directive on equal treatment in employment, ensuring equal opportunities in the labour market for people with disabilities, in 2000,

which can be considered a step towards creating a community at risk of economic exclusion in Europe that is inclusive of economic activation (Covey, 1998; Gebrehivot, 2015).

Among European countries, in the following years, the introduction of programs and initiatives supporting the employment of people with disabilities in the SME sector was observed. Financial support, vocational training, counselling, and advice for employers on the adaptation of workplaces were offered. Incentive systems are also often used, such as tax breaks or preferential public procurement for companies employing people with disabilities (National Federation of the Blind, 2023). Currently, the development of technology, social awareness, and legislative progress continue to shape the state policy for people with disabilities in micro, small, and medium-sized enterprises, which requires further actions aimed at their full integration into the professional sphere, such as education, awareness building and adaptation of infrastructure environment. There is a need to broaden the knowledge among employers to reduce negative stereotypes and prejudices against people with disabilities. It was noted that one of the barriers among employers may be the lost costs and difficulties associated with adapting the workplace to the needs of employees with reduced mobility (Shavinina, 2006).

1.1 Situation in Poland

The time to pay attention to comprehensive support dedicated to people with disabilities came after the economic and political reform by the Polish politician, economist, and academic teacher Leszek Henry Balcerowicz. The Balcerowicz Plan covered ten acts adopted by the Polish government at the turn of 1989 and 1990, the goal of which was to transition the economy to a market system by: i) privatizing enterprises; ii) reducing inflation, and iii) opening the market for imports (Morawski, 2018). However, the most act impact – from the point of view of the concept of state management – focused on the issues of people with disabilities (adopted on May 9, 1991, on the employment and vocational rehabilitation of people with disabilities – Journal of Laws of 1991, No. 46, item 201 (Parliament RP, 1991)).

Two crucial ways of support in Poland were described:

- i) State Fund for Rehabilitation of the Disabled (PFRON) – based mainly on contributions made by employers who fail to hire the required number of disabled employees. Funds allocated for PFRON's projects come from obligatory monthly contributions made by employers who hire at least 25 full-time employees (considering their working hours), yet the percentage of disabled people among their staff is lower than 6% (PFRON, 2023);
- ii) Ideas of sheltered employment in the form of sheltered employment workshops (SEWs) as supported employment – get a fully paid job in the open labour market, as employed in an integrated environment or to get a job coach (Polish Federation of Supported Employment, 2023).

This support is closely connected with three levels of disability, which is, according to Article 5 of the Act of August 27 1997 on Vocational and Social Rehabilitation and Employment of Disabled Persons (Journal of Laws 2023 items 100, 173, 240, 852, 1234, 1429; Act 129 of August 27, 1997): i) severe; ii) moderate; and iii) light. A severe degree of disability includes a person with impaired fitness of the body: i) incapacitated for employment; and ii) capable of performing employment in sheltered work or an establishment of occupational activation, requiring permanent or long-term care or assistance by another person to perform social roles due to a considerably limited possibility of independent existence. A moderate degree of disability includes a person with impaired physical fitness capable of performing employment in a job adapted to the needs and opportunities arising from the disability, requiring to perform social roles, the partial or periodic assistance of another person in connection with the limited possibility of independent existence. A light degree of disability includes a person with impaired fitness of an organism capable of performing employment, who does not require the assistance of another person to perform social roles.

Nowadays, more than 2.2 million Polish people report a certificate of disability, a certificate of level of disability (issued by the medical examination committees) or a certificate of inability to work at the age of 19+ (issued by the Social Insurance Institution), compared to 17.294 million of Polish people, who are reported as economically active (Główny Urząd Statystyczny, 2023). It means that nearly

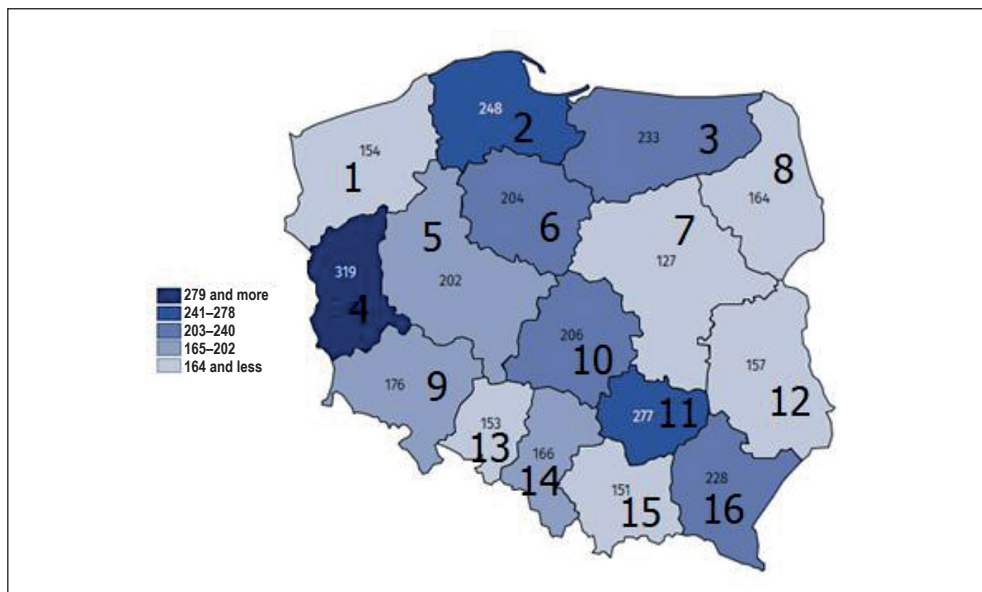


Fig. 1: Number of people reported as disabled in number per 10,000 people

Note: 1 – Zachodniopomorskie; 2 – Pomorskie; 3 – Warmińsko-mazurskie; 4 – Lubuskie; 5 – Wielkopolskie; 6 – Kujawsko-pomorskie; 7 – Mazowieckie; 8 – Podlaskie; 9 – Dolnośląskie; 10 – Łódzkie; 11 – Świętokrzyskie; 12 – Lubelskie; 13 – Opolskie; 14 – Śląskie; 15 – Małopolskie; 16 – Podkarpackie.

Source: own (based on Główny Urząd Statystyczny, 2023)

1/8 of economically active persons have some kind of disability. The situation varies across Polish regions (voivodships). The worst situation is in Świętokrzyskie and Lubuskie voivodships, as illustrated in Fig. 1.

1.2 Current studies and research question formulation

As a result of these assumptions, studies were sought to map the current situation of the participation of disabled people in the labour market. Earlier studies showed that disabled people can be motivated by governmental motivating instruments mentioned by Kobus-Ostrowska (2018) in the form of salary subsidies, refunding of expenses for adaptation or purchase of new equipment, or hiring a work assistant to help people with work. On the other hand, in this analysis, there are examples of various non-governmental organizations and vocational rehabilitation institutions that contribute to the creation of suitable jobs for people with disabilities. Unfortunately, the employment rate

of disabled people in 2019 was 26.8% compared to 78.4% of people without disabilities in the labour market in Poland (Rodacka, 2021). Subsequently, Grabowska et al. (2022) built a MIMIC model (based on structural equation model – SEM) to monitor the implementation of the UN Convention on the Polish labour market or, more generally, to monitor the quality of life of people with disabilities, using secondary data from the EU-SILC survey for the model, which focused on health, living conditions and social dimensions – relationship, where the labour market was not described in detail (Eurostat, 2018). Contrary to this study based on secondary data, several papers based on primary data were published. Politaj and Koza (2018) collected 466 surveys from all over Poland to describe the current barriers in employing disabled people, in particular in becoming self-employed. They had a sample of 37% women and 63% men, with 14% of respondents reporting a significant degree of disability, 63% a moderate degree and 23% a light

degree. These respondents discussed difficulties with legal regulations in 30% and insufficient financial support from governmental bodies to have start-up aid or to cover costs through PFRON funding.

Pilat et al. (2019) expanded on the results of this paper by presenting other barriers to integration and reintegration for people with chronic illnesses. This article confirmed that Poland has a multi-level and multi-sectoral system of public institutions, which should provide support for people with disabilities and chronic diseases, but the system has insufficient implementation of existing solutions to help disabled people to be active at work process, to motivate people that with the certificate they could work and they do not lose their status of disabled person. Another study by Grześkowiak et al. (2021) compared the conditions of disabled people in Poland ($N = 214$) and Finland, also compared with people without disability. They concluded that in both countries when describing activities related to inclusion and presenting different concepts of social inclusion/exclusion of people with disabilities, no differences were observed in the opinions of employers according to the size of the company and the assessment of the importance of competences for working in a diverse team.

Recent regional findings by Ćwirlej-Sozańska et al. (2021) have led to the evaluation of workplaces for people of pre-retirement age with health problems in order to find the barriers to their employment. Although this is an interesting approach, it does not take into account the whole group of people with disabilities. This paper had a regional character, focusing on Podkarpackie and Świętokrzyskie voivodships (201 respondents, mixed approach with qualitative evaluation of workplaces). It used the standardized WHO Disability Assessment Schedule 2.0 (WHODAS 2.0) developed by WHO and used to assess disability. The review of the literature shows that the study of the professional activity of people with disabilities is a challenging issue. The purpose of this article is to address this research gap through the definition of three research questions:

RQ1: Does the degree of disability depend on choosing the size of the company by people with disabilities?

RQ2: Does the size of a company have an impact on the type of disability of disabled people?

RQ3: Are people with disabilities who are able to work economically active?

Research gap identification. When only one regional mixed study was found, the motivation was to select one voivodship to provide a detailed study of the current situation among disabled people. The uniqueness of this paper is that it was conducted in two rounds. The article analyzed the economic activity of people with disabilities in micro, small, medium, and large enterprises in Poland. The aim, due to the research questions posed, was to identify existing challenges, assess economic activity instruments, and propose solutions that could contribute to improving the situation of people with disabilities in the entrepreneurial sector.

2. Research methodology

Analysis of the proportion of the world's population that is disabled indicates that, depending on the source, they make up between 12% and 20% of the total human population. However, this data is not collected in a complete and consistent manner, as certain areas of the world remain outside the scope of government statistics that are made available to the public. It is a complex issue because, on a continent like Africa, it is part of a cultural rite rather than a health hazard. Therefore, the research and analysis were based on data provided by global organizations dealing with disabled people (UN, the EU, and governmental institutions supporting disabled people). Poland is a country in which the population of persons with disabilities makes up 12.34% of the total population of the country (4.7 million people). This means that out of the total group of persons with disabilities in the world, about 0.43% are living in Poland (Główny Urząd Statystyczny, 2023).

2.1 Regional data analysis – Wielkopolska region case study

Since joining the EU, the Polish Government has been obliged to collect statistical data and make it publicly available in systematic reports, which serve to analyze how Poland implements sustainable development. However, these data are not systematically compiled and regularly made available to the public. Some of the data sets can only be obtained for analysis through special, individual orders in the form of a fee. Therefore, due to their limited accessibility, only those data sets and statistics were analyzed

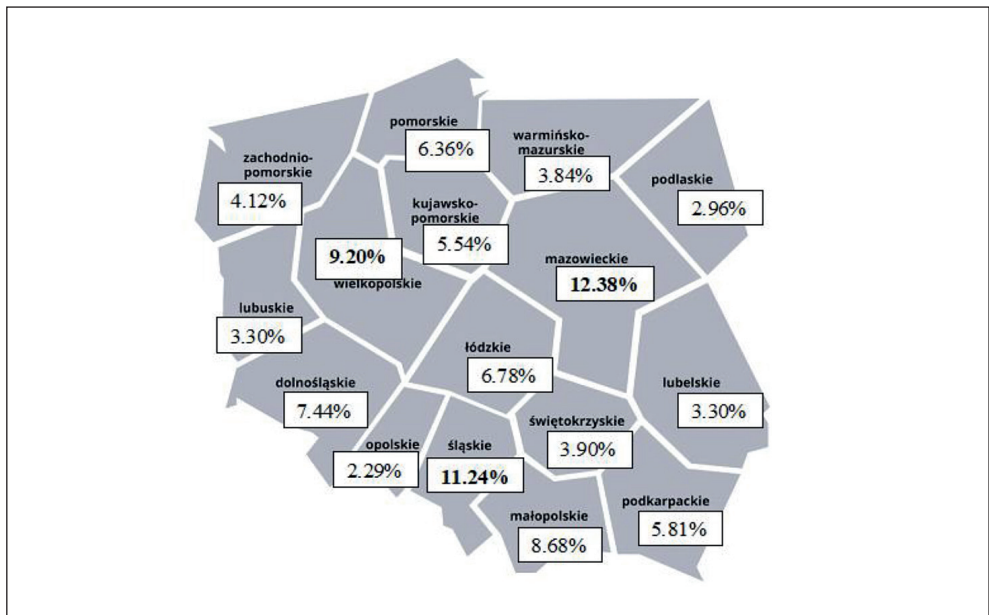


Fig. 2: Persons with disabilities by province in Poland (%)

Source: own (based on Główny Urząd Statystyczny, 2023)

that made it possible to carry out a reliable analysis. For this reason, the Wielkopolska region was selected for the study, as the population of persons with disabilities confirmed by a legal document in this region represents 9.96% of the total population of persons with disabilities in Poland. Wielkopolska is also the largest voivodship in Poland (Fig. 2).

In addition, people with disabilities in Wielkopolska can benefit from forms of support and services they can access: education, assistance in finding employment, and participation in therapy and rehabilitation aimed at developing and improving their quality of life. Cities in Wielkopolska, as well as rural areas, are taking measures to improve accessibility for residents with reduced mobility by modernizing infrastructure, and creating facilities for public transport and public utilities.

In addition, there are associations and foundations in Wielkopolska that provide support for people with disabilities. All these organizations play an important role in creating an inclusive society and provide much-needed support to people with different disabilities.

Their activities include therapies, education, emotional support and a variety of activities to improve quality of life and participation in society. The Wielkopolska region also provides support for people with disabilities through municipal support centres. Each municipality in the region has its own Municipal Social Support Centre (in Polish: GOPS), which provides assistance to residents in need. In addition, individual cities, i.e., Poznań, Kalisz, Konin, Piła, Leszno and Gniezno, provide support through day activity centres, rehabilitation and therapy centres, social integration centres, vocational training and rehabilitation centres, family support centres and long-term care centres. In conclusion, the Wielkopolska region can be considered statistically representative in many ways, and additionally, due to the high demographic indicator of women and men with disabilities (9.12% and 9.29%, respectively), and the research conducted in this area can be used to make recommendations for the whole of Poland, as well as for other countries, identical to the economic development and structure of disabled people in Europe.

2.2 Research methodology

For Study I (2021) and Study II (2022), a questionnaire was distributed online to a group of respondents who have a legally certified disability. The research samples for Study I ($N_{I}^{2021} = 103$) and Study II ($N_{II}^{2022} = 302$) were directly targeted at people with disabilities (PwD) in the Wielkopolska Voivodeship, Poland.

The questionnaire for Studies I and II consisted of two parts: a descriptive section and 38 questions directed towards respondents residing in the Wielkopolskie economic area. The questions pertained to economic activity, the subjective evaluation of the effectiveness of support programs/instruments, and the perception of their social impact on the ecosystem. The study was conducted using the CAWI method (computer assisted web interview), and the questionnaires were sent and completed online. In Studies I and II, all respondents declared having a certificate of disability. The CAWI was chosen based on the results of a pilot phase using CATI (computer assisted telephone interviewing). Respondents required more time, repeating the questions and having a series of questions in front of them. It had to be considered that these were disabled people, most of whom did not want to be visited in person.

The criteria for qualifying as an SME are defined in the European Commission Regulation

No. 651/2014 of June 17, 2014 (European Commission, 2014). These criteria include having less than 250 employees, an annual turnover not exceeding EUR 50 million, and an annual balance sheet total not exceeding EUR 43 million. Additionally, a micro-enterprise has 0 to 9 employees, while a small enterprise has 10 to 49 employees, medium-sized companies have 50 to 249 employees, and large enterprises have 250 or more employees (Kok & Berrios, 2019; PARP, 2023).

We have also categorized enterprises according to the percentage of employees with disabilities (PwD):

- i) Enterprises A have less than or equal to 50% PwD of all employees, while;
- ii) Enterprises B have more than 50% PwD of all employees.

The data collection schedule is divided into periods:

(1) Quantitative Study I, $N_{I}^{2021} = 103$: July–August 2021;

(2) Quantitative Study II, $N_{II}^{2022} = 302$: July–September 2022.

In an attempt to answer individual research questions (RQ1 to RQ2), statistical tools were used, such as the χ^2 statistical test as an experimental approach and the Statistica software. In those two rounds, the following research sample was obtained and divided by descriptive questions (Tab. 1).

Tab. 1: Data sample description – Part 1

Variable		Study I (2021; %)	Study II (2022; %)	Difference	Trend
Gender	Women	42.72	50.99	8.27	↑
	Men	57.28	49.01	−8.27	↓
Place of living (number of inhabitants)	≤5 thousand	3.88	7.62	3.74	↑
	5–50 thousand	9.71	17.55	7.84	↑
	50–150 thousand	17.48	10.60	−6.88	↓
	>150 thousand	48.54	43.05	−5.49	↓
	Rural	20.39	21.19	0.80	↑
Education	Without	0.00	0.00	0.00	↓
	Primary	0.00	0.00	0.00	↓
	Secondary	33.01	31.46	5.26	↑
	MBA	4.85	3.31	−2.49	↓
	Vocational	1.94	1.99	−1.91	↓
	Higher	60.19	63.25	−0.85	↓

Tab. 1: Data sample description – Part 2

Variable		Study I (2021; %)	Study II (2022; %)	Difference	Trend
Age (years)	51+	0.00	0.33	0.33	↑
	41–50	2.91	5.30	2.39	↑
	31–40	39.81	42.38	2.57	↑
	21–30	52.43	45.36	−7.07	↓
	≤20	4.85	6.62	1.77	↑
Type of disability	Mental health	2.91	3.31	0.40	↑
	Visual	6.80	8.94	2.14	↑
	Hearing	7.77	8.61	0.84	↑
	Motoric	65.05	52.65	−12.40	↓
	Other	17.48	26.49	9.01	↑

Note: Correlation for brand penetration and average duplication.

Source: own

3. Results and discussion

3.1 Results

The respondents, who were all people with disabilities (PwDs), were asked about their

economic activity in the labour market, considering the size of the enterprise in Poland (twelve options were given, and just one possibility could be chosen). The majority of Study II participants

Tab. 2: Preferences for choosing the work environment by people with disabilities (PwD)

Study I (N = 103)			Study II (N = 302)		
Option	Answers	Value (%)	Option	Answers	Value (%)
1	Any labour market	31.07	1	Any labour market	14.56
2	Small	13.59	2	Small	12.94
3	Large	11.65	3	Large	10.84
4	Micro	10.68	4	Micro	10.03
5	Self-employment	9.71	5	Medium	8.74
6	Micro (PwD > 50%)*	6.80	6	Self-employment	8.25
7	Medium	4.85	7	Public sector	7.93
8	SEWs**	3.88	8	Large (PwD > 50%)*	6.96
9	Public sector	2.91	9	Medium (PwD > 50%)*	6.15
10	Large (PwD > 50%)*	1.94	10	Micro with (PwD > 50%)*	5.66
11	Medium (PwD > 50%)*	1.94	11	SEWs**	4.85
12	Small (PwD > 50%)*	0.97	12	Small with (PwD > 50%)*	3.07

Note: * the percentage of people with disabilities are over than 50% of all employees in enterprise; ** sheltered employment workshops.

Source: own

(14.56%) expressed a desire to have access to any labour market. The preferences of people with disabilities in choosing a work environment were compared between Study II and Study I to observe changes (Tab. 2).

In Study II, it was observed that people with disabilities showed diversity in their preferred forms of employment depending on the size of the enterprise. 8.25% of respondents preferred self-employment (compared to 9.71% in Study I). In addition, 4.85% of respondents

indicated a preference for a sheltered working environment, specifically sheltered employment workshops (SEWs), which is slightly higher than the 3.88% reported in Study I. It is important to note that this preference was ranked 11th out of 12 in our research. In Study I, it was ranked 8th out of twelve options. There is an increase in the number of people with disabilities in the work environment, according to our observations from Study I and Study II (Tab. 3).

Tab. 3: Work environment growing by people with disabilities based on Studies I and II

Option	Answers	Study I	Study II	Growth (%)
		Value (%)	Value (%)	
1	Any labour market	31.07	14.56	-16.50
2	Small	13.59	12.94	-0.65
3	Large	11.65	10.84	-0.81
4	Micro	10.68	10.03	-0.65
5	Self-employment	9.71	8.25	-1.46
6	Micro (PwD > 50%)*	6.80	5.66	-1.13
7	Medium	4.85	8.74	3.88
8	SEWs**	3.88	4.85	0.97
9	Public sector	2.91	7.93	5.02
10	Large (PwD > 50%)*	1.94	6.96	5.02
11	Medium (PwD > 50%)*	1.94	6.15	4.21
12	Small (PwD > 50%)*	0.97	3.07	2.10
Total		100.00	100.00	-

Note: * the percentage of people with disabilities are over than 50% of all employees in enterprise; ** sheltered employment workshops.

Source: own

The study found that the highest percentage difference was observed in the labour market, with a growth of 31.07% (Study I) and 14.56% (Study II). The respondents' next choice was the enterprise without a predominance of people with disabilities (42.56% for Enterprises A), followed by enterprises where the percentage of people with disabilities is over 50% of all employees (21.84% for Enterprises B). Self-employment and the public sector combined account for 16.18% of the workforce, with self-employed individuals making up 8.25% and the public sector 7.93%. Only

4.85% of respondents expressed a willingness to work in sheltered employment workshops (SEWs). The preferred size of enterprises ranges from 8.74% to 12.94% (Tab. 4), where the total number of employees with disabilities does not exceed 50% of the total number of employees.

The survey results show that among enterprises where the percentage of people with disabilities (PwD) does not exceed 50% of all employees, small enterprises had the highest percentage at 12.94%, followed by medium enterprises at 8.74%. On the other hand, for

Tab. 4: Preferences for choosing the size of a commercial enterprise by people with disabilities from Study II

No.	Enterprises A (%)		No.	Enterprises B (%)	
1	Small	12.94	1	Large (PwD > 50%)*	6.96
2	Large	10.84	2	Medium (PwD > 50%)*	6.15
3	Micro	10.03	3	Micro (PwD > 50%)*	5.66
4	Medium	8.74	4	Small (PwD > 50%)*	3.07
Sum		42.56	Sum		21.84

Note:* the percentage of people with disabilities are over than 50% of all employees in enterprise.

Source: own

enterprises where the percentage of PwD exceeds 50% of all employees, the percentage of PwD decreases with the size of the enterprise, with big enterprises having the lowest percentage at 6.96%, followed by medium enterprises at 6.15%, micro-enterprises at 5.66%, and small enterprises at 3.07%. In comparison to the pilot Study I, the surveyed group of respondents seemed to be more aware of their choice of workplace. This result can be a basis for further exploration of the research topic and evaluation of the research questions.

Degree of disability and company size (RQ1). Two parameters were tested as Q1_A: degree of disability and Q1_B: enterprise size. The evaluation was conducted using the χ^2 statistical test,

which involved formulating both the null hypothesis (H_0) and the alternative hypothesis (H_1).

H_0 : The degree of disability does not depend on the choice of enterprise size for people with disabilities.

H_1 : The degree of disability depends on the choice of company size for people with disabilities.

It was found that individuals with severe disabilities may be less willing to operate their own sole proprietorship (8.33%) and may face greater challenges in accessing resources to support this economic activity in the labour market compared to entrepreneurs with moderate (66.67%) and light (25.00%) disabilities. In accordance with the European Commission

Tab. 5: Summary test χ^2_{Q1} research question RQ1 (with the value parameter Q1_B: micro + SE*)

Q1_A: degree of disability	Q1_B: enterprises size					Sum
	Micro + SE*	Small	Medium	Large	No working	
Considerable	8	7	14	17	41	87
Moderate	22	29	18	36	26	131
Light	21	13	16	14	20	84
Sum	51	49	48	67	87	302
Value (%)						
Considerable	15.69	14.29	29.17	25.37	47.13	–
Moderate	43.14	59.18	37.50	53.73	29.89	–
Light	41.18	26.53	33.33	20.90	22.99	–
Sum	100.00	100.00	100.00	100.00	100.00	–

Note: * SE – one-person company (self-employment).

Source: own

directive and the classification of micro-enterprises as having less than 10 employees, it was decided to group individuals with disabilities who are employed in this category with those who are self-employed (Tab. 5).

Similar values were obtained from the Pearson χ^2 test and χ^2 LRT (χ^2 likelihood-ratio test) statistics of 31.26810 and 30.82499, respectively, with an observed difference of 0.44311. Both tests provided evidence to accept the alternative hypothesis ($H1$) regarding the relationship as the p -value was less than the 95% confidence level specified in the experiment (Pearson χ^2 : 0.00013 and χ^2 LRT: 0.00015). Therefore, the degree of disability, as determined by the sum of the values of the parameters micro + self-economic activity, depends on the size of the enterprise chosen by people with disabilities.

Type of disability and company size (RQ2). Two parameters were tested to answer the research question – Q2_A: type of disability

and Q2_B: enterprise size. The study revealed that a certain type of disability related to visual, hearing, and mental disorders is uncommon among individuals who declare their economic activity or lack thereof in the labour market. Respondents with this type of disability showed less inclination towards self-employment (8.33% or 24 out of 100) and medium-sized enterprises (14.58% or 48 out of 100). The data shows that individuals with hearing impairment and those who report having mental disorders are the least economically active, with respective employment rates of 42.31% (26 out of 100) and 50% (10 out of 100). The data shows that individuals with hearing impairment and those who report having mental disorders are the least economically active, with respective employment rates of 42.31% (26 out of 100) and 50% (10 out of 100). This suggests that these types of disabilities present significant barriers to both traditional employment and self-employment. Furthermore, the study

Tab. 6: Summary test χ^2_{Q2} research question RQ2 (with the value parameter Q 2_A: visual + hearing + mental and Q2_B: micro + SE*)

Q2_A: type of disability	Q2_B: enterprises size					Sum
	Micro + SE*	Small	Medium	Large	No working	
Motor impairment	20	20	28	40	51	159
other	19	16	13	15	17	80
Visual + hearing + mental	12	13	7	12	19	63
Sum	51	49	48	67	87	302
Value (%)						
Motor impairment	39.22	40.82	58.33	59.7	58.62	–
other	37.25	32.65	27.08	22.39	19.54	–
vision + hearing + mental	23.53	26.53	14.58	17.91	21.84	–
Sum	100.00	100.00	100.00	100.00	100.00	–
Statistics	χ^2_{Q2}	Number degrees freedom	p -value			
Chi ² Pearson	11.67518	df = 8	0.16630			
Chi ² LRT**	11.83562	df = 8	0.15869			

Note: * SE – one-person company (self-employment); ** χ^2 likelihood-ratio test.

Source: own

suggests that individuals with physical disabilities may face challenges when seeking employment in micro-enterprises, with only 2.56% (159 out of 100%, including 32.08% who are professionally inactive) being employed. This may be due to a lack of available job positions, which could be attributed to the lower financial resources of the employer. It was necessary to create a mutual category of visual, hearing and mental disability, when number of observations did not meet the criteria for χ^2 test (less than 5; Tab. 6).

Similar values of tests were obtained using Pearson's test and LRT statistics. The observed difference was 0.16044. However, as the p -values in both cases are higher than the 95% confidence level specified in the experiment, no clear answer to $RQ2$ was obtained, but we cannot

reject $H0$ (the choice does not depend on the size of the company by people with disabilities).

Ability to work and economic activity ($RQ3$). The statistical analysis was conducted using the χ^2 test, which involved formulating both the null hypothesis ($H0$) and the alternative hypothesis ($H1$; Tab. 7).

$H0$: The ability to work for people with disabilities is not dependent on being economically active.

$H1$: The ability to work for people with disabilities depends on being economically active.

Similar values were obtained using Pearson's χ^2 test and χ^2 LRT statistics. The observed difference was 2.5153. It was found that the significance level of the p -value in both cases is lower (for Pearson's χ^2 : 1.3769E-225

Tab. 7: Summary test χ^2_{p3} for research question $RQ3$

Q3_A: ability to work	Q3_B: economic active		Sum
	Yes	No	
Yes	189.00	51.00	240.00
No	26.00	36.00	62.00
Sum	215.00	87.00	302.00
Value (%)			
Yes	87.91	58.62	–
No	12.09	41.38	–
Sum	100.00	100.00	–
Statistics	χ^2_{Q3}	Number degrees freedom	p -value
χ^2 Pearson	32.5605	df = 1	1.3769E-225
χ^2 LRT*	30.0452	df = 1	1.3772E-225

Note: * χ^2 likelihood-ratio test.

Source: own

and χ^2 LRT: 1.3772E-225) than the 95% confidence level specified in the experiment, which gave grounds for accepting the alternative hypothesis ($H1$) that the ability to work of people with disabilities depends on being economically active.

3.2 Discussion

Despite the availability of numerous interventions and government support instruments, the employment rate of people with

disabilities in Poland and the EU remains low, which is in line with Rodacka (2021) and Politaj and Koza (2018). However, the proposed act to create enterprises in Poland with a special legal status, known as sheltered employment workshops (SEWs), adapted to employ people with disabilities, has not yet improved this situation (Czerkawski & Małecka 2022; Czerkawski et al. 2021; Małecka et al., 2021). It has been found that individuals with severe disabilities may be less willing to operate their own sole

proprietorship (8.33%) and may face greater challenges in accessing resources to support this economic activity in the labour market compared to entrepreneurs with moderate (66.67%) and mild (25.00%) disabilities. This extends the findings of regional studies conducted by Ćwirlej-Sozańska et al. (2021). The study revealed that a certain type of disability related to visual, hearing, and mental disorders is uncommon among individuals who declare their economic activity or lack thereof in the labour market. Additionally, individuals with this type of disability are less inclined to pursue self-employment, with only 8.33% (24 out of 100) willing to run their own self-led company and 14.58% (48 out of 100) willing to work for medium-sized enterprises. The individuals who reported hearing impairment and mental disorders were the least economically active, which is in line with the job integration findings of Piłat et al. (2019) and Grześkowiak et al. (2021) or Starek (2022).

The survey found that 42.56% of respondents preferred enterprises without a predominance of people with disabilities (Enterprises A). Additionally, 21.84% of respondents preferred enterprises where over 50% of all employees have disabilities (Enterprises B). Self-employment and the public sector together accounted for 16.18% of preferences, with self-employed individuals making up 8.25% and the public sector making up 7.93%. 4.85% of the respondents indicated a willingness to work in a protected environment, i.e., sheltered employment workshops (SEWs). Preferences ranged from 8.74% to 12.94% for the size of the company, where no more than 50% of employees are disabled, which is a new finding in that research area. This study identified significant factors that contribute to the active participation of disabled individuals in the workforce, particularly in the Wielkopolska region:

- The respondents are predominantly aged 21 to 30 and have higher education. They live in cities with a population of over 150,000 in the Wielkopolska economic area;
- The preferred enterprise environment for respondents is one without a predominance of people with disabilities;
- The choice of company size by people with disabilities depends on the degree of disability;
- The ability to perform a job for people with disabilities depends on professional activity.

According to the results, improvements to a well-known system should take into account

either the size of the company or the degree of disability; in addition, tools should be created to assess the ability to perform the job; job coaches should be actively used; and incentive mechanisms for economic activity should not be based on the type of disability, which is extending results of Kuklek et al. (2021).

Conclusions

The increased willingness to change the working environment may indicate that vocational activity is a more important factor for people with disabilities in the study than physical inaccessibility. The survey results show the respondents' preferences for work environments when rejecting enterprises with a protected purpose. This information can be used to change the way jobs are created in the SME sector, making establishments with a commercial purpose more attractive. This, in turn, may improve the professional activity rate of people with disabilities in Poland or on a regional level. As mentioned in the introduction, this situation also applies in general to the other Visegrad Four countries (the Czech Republic, Slovakia and Hungary).

Limitation of the study. This study presents the results from one voivodship, but the research steps are standardized and could be repeated in other voivodships in Poland in order to allow for a comparison with the overall studies. In addition, the study could be improved by comparing the employment of people with disabilities in different SME industry segments, which would help to identify motivational factors for both people with disabilities and employers, and provide insight into how to create inclusive workplaces and supportive environments of high quality.

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How does digital transformation affect innovation quality?

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Abstract: In the digital era, digital transformation is disrupting traditional business models and innovation activities. Numerous firms have expedited their endeavors in digital transformation to augment their manufacturing capabilities, operational efficiency, and competitive standing. Despite the increasing scholarly attention on the pivotal role of digital transformation in economic progress, there exists a paucity of research delving into the intricate nexus between digital transformation and innovation quality. The objective of this study is to investigate the relationship between digital transformation and innovation quality. Leveraging annual report data and patent information from Chinese listed companies spanning from 2012 to 2021, we have identified that digital transformation significantly enhances innovation quality. Interestingly, upon further investigation into the relationship between the five sub-dimensions of digital transformation (artificial intelligence, blockchain, cloud computing, big data, and digital technology applications) and innovation quality, positive and significant correlations were observed with artificial intelligence, cloud computing, big data, and digital technology applications, while blockchain did not exhibit a significant impact. Furthermore, the study reveals that the impact of digital transformation on innovation quality varies depending on property rights and regional location. Specifically, this promotional effect is significant only in non-state-owned enterprises and in the central and eastern regions. Overall, this paper enriches the research on digital transformation and innovation quality, providing valuable insights to promote the advancement of digital transformation levels for better serving the high-quality development of the real economy.

Keywords: Digital transformation, innovation quality, artificial intelligence, blockchain, cloud computing, big data, digital technology applications.

JEL Classification: G34, O31, O32, O33.

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Introduction

The adoption of contemporary technologies, encompassing artificial intelligence, blockchain, cloud computing, and big data, has catalyzed a broader phenomenon known as “digital transformation” across diverse sectors (Guo et al., 2022; Peng & Chang-Qi, 2022; Tian

et al., 2022; Tu & He, 2022). Firms currently comprehend the crucial significance of digital transformation as it upsets conventional business models and approaches to innovation (Loonam et al., 2018; Zhuo & Chen, 2023). On the whole, within the realm of the economic ramifications of digital transformation, existing

research has confirmed its potential to stimulate product innovation, enhance operational efficiency, and improve economic prospects (e.g., Hess et al., 2020; Reuschl et al., 2022; Verhoef et al., 2021). As a result, the influence of corporate digital transformation on various aspects of economic development has increasingly garnered extensive attention from economists and policymakers.

Innovation is crucial for enhancing a firm's competitiveness and sustaining its financial performance, constituting a vital component of a nation's economic development and competitive advantage (Iqbal et al., 2020; Ma & Zhu, 2022; Zhang et al., 2022). However, numerous low-quality "innovation bubbles" do not necessarily equate to actual technological or innovative improvements (Wang et al., 2022a). Conversely, due to the limitations of innovation resources, even with a surge in the quantity of innovations, declining quality remains unfavorable for innovation-driven economic transformation (Hu et al., 2020; Ma & Zhu, 2022). Given that innovation quality stands as a prominent theme in corporate marketing and management, digital transformation has introduced a new economic paradigm, catalyzing profound changes in production methods and governance. Hence, investigating the unverified relationship between digital transformation and innovation quality holds significant economic value.

This study aims to address this gap by investigating the influence of digital transformation on innovation quality in China, the world's second-largest contributor to the digital economy (Sun et al., 2022). As outlined in the China digital economy development white paper by the China Academy of Information and Communications Technology, the scale of China's digital economy has reached 39.2 trillion yuan (approximately USD 5.4 trillion), constituting 38.6% of China's GDP in 2020 (Tian et al., 2022). This vast market scale provides abundant data samples for research purposes. The paper seeks to answer the following questions. (I) Can digital transformation enhance innovation quality? (II) If so, which sub-dimensions of digital transformation have driven this effect? (III) Which types of firms are more sensitive to the effect of digital transformation on innovation quality?

Using a sample of 3,920 Chinese listed companies from 2012 to 2021, we examined the impact of digital transformation on

innovation quality. To account for the dynamic and highly persistent nature of innovation, this study employed the generalized method of moments (GMM) estimator. It found that digital transformation enhances innovation quality. This result remains robust across a battery of tests. Heterogeneity analysis indicates that this facilitating effect is more pronounced in non-state-owned enterprises and in regions located in central and eastern China. Extended analysis reveals that among the five sub-dimensions of digital transformation generated using text analysis techniques, blockchain did not exert a positive and significant impact, unlike the other four sub-dimensions.

This research provides the following contributions. First, it employs text mining techniques based on machine learning in conjunction with information from annual reports to construct a comprehensive digital transformation indicator for firms. The unsupervised machine learning technique employed in this paper, word2vec, is a deep learning algorithm that enhances traditional text analysis methods. This improvement is achieved through processes such as training models on the entire dataset and computing word vector similarities. Second, this study identifies and examines the sub-dimensions of digital transformation that impact innovation quality, thereby unveiling the "black box" of its influence. This not only broadens the investigation into the economic effects and mechanisms of digital transformation but also enhances the exploration of factors influencing innovation activities, aligning with the needs of the digital economy era for high-quality innovation-driven development. Third, the research, taking into account the characteristics of both property rights and regions, examines the heterogeneous effects of digital transformation on innovation quality. This contributes to a more profound comprehension of the economic advantages associated with corporate digital transformation, thereby informing the formulation of targeted policies.

The paper is organized as follows. Section 1 introduces the main aspects of theoretical and empirical issues. Section 2 outlines the research design, encompassing the description of data, variables, and the empirical model. Section 3 presents the empirical findings, along with robustness checks, extended analysis, and discussions. Concluding remarks are offered in the last section.

1. Theoretical background

Digital transformation has increasingly become a priority for firms aiming to optimize production processes and reshape organizational business models (Baiyere et al., 2020). This entails the integration of digital technologies such as artificial intelligence, blockchain, cloud computing, and big data into various aspects of business operations (Sun et al., 2022). This shift necessitates organizations to innovate and modify their products, services, and operations by leveraging digital transformation to drive intelligent business processes. For instance, Vial (2019) defines digital transformation as the organizational adjustments made in response to environmental changes, reconstructing the value of products through the adoption of digital technologies such as mobile computing, artificial intelligence, and cloud computing. Similarly, Hess et al. (2020) and Gong and Ribi  re (2021) consider digital transformation as the integration of cutting-edge technologies, signifying a substantial change propelled by digital technologies, which brings forth new advanced value creation. Furthermore, Verhoef et al. (2021) delineate the digital transformation process into three stages: digitizing analog information, adjusting business processes through digital technologies, and strategically altering the business operational model. These transformations often reimagine business models, processes, and organizational cultures to fully exploit the potential of digitalization in driving enterprise innovation strategies (Zhuo & Chen, 2023).

Most research exploring the economic impacts of digital transformation has predominantly focused on its effects on production and operations. A key perspective suggests that digital technologies enable firms to overcome internal resource and capability constraints, allowing them to leverage external resources for strategic expansion into new markets and product development (Chan et al., 2018). Scholars argue that organizations can optimize their production processes through digital transformation. This optimization can be achieved by leveraging consumer data (Earley, 2014), restructuring organizational frameworks (Kretschmer & Khashabi, 2020), and modifying value creation methods (Rachinger et al., 2019). Additionally, digital transformation expands organizational coverage by enhancing internal connectivity and collaboration within

the supply chain (Reuschl et al., 2022), fostering operational efficiency, value creation, and innovation through ecosystem and platform utilization (Chan et al., 2018; Gong & Ribi  re, 2021; Rachinger et al., 2019).

In the case of developing countries, Comander et al. (2011) found that investments in digital technologies, such as information and communication technology, can enhance productivity for firms through workplace restructuring, allowing for more decentralized decision-making. Similarly, evidence from developed countries also demonstrates similar findings. For example, Brynjolfsson and Hitt (2003) found evidence of complementary positive effects between skilled labor and organizational innovation in the United States firms sampled, accelerated by investments in information and communication technology. Drawing upon a substantial sample of 4,598 firms engaged in digital software development surveyed between 2016 and 2018 in Sweden, Andersson et al. (2021) substantiate that digitally transformed firms involved in software development demonstrate a heightened likelihood of innovation adoption and increased innovation sales. However, innovation quality emphasizes the effectiveness and impact of the introduction of new products, services, or processes by organizations (Sethi & Sethi, 2009). It includes aspects such as uniqueness, market competitiveness, and customer satisfaction (Tidd & Bessant, 2018). The relationship between various aspects of digital transformation and innovation quality has not received sufficient attention. Indeed, the relationship between digital transformation and innovation quality can be built within existing theoretical frameworks, such as agency theory (Eisenhardt, 1989), and resource dependence theory (Salancik & Pfeffer, 1978), the former explores the agency costs resulting from the divergence of interests between agents and principals, and the latter emphasizing organizations' survival needs to extract resources from the surrounding environment, achieving interdependence and interaction with the surrounding environment.

From an agency theory perspective, digital transformation can reduce information asymmetry between managers and shareholders, thereby addressing the problem of insufficient innovation investment within organizations due to agency conflicts. In general, managers are responsible for daily innovation activities

and the disclosure of financial data, including innovation investments (Iqbal et al., 2020). Shareholders, however, are at a disadvantage in obtaining comprehensive information, which may lead to information asymmetry between managers and shareholders, resulting in agency conflicts (O'Connor & Rafferty, 2012). Additionally, given the high-risk and long-term nature of innovation activities, managers may be biased towards their short-term interests and overlook the interests of shareholders because long-term innovation investment may sacrifice short-term performance, impacting their immediate income and reputation (Chen & Huang, 2023; Yuan & Wen, 2018). Correspondingly, the utilization of digital technologies, big data, cloud computing, and blockchain has revolutionized the corporate landscape of financial information disclosure. This transformation is manifested in the heightened efficiency of information transmission and collection, thereby ensuring a more expansive and inclusive dissemination of information (Cong & He, 2019). On the one hand, through digital transformation, organizations can enhance the transparency of information related to innovation input, improving the timeliness and openness of the dissemination of information concerning research and development (R&D) input (Zhuo & Chen, 2023). This, in turn, reduces the risk of managers communicating false or lagging information to the board and shareholders (Ferreira et al., 2019; Iqbal et al., 2020; Peng & Chang-Qi, 2022). On the other hand, firms can leverage new digital technologies to automate the processing of financial data, thereby reducing managerial discretion in R&D investment and ensuring the financial sustainability of innovation (Llopis-Albert & Rubio, 2021; Urbinati et al., 2018).

According to the view of resource dependence, digital transformation can significantly improve the efficiency of innovation activities by reshaping internal resource sharing and environmental dependence levels. To date, extensive research has identified that digital transformation utilizes technologies such as artificial intelligence, blockchain, cloud computing, and big data to reduce reliance on traditional and inefficient platforms (Ferreira et al., 2019; Rachinger et al., 2019; Şimşek et al., 2019). This improves organizational processes, thereby enhancing the operational efficiency of innovation activities. Additionally, digital technologies

facilitate interactive management between firms and other participants in innovation networks. This, in turn, reduces the knowledge gap between firms and external social networks (Goldfarb & Tucker, 2019; Şimşek et al., 2019), aiding in more effective innovation outcomes. Furthermore, given the complexity of innovation strategies, digital technologies can enhance decision-making efficiency in innovation activities (Guo et al., 2022; Peng & Chang-Qi, 2022). Additionally, digital platforms and networks allow firms to establish strategic partnerships and alliances, reducing reliance on a single resource supplier (Ferreira et al., 2019; Srinivasan & Venkatraman, 2017), thereby facilitating knowledge exchange, resource sharing, and collaborative innovation, thereby improving internal efficiency of innovation activities (Gupta et al., 2022; Llopis-Albert & Rubio, 2021; Ma & Zhu, 2022).

To sum up, digital transformation represents a paradigm shift in organizational innovation approaches, breaking through traditional organizational boundaries, weakening barriers of information asymmetry, accelerating the flow of resource elements between enterprises, and providing unprecedented opportunities for enterprises to drive innovation quality through digitalization. This study aims to explore whether and how digital transformation affects innovation quality, contributing to a deeper understanding of the relationship between digitization and innovation in contemporary business environments.

2. Research methodology

2.1 Data and sample

This study utilised the research sample of all Chinese A-share listed companies from 2012 to 2021. The China Stock Market & Accounting Research Database provided financial data, annual reports were used to collect the phrases and words of digital transformation, and patent information was obtained from the Chinese Research Data Services Database. In addition, the data were pre-processed through the following steps: (I) financial firms were excluded due to their different governance and performance systems compared to non-financial Chinese firms; (II) firms designated as "special treatment" (i.e., firms that suffered continuous losses for two successive years and faced the risk of delisting were not included to avoid the impact of abnormal

financial conditions; (III) data samples with missing information were removed to improve the accuracy and availability of data and reduce the impact of missing values on the results; (IV) all continuous variables were winsorised at the 1st and 99th percentiles to minimise the influence of extreme values. Applying the aforementioned selection criteria,

we obtained 27,163 firm-year observations of non-balanced samples, representing 3,920 unique firms. In comparison to all Chinese A-share listed companies during the period, our sample firms comprised 82.23%, constituting a substantial proportion of the typical corporate cohort. The details of our sample selection procedure are outlined in Tab. 1.

Tab. 1: Sample selection procedure

	Number of observations	Number of unique firms	Percentage of firms (%)
Original sample	33,666	4,767	100.00
Less: observations in the financial sector	753	124	2.60
Less: observations of specially treated firms	825	132	2.77
Less: observations with missing variables	4,925	591	12.40
Final sample	27,163	3,920	82.23

Note: Table presents the sample selection procedure over the period 2012 to 2021.

Source: own

Tab. 2: Sample distribution by year

Year	Total	Dummy (DT) = 0	Dummy (DT) = 1	Percentage of DT = 1
2012	1,964	1,282	682	34.73
2013	2,109	1,216	893	42.34
2014	2,163	1,017	1,146	52.98
2015	2,272	840	1,432	63.03
2016	2,443	817	1,626	66.56
2017	2,719	805	1,914	70.39
2018	3,089	856	2,233	72.29
2019	3,160	794	2,366	74.87
2020	3,324	675	2,649	79.69
2021	3,920	855	3,065	78.19
Total	27,163	9,157	18,006	66.29

Note: Table presents the distribution of the sample over the period 2012 to 2021.

Source: own

Tab. 2 reports the distribution of firms undergoing digital transformation (measured by a binary variable) over the sample period. Across

all observed years, the percentage of firms with digital transformation was at its lowest in 2012, at approximately 34.37%, while it peaked

in 2020, approaching 79.69%. The overarching trend indicates a gradual increase in the prevalence of firms with digital transformation.

2.2 Variables

(I) Dependent variable. The dependent variable of our research is innovation quality (*IQ*), with a natural logarithm of one plus firm's invention patents applied for being utilized as a measure of *IQ*. The reason for exclusively using invention patents instead of all types of patents (including design and utility patents) as a proxy for *IQ* is that, in China, invention patents must meet the requirements of "novelty, inventiveness, and practical applicability" to pass the examination. In contrast, design or utility patents only require the absence of similar prior applications. Therefore, invention patents exhibit a higher degree of technological advancement and quality. Additionally, *IQ_A* is the natural logarithm of one plus firm's invention patents granted, which is used as an indicator for robustness check. These are two of the most commonly used measures for innovation quality in prior studies (e.g., Hu et al., 2020; Iqbal et al., 2020; Mao et al., 2020; Yuan & Wen, 2018).

(II) Independent variable. Digital transformation (*DT*) is the independent variable of our

focus. Annual reports reflect a firm's strategy and future direction, which means that textual analysis of annual reports can effectively reflect a firm's strategic orientation (Kindermann et al., 2021).

Following Tu and He (2022) and Sun et al. (2022), the paper uses a Python crawler for the construction process of the digital transformation measures to collect the annual reports of selected sample firms as follows. First, this research employed terms such as "artificial intelligence," "cloud computing," "blockchain," "big data," and "digital technology application" as seed words. Second, Python's Jieba and Re modules extracted all textual content, followed by text cleansing, matching, and word frequency statistics. This process involved word segmentation and the removal of stop words to create the corpus for this study. Third, the word2vec model of machine learning was employed to train on the corpus, generating word vectors and calculating similarities between words. This allowed for the identification of semantically related words to the seed words. Fourth, the generated seed dictionary of the five dimensions (Tab. 3) was utilized to calculate the frequency of occurrence of digital transformation keywords across firms.

Tab. 3: Keywords of digital transformation

Dimension	Keywords
Artificial intelligence (AI)	Artificial intelligence, business intelligence, intelligent robotics, machine learning, deep learning, image understanding, investment decision aids, intelligent data analysis, semantic search, biometrics, face recognition, voice recognition, identity verification, autonomous driving, natural language processing
Blockchain (BC)	Blockchain, digital currency, differential privacy technologies, smart financial contracts, distributed computing
Cloud computing (CC)	Cloud computing, streaming computing, converged architecture, EB-class storage, billion concurrency, graph computing, in-memory computing, multiparty secure computing, brain-like computing, green computing, cognitive computing, internet of things, information physical systems
Big data (BD)	Big data, data mining, text mining, data visualization, heterogeneous data, credit reporting, augmented reality, mixed reality, virtual reality
Digital technology application (DTA)	Mobile internet, B2B, B2C, C2B, C2C, O2O, e-commerce, industrial internet, mobile internet, internet healthcare, mobile payment, third-party payment, smart customer service, smart marketing, quantitative finance, NFC payment, smart energy, netlink, smart wearing, smart agriculture, smart transportation, smart healthcare, smart home, smart investment, smart tourism, smart environmental protection, smart grid, digital marketing, unmanned retail, internet finance, digital finance, fintech, financial technology, open banking

Source: own

The frequencies were then subjected to a natural logarithmic transformation with an addition of one that is, LN (keyword occurrence frequency + 1), which is used to measure all samples' degree of digital transformation.

(III) Control variables. This study controlled for a series of factors potentially associated with innovation quality. Consistent with previous research (e.g., Choi et al., 2011; Hou et al., 2017; Hu et al., 2020; Yuan & Wen, 2018; Zhang et al., 2022), the control variables include firm size (*FS* – the natural logarithm of total assets), firm age (*FA* – the natural logarithm of the number of years since the firm's establishment plus one), financial leverage (*LEV* – the book value of total debts divided by total assets), return on assets (*ROA* – the value of net income divided by total assets), sale growth (*SG* – the ratio of the operating income changed to the operating income in the last year), board size (*BS* – the natural logarithm of the total number of directors on a firm's board), ownership concentration (*OC* – the percentage of shares owned by the largest shareholder), and institutional ownership (*IO* – the number of shares held by institutional investors divided by the total shares).

2.3 Empirical model

In the realm of innovation, past innovation levels have been shown to influence future innovation output to some extent (e.g., Iqbal et al., 2020; Pu & Zulkafli, 2024). Simultaneously, reverse causality and omitted variables are acknowledged shortcomings often associated with the use of static models (e.g., Yuan & Wen, 2018; Zhang et al., 2022). To mitigate the bias caused by endogeneity issues mentioned above, we employed a two-step system GMM estimation approach (Arellano & Bond, 1991; Blundell & Bond, 1998). This method addresses unobserved endogeneity through technical treatment of instrumental variables. The following dynamic innovation quality model is utilized to examine the relationship between digital transformation and innovation quality.

$$IQ_{it} = \chi_0 + \alpha IQ_{it-1} + \beta DT_{it} + \gamma Controls_{it} + \eta_i + \mu_t + \varepsilon_{it} \quad (1)$$

where: IQ_{it} represents the innovation quality of firm i in year t .

The lagged values of this variable are included as regressors to capture the persistence

of innovation. Given the highly persistent nature of innovation, we also experimented with higher-order lags but found that second order and higher-order lags were not statistically significant, indicating that the appropriate empirical specification should include one lags of the dependent variable.

The primary variable of interest DT_{it} is the level of digital transformation of firm i in year t . Thus, β measures the effect of digital transformation on innovation quality. $Controls_{it}$ is the vector of control variables, χ_0 represents the intercept of the equation, η_i denotes the set of firm dummies, μ_t denotes the year fixed effects, and ε_{it} is the error term.

3. Results

3.1 Descriptive statistics

The descriptive statistics for the key variables in our investigation are presented in Tab. 4, illustrating the mean, standard deviation, minimum, and maximum values of these variables. For *IQ*, the mean and standard deviation after natural logarithm transformation is 1.863 and 1.532, respectively, indicating an average of 5.44 invention patent applications across all firms in our sample, with significant variations observed in most *IQ* values compared to the mean. The natural logarithm of *DT* ranges from a minimum of 0 to a maximum of 5.056, with a mean value of 1.415. This indicates that while the maximum occurrence of digital transformation keywords in our sample firms' annual reports reaches up to 156 instances, the overall level of digital transformation remains relatively low. The descriptive statistics of the remaining variables are generally consistent with the existing literature and the actual situation (e.g., Yuan & Wen, 2018; Zhang et al., 2022).

3.2 Main results

Before employing the two-step system GMM estimator, we conducted within-group parameter tests on lagged dependent variables using both the pooled ordinary least squares (POLS) and fixed effects model (FEM). As noted by Bond (2002), due to unobserved heterogeneity and the positive correlation between lagged dependent variables and error terms, POLS introduces an upward bias in dynamic regression models. Conversely, FEM in dynamic regression models exhibits a downward bias owing to the negative correlation between transformed lagged dependent variables

Tab. 4: Descriptive statistics

Variables	N	Mean	Std. dev.	Min	Max
<i>IQ</i>	27,163	1.863	1.532	0.000	5.974
<i>DT</i>	27,163	1.415	1.388	0.000	5.056
<i>FS</i>	27,163	22.267	1.293	19.814	26.153
<i>FA</i>	27,163	2.921	0.319	1.609	3.497
<i>LEV</i>	27,163	0.422	0.203	0.050	0.893
<i>ROA</i>	27,163	0.041	0.063	-0.239	0.222
<i>SG</i>	27,163	0.170	0.390	-0.544	2.445
<i>BS</i>	27,163	2.122	0.198	1.609	2.708
<i>OC</i>	27,163	34.206	14.810	8.630	74.180
<i>IO</i>	27,163	44.383	25.029	0.321	94.529
<i>IQ_A</i>	27,163	1.225	1.253	0.000	5.063
<i>DT_A</i>	27,163	0.663	0.473	0.000	1.000

Note: *IQ* – innovation quality; *DT* – digital transformation; *FS* – firm size; *FA* – firm age; *LEV* – financial leverage; *ROA* – return on assets; *SG* – sale growth; *BS* – board size; *OC* – ownership concentration; *IO* – institutional ownership; *IQ_A* – alternative variables of innovation quality; *DT_A* – alternative variables of digital transformation.

Source: own

and transformed error terms. In other words, the coefficient of lagged dependent variables in the transformed GMM estimator should fall between those of FEM and POLS.

Columns (1) and (2) of Tab. 5 present the POLS estimate and FEM-computed coefficients of lagged dependent variables (*L.IQ*), which are 0.824 and 0.289, respectively. As indicated in column (3) of Tab. 5, the coefficients of *L.IQ* calculated using GMM are 0.356 lies between FEM (downward bias) and POLS (upward bias), emphasizing the accuracy of GMM for panel system estimation of dynamic innovation quality models and their associated conclusions. Following Roodman (2009), we collapse the instrument matrix to limit the number of instruments preventing the model from being over-fitted. Furthermore, we use only one lags as instruments. In all the specifications, the lagged dependent variable is treated as predetermined, and all the control variables are assumed to be endogenous, except, of course, year dummies that instrument themselves. Additionally, diagnostic tests for the dynamic panel GMM produce satisfactory results. As anticipated, the null hypothesis of no first-order serial correlation (AR1) is rejected, while the null hypothesis

of no second-order serial correlation (AR2) stands unchallenged. Hansen test statistics for instrument over-identification do not merit rejection at conventional significance levels, affirming the validity and suitability of the employed instruments.

Column (3) of Tab. 5 indicates a significant positive correlation between lagged innovation quality (*L.IQ*) and current innovation quality (*IQ*), suggesting that past innovation output quality influences current innovation output quality, confirming that *IQ* is a dynamic process. Column (3) also reports regression results testing the relationship between *DT* and *IQ* in the study. The coefficient on *DT* is significantly positive at the 1% significance level ($\beta = 0.187$), which indicates that the overall impact of *DT* on *IQ* is significantly positive with eight control variables. Thus, it can be concluded that digital transformation significantly enhances innovation quality.

Regarding control variables, *FS* and *BS* are positively correlated with *IQ*, indicating that firms with larger asset and board sizes exhibit better innovation quality compared to those with smaller asset and board sizes. Moreover, the results suggest significant negative relationships between *FA*, *LEV*, and *IO* with *IQ*,

implying that firms with longer existence, higher debt financing ratios, and more institutional holdings are unfavorable for innovation quality. Finally, ROA, SG, and OC coefficients are

insignificant. Overall, those results for coefficients and significance are generally the same as the conclusions of Iqbal et al. (2020) and Yuan and Wen (2018).

Tab. 5: Main results

Variables	POLS IQ (1)	FEM IQ (2)	GMM IQ (3)
<i>L.IQ</i>	0.824***	0.289***	0.356***
	(0.004)	(0.012)	(0.025)
<i>DT</i>	0.033***	0.031***	0.187***
	(0.004)	(0.009)	(0.058)
<i>FS</i>	0.096***	0.316***	0.365***
	(0.006)	(0.025)	(0.094)
<i>FA</i>	-0.124***	-0.087	-2.320***
	(0.020)	(0.161)	(0.785)
<i>LEV</i>	-0.080**	-0.229***	-1.146**
	(0.034)	(0.081)	(0.523)
<i>ROA</i>	0.615***	0.050	0.092
	(0.097)	(0.132)	(1.455)
<i>SG</i>	0.109***	0.028*	-0.181
	(0.018)	(0.016)	(0.359)
<i>BS</i>	-0.012	0.007	5.882**
	(0.030)	(0.065)	(2.527)
<i>OC</i>	-0.001***	0.000	0.008
	(0.000)	(0.002)	(0.009)
<i>IO</i>	-0.001	-0.000	-0.011**
	(0.000)	(0.001)	(0.005)
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
No. of firms	3,441	3,441	3,441
No. of IVs			35
<i>P</i> -value of AR1			0.000
<i>P</i> -value of AR2			0.162
<i>P</i> -value of Hansen			0.613
<i>R</i> -squared	0.732	0.686	
<i>N</i>	22,910	22,910	22,910

Note: *, ** and *** denote statistical significance at the 10, 5 and 1% levels, respectively; robustness standard errors are reported in brackets.

Source: own

3.3 Robustness checks

(I) Subsample regression test. The COVID-19 pandemic led to the rapid adoption of remote working. It forced firms to quickly adopt digital tools to support employees in their innovative activities. While these accelerated certain aspects of digital transformation, it might have been an emergency measure rather than a long-term strategic shift in some cases. To ensure more reliable results, this study dropped samples of 2020 and 2021. After passing diagnostic tests for dynamic panel GMM, the results of *DT* in column (1) of Tab. 6 support the previous regression results.

(II) Substitute estimation method: use difference GMM. The difference GMM offers a robust tool to eliminate regression outliers and reduce estimation bias (Bond, 2002). This section proceeds to re-estimate model (1) using the dynamic two-step difference GMM estimator.

The coefficient and significance level of *DT* ($\beta = 0.490$, $p < 0.05$) reported in column (2) of Tab. 6 is consistent with the baseline conclusions.

(III) Substitute dependent variable. Following Mao et al. (2020), this paper takes the natural logarithm of one plus firm's invention patents granted, yielding new measures of innovation quality (*IQ_A*). Then, model (1) is re-ran. As shown in column (3) of Tab. 6, the diagnostic tests for the dynamic panel GMM exhibit satisfactory results, and the regression coefficient of *DT* on *IQ_A* remains positive and significant at the 1% level, which confirms the baseline findings of this research that there is a positive relationship between *DT* and *IQ*.

(IV) Substitute independent variable. We utilize a binary dummy variable (*DT_A*) to capture firms' digital transformation within a given year. Specifically, *DT_A* is assigned

Tab. 6: Robustness checks

Variables	SYS-GMM <i>IQ</i> (1)	DIF-GMM <i>IQ</i> (2)	SYS-GMM <i>IQ_A</i> (3)	SYS-GMM <i>IQ</i> (4)
<i>L.IQ</i>	0.326*** (0.042)	0.446*** (0.130)		0.423*** (0.036)
<i>L.IQ_A</i>			0.249*** (0.048)	
<i>DT</i>	0.143** (0.064)	0.490** (0.231)	0.167*** (0.058)	
<i>DT_A</i>				0.435** (0.191)
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of firms	3,142	3,223	3,441	3,441
No. of IVs	30	24	28	38
<i>P</i> -value of AR1	0.000	0.000	0.000	0.000
<i>P</i> -value of AR1	0.111	0.292	0.364	0.130
<i>P</i> -value of Hansen	0.741	0.204	0.175	0.110
<i>N</i>	16,525	19,323	22,910	22,910

Note: ** and *** denote statistical significance at the 5% and 1% levels, respectively; robustness standard errors are reported in brackets.

Source: own

a value of 1 if digital transformation-related words are mentioned in a firm's annual report for that year; otherwise, it is assigned a value of 0. Model (1) underwent re-estimation, and the regression outcomes are presented in column (4) of Tab. 6. It is evident from the results that there is a significant positive correlation between digital transformation and innovation quality, consistent with the findings in Tab. 5.

3.4 Extended analysis

(1) Dimensions of digital transformation

These results indicate that digital transformation can promote innovation quality. An intriguing question arises regarding the dimensions driving this effect.

As mentioned in the theoretical background section, numerous studies emphasize the transformative potential of artificial intelligence, blockchain, cloud computing, big data, and digital technology applications in reshaping organizational operations and fostering innovation (e.g., Guo et al., 2022; Şimşek et al., 2019; Srinivasan & Venkatraman, 2017). These technologies provide firms with unprecedented opportunities to optimize processes, enhance decision-making, and drive product and service innovation. However, there is no clear answer

as to which dimension of digital transformation can navigate the complex technological landscape and make informed decisions to enhance innovation quality.

To examine the relationship between different dimensions of digital transformation and innovation quality, we decompose the indicators calculated from digital transformation keywords (Tab. 3) into single indicators of five dimensions: artificial intelligence (AI), blockchain (BC), cloud computing (CC), big data (BD), and digital technology applications (DTA). Columns (1–5) of Tab. 7, respectively, display the results for artificial intelligence, blockchain, cloud computing, big data, and digital technology applications. Overall, except for the second column representing BC, which does not influence IQ, the other four columns (AI, CC, BD, and DTA) positively promote IQ. This finding aligns with the conclusions of Wang et al. (2022b), suggesting that while blockchain technology can enhance the security of customer information and accelerate knowledge sharing, the limitation of protecting customer privacy necessitates more time for firms to consider embracing this groundbreaking technology correctly in the innovation domain.

Tab. 7: Dimensions of digital transformation and innovation quality – Part 1

Variables	Artificial intelligence IQ (1)	Blockchain IQ (2)	Cloud computing IQ (3)	Big data IQ (4)	Digital technology application IQ (5)
L.IQ	0.371***	0.859***	0.300***	0.907***	0.269***
	(0.026)	(0.153)	(0.048)	(0.123)	(0.049)
AI	0.278***				
	(0.072)				
BC		-0.190			
		(0.848)			
CC			0.254**		
			(0.103)		
BD				0.199**	
				(0.085)	
DTA					0.290**
					(0.136)

Tab. 7: Dimensions of digital transformation and innovation quality – Part 2

Variables	Artificial intelligence IQ (1)	Blockchain IQ (2)	Cloud computing IQ (3)	Big data IQ (4)	Digital technology application IQ (5)
Control variables	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
No. of firms	3,441	3,441	3,441	3,441	3,441
No. of IVs	28	28	32	27	25
P-value of AR1	0.000	0.000	0.000	0.000	0.000
P-value of AR1	0.106	0.810	0.109	0.671	0.135
P-value of Hansen	0.744	0.778	0.111	0.806	0.600
N	22,910	22,910	22,910	22,910	22,910

Note: ** and *** denote statistical significance at the 5% and 1% levels, respectively; robustness standard errors are reported in brackets.

Source: own

(2) Heterogeneity analysis

To clarify the diverse effects of digital transformation on innovation quality, this research performs a subsample analysis considering variations in property rights and regional heterogeneity in China.

(I) Property rights. Due to variations in property rights across firms, the impact of firms' digital transformation on innovation quality may vary. To verify this assumption, this study conducted a subsample analysis separately for state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs), as shown in columns (1–2) of Tab. 8. In SOEs subsample, the coefficients of *DT* are 0.040, which is insignificant. In contrast, the coefficient of *DT* is significantly positive at the 5% level in the non-SOEs subsample, signifying that digital transformation distinctly enhances innovation quality among non-state-owned enterprises.

(II) Regional heterogeneity. The extent of digitization within a region and the strength of policy support both shape a firm's inclination toward digital transformation. Consequently, this may indirectly impact the role of digital transformation in fostering innovation quality within firms, resulting in spatial disparities (Miao

et al., 2021). Accordingly, utilizing the regional classification standards of the National Bureau of Statistics of China, this study categorizes the provinces hosting the sample firms into eastern, central, and western regions to explore the heterogeneity of the promoting effect of digital transformation on innovation quality. As detailed in columns (3–5) of Tab. 8, where East, Central, and West represent the eastern, central, and western regions, respectively, disparities in the influence of digital transformation on innovation quality across these regions are evident. Notably, the Central region demonstrates the most substantial and statistically significant positive impact ($\beta = 0.356$, $p < 0.05$), succeeded by the Eastern region ($\beta = 0.195$, $p < 0.05$), while the Western region exhibits no discernible contribution of digital transformation to innovation quality. These findings underscore a distinct spatial imbalance in the relationship between digital transformation and innovation quality.

3.5 Discussion

Digital transformation underscores the amalgamation of artificial intelligence, blockchain, cloud computing, and big data to reconfigure

Tab. 8: Heterogeneity effects of digital transformation on innovation quality

Variables	SOE IQ (1)	Non-SOE IQ (2)	East IQ (3)	Central IQ (4)	West IQ (5)
<i>L.IQ</i>	0.397***	0.321***	0.334***	0.364***	0.467***
	(0.051)	(0.028)	(0.038)	(0.063)	(0.062)
<i>DT</i>	0.040	0.168**	0.195**	0.356**	0.073
	(0.034)	(0.075)	(0.076)	(0.179)	(0.063)
Control variables	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
No. of firms	1,200	2,490	2,517	438	523
No. of IVs	34	29	25	28	33
<i>P</i> -value of AR1	0.000	0.000	0.000	0.000	0.000
<i>P</i> -value of AR1	0.154	0.111	0.489	0.155	0.527
<i>P</i> -value of Hansen	0.530	0.578	0.194	0.989	0.642
<i>N</i>	8,399	14,511	16,189	3,039	3,681

Note: ** and *** denote statistical significance at the 5% and 1% levels, respectively; robustness standard errors are reported in brackets.

Source: own

prevailing economic production and service models. It fundamentally overhauls both internal and external organizational structures, operational processes, and value creation patterns (Guo et al., 2022; Peng & Chang-Qi, 2022; Reuschl et al., 2022). The findings of this study confirm a significant enhancement in innovation quality due to digital transformation. This evidence aligns with previous research perspectives, indicating digital transformation as a driver of microeconomic impacts. For instance, Vial (2019) affirmed that digital technologies trigger strategic responses within organizations, with dynamic capabilities in digital structures acting as key catalysts for transformation. Ferreira et al. (2019) revealed the beneficial impact of digital transformation on service and process innovation within enterprise innovation domains.

Regarding the specific dimensions driving innovation quality, this study reveals that the four sub-dimensions of digital transformation – artificial intelligence, cloud computing, big data, and digital technology applications – all have a positive and beneficial impact

on enhancing innovation quality. Our findings resonate with established literature in two main aspects. First, digital transformation aids in reducing barriers to information flow. The widespread adoption of digital technologies alleviates information asymmetry between managers and shareholders, thus reducing agency costs and promoting R&D investment (Ferreira et al., 2019; Gong & Ribi re, 2021; Rachinger et al., 2019). Second, digital technologies lower costs associated with knowledge storage, amplify operational platform efficiency, narrow knowledge gaps, and reduce reliance on single-resource suppliers (Ma & Zhu, 2022;  im ek et al., 2019; Srinivasan & Venkatraman, 2017). Consequently, it minimizes the waste of non-R&D time and significantly enhances the efficiency of innovation activities.

In subsequent analyses, this study indicates that the impact of digital transformation is more pronounced on non-state-owned enterprises as well as enterprises located in the central and eastern regions. Prior research has also noted potential differences associated with ownership and regional disparities.

Tian et al. (2022) found that the influence of digital transformation on risk-taking is more pronounced in non-state-owned enterprises, indicating potential differences in its impact across ownership types. Mao and Failler (2022) confirmed that the central regions of China are still in the early stages of digital economic development, with significant marginal effects of digital transformation on innovation quality. In contrast, the eastern regions, due to their geographical location, have entered the middle to mature stages of digital economic development, limiting to some extent the impact of digital transformation on driving innovation activities. However, the weaker market environment, innovation environment, and necessary external institutional support for digital economic development in western regions make it difficult for digital transformation to significantly affect innovation quality. Therefore, as mentioned above, heterogeneity testing of the impact of digital transformation on innovation quality also holds policy implications.

Conclusions

Using data from Chinese A-share listed companies from 2012 to 2021, this paper investigates the impact of digital transformation on innovation quality. The findings are as follows: first, digital transformation is positively associated with innovation quality. This result withstands within-group parameter tests on lagged dependent variables, subsample regression tests, alternative difference GMM methods, alternative innovation quality measures, and alternative digital transformation measures. Second, expanded analysis reveals that the four sub-dimensions of digital transformation – artificial intelligence, cloud computing, big data, and digital technology applications – drive the improvement of innovation output quality. Third, the relationship between digital transformation and innovation quality exhibits heterogeneity. Specifically, this promotional effect is prominent only in nonstate-owned enterprises, as well as in the central and eastern regions.

This paper makes significant theoretical contributions and offers valuable policy insights. From a theoretical perspective, it examines the impact of digital transformation on innovation quality through the lenses of agency theory and resource dependence theory, opening the “black box” of factors influencing innovation quality from the sub-dimensions of digital

transformation. Furthermore, this research has important policy implications. Our findings of further tests underscore the heterogeneous impact of digital transformation on innovation quality. Given the significant scale of China's digital economy and the rapid growth of enterprises undergoing digital transformation, policymakers in China may consider strengthening the digital technology infrastructure in western regions, enhancing regulatory frameworks for digital technology protection, and providing policy subsidies to facilitate the flow of innovation elements. Additionally, recognizing the crucial role of state-owned enterprises in China's innovation activities, the government should incentivize them to adopt digital transformation strategies, leveraging technologies such as big data, cloud computing, and artificial intelligence to gain a competitive edge in the digital era. These experiences also offer valuable lessons for other countries undergoing digital transformation. They can explore tailored digital pathways to enhance their own innovation quality. By implementing differentiated policies to promote balanced development among enterprises with different ownership structures and in different regions, policymakers can ensure that the dividends of digital transformation benefit a wider range of areas and firms.

The research comprises a couple of limitations, which may be seen as a suggestion for more investigation. First, although we constructed a relatively comprehensive digital transformation indicator using machine learning methods, we have not examined the relationship between digital transformation and aspects such as corporate R&D expenditure, green innovation, and the sustainability of innovation. Second, our study only attempts to examine the relationship between digital transformation (including five dimensions) and innovation quality, lacking some factors that moderate this relationship. Therefore, it is suggested that future researchers extend relevant topics by incorporating other aspects of innovation activities and moderating factors to gain a deeper understanding of the impact of digital transformation on innovation.

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The welfare effects of digital infrastructure: Micro-level evidence from China

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Abstract: Over the past 40 years of reform and opening-up, China has achieved remarkable progress in rural infrastructure development. Although some empirical studies have demonstrated a positive relationship between the provision of digital infrastructure and increases in agricultural output and farmer income in various developing countries, research exploring the impact of digital infrastructure on rural households' welfare is rare. This gap represents a significant issue for policymakers and academic researchers in developing countries today. By matching micro-survey data with county-level digital infrastructure investment data, this paper empirically examines the effects and mechanisms of digital infrastructure on the welfare of rural households using ordered probit and mediation models. We found that digital infrastructure has a significant impact on rural households' overall welfare levels. Mechanism testing revealed that digital infrastructure operates through at least three distinct pathways, positively affecting both the economic and non-economic welfare of rural households. Additionally, the level of human capital and regional economic development exhibit notable heterogeneous effects on the impact of digital infrastructure. The validity of the results was demonstrated through instrumental variable regression and a series of robustness tests. The reason behind this result lies in the fact that the improvement of digital infrastructure in rural areas enhances households' ability to access resources, develop skills, and engage in decision-making processes. This objectively improves their living standards and meets their needs. The empirical findings of this study have important policy implications for strengthening rural digital infrastructure, further enhancing rural households' digital skills, and ultimately improving their overall welfare.

Keywords: Digital transformation, rural digital economy, capability theory, household behavior, human capital.

JEL Classification: D10, I31.

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Introduction

In recent years, China's economy has undergone a significant transformation, shifting from a phase of rapid growth to one emphasizing high-quality development (Zhu, 2012). However,

the corresponding progress in the well-being of its residents has not necessarily kept pace with this progress. The World happiness report 2022, published by the United Nations, reveals that over the past decade, residents of mainland

China have experienced a significant 40-place increase in their happiness rankings (Helliwell et al., 2022). Despite this progress, China's ranking of 72 out of 146 countries and regions included in the survey underscores the fact that residents' overall subjective well-being remains below what one might expect from the country's level of economic development. Moreover, unbalanced and insufficient development remains a salient issue in China. This is reflected in the weak agricultural foundation, inadequate rural infrastructure, and substantial disparities in regional development and income distribution between urban and rural areas (Wang et al., 2020). Rural households lag behind their urban counterparts in terms of livelihood and overall quality of life, which adversely affects their subjective well-being (Liu et al., 2020). The ultimate goal of sustainable development is to improve people's livelihood and well-being, with a paramount focus on continuously amplifying their sense of gain, happiness, and security. This is an inevitable requirement that centers on the people and their needs. Against this backdrop, policymakers have come to acknowledge the critical significance of sustainable and balanced development and are striving to elevate the overall well-being of rural households, which represents an integral facet of the ongoing rural revitalization strategy.

Efforts are underway to address this purpose and foster inclusive growth. China has been actively pursuing a digital village construction that aims to optimize the accessibility and connectivity of digital infrastructure in rural areas (Zhao et al., 2022). The Digital Village Development Strategy Outline released by China clearly defines the concept of a digital village as the application of network, informatization, and digitization in the economic and social development of agriculture and rural areas, as well as the empowerment of farmers' modern information skills. This is an important aspect of endogenous agricultural and rural modernization development and transformation process. In 2015, approximately 50,000 administrative villages in China lacked access to broadband, while 150,000 administrative villages had broadband access capacity below 4 Mbps. This created a noticeable "digital divide" between urban and rural areas. However, significant progress has been made through the construction of digital villages. As of the end of 2021, every administrative village in China has successfully achieved

broadband connectivity. The construction of digital village serves to augment the accessibility of digital technologies and services specifically tailored to the domains of "agriculture, rural areas, and farmers," thereby effectively bridging the digital divide between urban and rural regions (Cai et al., 2023). In the era of the digital economy, the digital village construction is fundamentally transforming traditional behavior patterns, working arrangements, and social relationships among rural households, leading to far-reaching impacts on their income sources, employment opportunities, and participation in rural governance (Zhao & Li, 2022). However, does digital village construction truly make rural households happier and more satisfied with their daily work and life? And if so, what are the specific mechanisms involved?

With the increasing availability and advancement of information technology, the digital economy has flourished in rural areas of China, resulting in significant transformations in production and living environments. These developments have inevitably impacted the subjective well-being of rural households themselves (Bao et al., 2021; Xie & Liu, 2023). First, the construction of digital villages is seen as a significant step towards promoting rural digital economy. Its primary objective is to accelerate the construction of rural digital infrastructure and facilitate the digital transformation of agriculture and rural areas. Digital technology plays a crucial role in advancing the quality of agricultural information services, facilitating the integration of the digital economy and characteristic agriculture, and fostering new rural business forms (Qin et al., 2022). Furthermore, rural e-commerce has the potential to revolutionize the rural circulation service system, mitigate information asymmetry in the agricultural market, and boost the agricultural economic cycle (Phelps et al., 2022). Second, digital village construction can deepen rural services for the benefit of the people. The application of digital technology can facilitate the comprehensive coverage of rural social security, settle medical insurance for rural residents in different places, and enable online transfer and continuation of social security (Hirko et al., 2020). "Internet plus" empowering rural public services can advance the quality of rural education and medical services, promote the connection between urban high-quality public resources

and rural areas, and promote the integrated development of urban and rural informatization (Velsberg et al., 2020). Digital village construction can help the coordinated sustainable development of the rural economy and society, and promote the equalization of urban and rural public services. It serves as the intersection between China's rural revitalization strategy and the development of the digital economy, presenting a historic opportunity to enhance the well-being and foster a better quality of life for rural households. Previous research has given little attention to the relation between digital village construction and rural households' subjective well-being, and there is also a shortage of empirical analysis based on concrete evidence. In light of this, this paper aims to test empirically the impact of digital village construction on rural households' subjective well-being by using micro-survey data, and to investigate its mechanisms as well as the heterogeneity of its effects. Our results are of interest to those involved in research about the well-being of low-income groups, the dynamics of the rural digital economy, and happiness economics.

We integrate the emerging concept of the digital village within the framework of happiness economics, and the main contributions of this paper are as follows. First, it offers a new research perspective. Previous studies have mainly focused on internal factors influencing well-being, neglecting the potential impact of external factors such as digital village construction. This paper expands the research scope by examining the level of digital village development, providing a valuable addition to the existing literature. Second, it provides more precise data. The existing literature often relies on provincial-level data for analysis. In contrast, we match digital village variables at the county level with micro-level data on subjective well-being in households, thereby overcoming the ambiguity and limitations of provincial-level data. This approach facilitates a deeper analysis of the mechanisms behind the promotion of rural households' subjective well-being through digital village construction. Third, this paper holds significant policy implications. On one hand, digital technology empowerment is an important direction for rural economic development. On the other hand, enhancing rural households' subjective well-being has become a highly prioritized concern for the policymaker. Based on the perspective

of happiness economics, we investigate the welfare effect of digital village construction, providing theoretical and empirical support for the sustainable development of rural areas within the digital economy.

There are five sections in this paper. The literature review and hypotheses are presented in Section 1. The methods and database used in this paper are described in Section 2. The main results are detailed in Section 3, along with the results of the mechanism test. In the final section, the conclusion is provided, along with policy implications and limitations.

1. Theoretical background

1.1 Research on subjective well-being

For a long time, research on human welfare has excelled in its interdisciplinary orientation, including philosophy, psychology, economics, and sociology, with a primary focus on understanding the concept and determinants of welfare. Happiness research shows that reported subjective well-being is a far better measure of individual welfare (McMahon, 2013). In particular, empirical studies in economics often rely on the assessment provided by the individuals directly involved, making it a straightforward approach to inquire about their well-being. Many surveys include questions on individuals' overall self-reported life satisfaction, which provides a favorable indication of their subjective well-being (Veenhoven, 2012). "Subjective well-being" encompasses a comprehensive evaluation of the extent to which an individual experiences "positive and negative emotion," "sense of happiness" or "satisfaction with life" (Andrews & McKennell, 1980). Therefore, it includes both economic well-being, which can be measured by objective indicators, and non-economic well-being, which is influenced by people characteristics and subjective perceptions. In general, however, as in the literature, the terms "welfare," "happiness," and "subjective well-being" are used interchangeably (Frey, 2010).

The philosophical origins of happiness can be traced back to ancient Greece, with notable contributions from Aristippus' hedonic theory and the Aristotelian school's concept of eudaimonia (Cherry, 2008). In the mid-20th century, the discourse on happiness shifted from philosophy to psychology, exemplified by Warner R. Wilson's influential 1967 work titled "Correlates of avowed happiness" (Wilson,

1967). This shift facilitated the empirical study of happiness within the province of psychology as a scientific endeavor. The integration of diverse perspectives from multiple disciplines forms a comprehensive understanding of subjective well-being, encompassing emotional and cognitive aspects of individual experiences. It denotes the subjective sense of overall pleasure and satisfaction that individuals derive from their lives, taking into account their unique standards and evaluations while considering their life circumstances (Diener, 2000).

The study of happiness by economists originated from the phenomenon known as the “Easterlin paradox.” This paradox posits that the rise in national income does not always result in a commensurate increase in individual happiness. Subsequently, the exploration of factors influencing happiness gradually expanded from psychology to economics (Easterlin, 1974). The majority of the literature has focused on economic factors that influence happiness, such as income, consumption, and employment (Blanchflower, 2021; Easterlin et al., 2011; Mahadea & Ramroop, 2015). Knight and Gunatilaka (2010) analyzed household-level micro-data and discovered that wealthy urban households had lower happiness compared with rural households (Knight & Gunatilaka, 2010). Sacks et al. (2013) argued that over time, income growth will lead to an increase in happiness, while the per capita level of happiness in affluent countries is relatively higher, suggesting that absolute income plays a decisive role in happiness. Gandelman and Porzecanski (2013) found that happiness increases when individual income rises relative to the past (adaptive expectations) or compared with others (social comparison). However, the income gap between countries tends to be stable, and as a result, happiness is also relatively stable, showing insensitivity to income growth (Khalil, 2022; Sarracino, 2013; Zagorski et al., 2014). Another body of literature focuses on non-economic factors, including individual and family characteristics such as age, gender, time preference, education level, health status, marital status, and family upbringing (Chapman & Guven, 2016; Cuiñado & Gracia, 2012; Ifcher & Zarghamee, 2011; Layard, 2006; Veenhoven, 2008). Additionally, social or natural environmental factors such as public policy, welfare systems, religion, social relations, social capital, climate, and pollution also impact an individual’s well-being (Chávez

Villegas, 2016; Lelkes, 2002; Leung et al., 2013; Pacek & Radcliff, 2008; Shier & Graham, 2015; Welsch, 2006).

Traditional welfare economics tends to prioritize the impact of material wealth on an individual’s well-being, often neglecting the significance of values such as fairness and freedom. Drawing on careful reflections of conventional approaches to measuring welfare, such as utilitarianism and John Rawls’ theory of justice, Amartya Sen provided a reinterpretation of the welfare concept and introduced the capability approach (Feibleman, 1973; Taylor, 1988). It broadens the understanding of welfare beyond economic factors and highlights the significance of individuals’ freedom to live lives they have reason to value based on factors such as health, adequate housing, and participation in political life (Sen, 1985). These beings and doings are the so-called functionings, which constitute an individual’s well-being (Sen, 2004). All the functionings an individual can choose are called the capability set. However, the capability set is often not directly observable, so the essence of well-being evaluation lies in the measurement of functionings. Regarding the practical application of the capability approach, it is neither possible nor desirable to create a catch-all definitive list (Robeyns, 2006). For example, if the objective is to study poverty, the researcher should try to measure the capability deprivation, which refers to specific forms of limited capability sets. On the other hand, if the goal is to analyze achieved living standards, one could focus on measuring functioning achievement (Suppa, 2015). However, Amartya Sen did not provide a definitive list of functionings. The precise constituents of functionings have been a fundamental area of inquiry that researchers have continuously explored (Alkire, 2002). In 1993, Amartya Sen examined five dimensions from the perspective of the capability approach, namely, political freedoms, economic facilities, social opportunities, transparency guarantees, and protective security (Sen, 1999). Laderchi conducted an examination of well-being using 1992 data from Chile, focusing on three functionings: education, health, and child nutrition (Laderchi, 1997). Martinetti (2000) conducted a well-being evaluation based on microdata from Italy in 1994, examining various aspects such as housing conditions, health, education and knowledge, social interactions, and psychological conditions. Nussbaum (2003), on the other

hand, proposed a comprehensive list of capabilities which includes ten functionings.

Traditional economics views subjective well-being as the satisfaction of individual desires, representing it in terms of utility and proposing a welfare analysis framework based on income and wealth (Kaldor, 1939). Psychology, on the other hand, defines subjective well-being from both emotional and cognitive dimensions (Ryan & Deci, 2001). Happiness economics, combining research methods from economics and psychology, expands the scope of utility and welfare in traditional economics. It emphasizes that individual subjective well-being stems from the satisfaction of diverse and multi-dimensional needs and desires (Clark & Oswald, 1998). As the focus of this paper, rural households not only desire a decent income, but also strive for equitable job opportunities and meaningful political participation. Based on Sen's capability approach and the realities of rural development in China, we will focus on examining the functionings that constitute the well-being of rural households from three different aspects: First, household income serves not only as the material foundation of well-being but also as a crucial means to attain welfare. According to Sen's theory, income is a key indicator determining whether an individual can achieve their freedoms and significantly influences the realization of other functionings (Oishi & Diener, 2001). Second, we consider non-farm employment opportunities. Considering the realities of China, despite having ample leisure time, many farmers face significant barriers to employment opportunities due to systems such as household registration and residence permits (Wu & Treiman, 2004). Reports on subjective well-being provide insights into how unemployment affects farmers in rural China, and this impact can be attributed to psychological and social factors (Knight et al., 2009). Third, we examine participation in rural governance. Farmers who experience bias and discrimination lack a sense of belonging and ownership in political life, making it difficult for them to truly engage. Therefore, the emotional aspect reflected in rural governance participation is an important component of their subjective well-being (Tang et al., 2020).

1.2 Research on digital village construction

With the rapid development of the digital economy in China, there has been a growing

interest in exploring the impacts of digital village construction. Research in this area primarily focuses on how digital village construction influences various aspects of rural life, including household income, family employment, and rural governance.

Household income

Digital village construction can revamp the digital infrastructure of rural areas and promote the widespread use of information technologies, such as the Internet and big data, in agriculture and rural areas. This can help rural households obtain information and knowledge, expand their income sources, and increase their income, thereby promoting progress in their production and quality of life (Demir et al., 2022). Additionally, digital empowerment in agriculture production can bolster data collection and analysis, promote agricultural technology advancements, and increase rural households' income. The digital development of agriculture and rural areas can also maximize the efficiency of information generation, dissemination, and utilization (Hollman et al., 2021). By expanding the spillover effect of knowledge, it can promote the comprehensive and deep integration of agriculture with other industries. This can lead to the development of multiple rural values, new rural business forms, and an increase in farmers' income. Furthermore, digital finance can ease the credit constraints of rural households, allowing them to expand investments in agricultural production and significantly increase their income (He & Du, 2022). E-commerce can break down the information barriers of the agricultural product market, integrate and optimize the supply chain of agricultural products, reduce the cost of production factors and transaction costs of products, and promote the production and consumption of agricultural products, thereby increasing farmers' income.

Family employment

Digital village construction can upgrade rural e-commerce networks, logistics, and distribution, thereby promoting the rapid development of rural e-commerce. According to research conducted by Ali Research Institute, the number of Taobao villages (the criteria for identifying a Taobao Village is an administrative village with an annual e-commerce transaction volume of 10 million yuan or more, and either a minimum of 100 active online shops

or active online shops accounting for 10% or more of the total village households) in China increased from 2,118 in 2017 to 7,780 in 2022, with a distribution range extending from the initial eastern coast of China to 28 provinces across the country (<http://www.aliresearch.com/EN/index>). Rural e-commerce can foster entrepreneurship among farmers and provide a large number of job opportunities, effectively absorbing surplus rural labor and exhibiting a robust employment-driven effect (Li et al., 2021). The emergence of new business forms associated with the development of the rural digital economy has transformed traditional production divisions and employment relationships in rural areas, leading to the creation of numerous non-farm employment opportunities. Simultaneously, digital economy growth has lowered farmers' employment search costs, eased financing constraints on entrepreneurship, and stimulated farmers' enthusiasm for employment participation (Liu et al., 2021). Therefore, digital village construction is conducive to promoting non-farm employment for rural households, enabling them to earn higher wages, and ultimately boosting their subjective well being.

Rural governance

Rural governance serves as the foundation of social governance and plays a crucial role in the revitalization of rural areas. Digital village construction can bolster the efficiency

of township governments in handling public affairs and enrich the offerings of rural public services. With the aid of digital technology, rural government services and information can be provided online, enabling farmers to access social insurance, agriculture-related subsidies, and other services without having to leave their homes. Digital village construction not only elevates the digital level of rural governance but also promotes social equity. The application of digital technology safeguards farmers' right to vote and right to know, reduces the cost of public affairs decision-making and supervision, strengthens the legality and transparency of rural governance, stimulates farmers' enthusiasm for participating in rural governance, and safeguards migrant workers' right to know and decision-making power concerning collective affairs (Shen & Shen, 2018). Overall, digital village construction empowers rural governance with digital technology, facilitates and benefits the people, and ensures and promotes social equity while improving the subjective well-being of rural households.

Based on the preceding analysis (Fig. 1), this paper proposes these hypotheses:

H1: Digital village construction can enhance the subjective well-being of rural households.

H2: Digital village construction can improve the subjective well-being of rural households by increasing farmers' income, promoting non-farm employment, and strengthening rural governance.

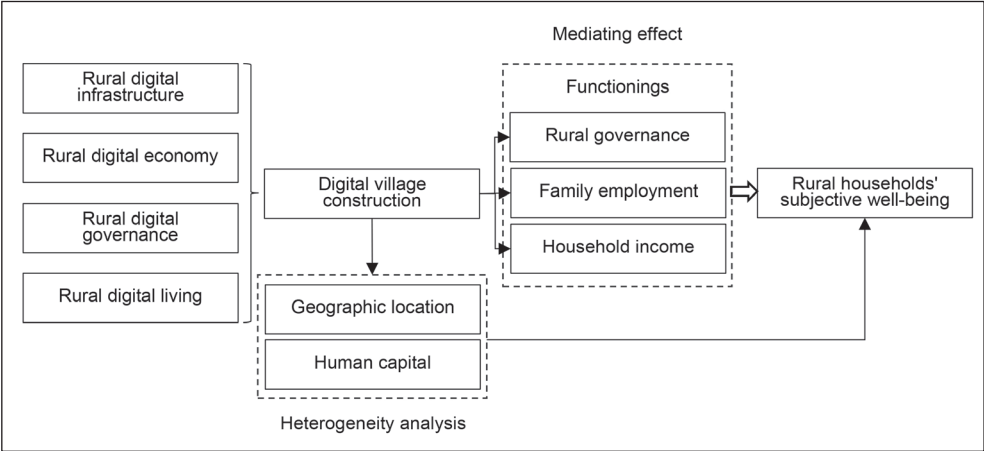


Fig. 1: Analysis framework

Source: own

2. Research methodology

2.1 Model specification

If ordinary least squares (OLS) or multinomial probit models were used directly, they would overlook the inherent ranking of rural households' subjective well-being and treat the ordinal data as cardinal, which could result in a loss of accuracy in model estimation. The ordered probit model, on the other hand, is suitable for analyzing the explained variable that represents discrete ordinal data. Therefore, we use the ordered probit model specified as follows:

$$SW_i = \alpha + \beta DV_i + \gamma_n Control_{i,n} + \varepsilon_i \quad (1)$$

where: the dependent variable SW_i represents the subjective well-being of rural households; the core explanatory variable DV_i represents the level of digital village construction in the county where the rural household i is located; $Control_{i,n}$ is a set of control variables that influence the subjective well-being of rural household i at the individual, family, and regional levels; the constant term is denoted by α , while the coefficients to be estimated are β and γ_n ; and the random error term is denoted by ε_i .

The parameter of interest in this paper is the estimated coefficient β in Equation (1), which represents the overall impact of the level of digital village construction on rural households' subjective well-being. To investigate its specific mechanisms, it is necessary to analyze the mediating effects. As identified in the preceding analysis, digital village construction primarily affects the subjective well-being of rural households through mechanisms such as increasing farmers' income, promoting non-farm employment, and strengthening rural governance. Therefore, we employ a mediation analysis to empirically examine these mechanisms. The mediation model is specified as follows:

$$MV_i = \alpha_1 + \beta_1 DV_i + \gamma_{1n} Control_{i,n} + \theta_i \quad (2)$$

$$SW_i = \alpha_2 + \beta_2 DV_i + \beta_3 MV_i + \gamma_{2n} Control_{i,n} + \varepsilon_i \quad (3)$$

where: the variable MV_i represents the intermediary variable which includes household per capita income, family employment choice, and rural governance level; the coefficients β_1 , β_2 , β_3 are to be estimated, with β_1 and β_3 representing the mediation effects that this paper focuses on.

2.2 Data sources

We use data mainly from the Index of digital rural county database of the Peking University New Rural Development Research Institute and the Ali Research Institute, as well as the China Household Finance Survey (CHFS) database released by China Southwestern University of Finance and Economics. The CHFS data are collected every two years and covers information on the family characteristics, economic conditions, employment, and living conditions of 34,643 households in 345 districts and counties across 29 provinces (autonomous regions and municipalities) in China. The Index of digital rural county (2018) is based on samples from 1,880 county-level administrative units (excluding municipal districts) in China (Fig. 2). It includes four first-level indicators: the rural digital infrastructure index, the rural economy digitalization index, the rural governance digitalization index, and the rural living digitalization index. It also includes 12 second-level indicators and 29 specific indicators. Due to its extensive coverage and the large amount of information collected up to the present, it is perhaps one of the best statistical sources in China for assessing digital village construction. In this paper, we will specifically use the overall digital rural county index for analysis. To ensure data accuracy and completeness, the CHFS 2019 (Gan et al., 2019) database is selected as the research object, and matched with the digital village construction data from the Index of digital rural county (2018). Likewise, data on the sample region characteristics are matched with data from the China County Statistical Yearbook, China Urban Statistical Yearbook, China Regional Economic Statistical Yearbook, etc. The data were matched according to the sample region and year, and a total of 8,205 sample data were obtained.

2.3 Variables

Rural households' subjective well-being

CHFS is a widely recognized microdata survey on the situation of China households. The survey data itself undergoes robust coding and reliability checks after collection. Additionally, the respondents are only eligible to receive compensation upon completing the questionnaire according to the specified requirements. The CHFS (2019) questionnaire includes a question "In general, do you feel happy now?" with five response options: very happy, happy,

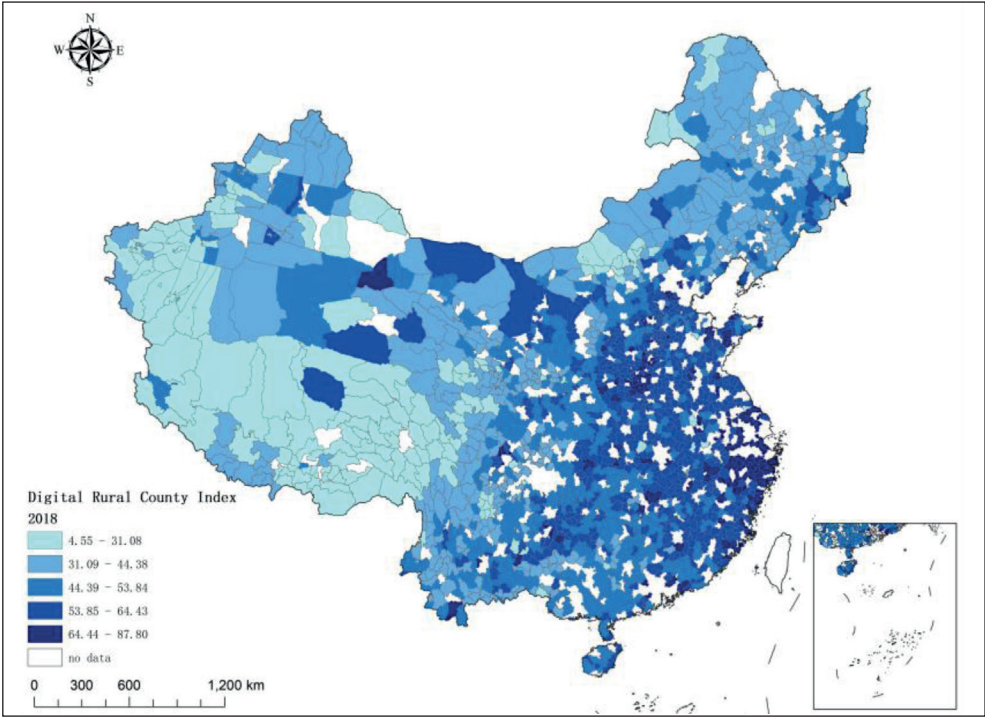


Fig. 2: Index of digital rural county (2018)

Source: the files used to create the map are licensed under GS (2019)1822 available at: <http://www.gov.cn>. The data on the Index of digital rural county were obtained from the Peking University New Rural Development Research Institute and the Ali Research Institute.

average, unhappy, and very unhappy. The responses are assigned values from 1 to 5, with a higher value indicating a greater level of overall family happiness.

Digital village construction

We employ the Index of digital rural county, which is a proxy variable released by the Peking University New Rural Development Research Institute and the Ali Research Institute, to examine the impact of digital village construction level on rural households' subjective well-being. The index adopts a standardized treatment method to uniformly process indicators with different properties and measurement units in a dimensionless manner, so as to reflect digital village development at county level. In the synthesis of specific indices, a layered aggregation approach is adopted, starting from the bottom and progressing to the top. This

means that sub-indices for each layer are calculated first, and then the composite index is obtained by weighting and summarizing these sub-indices. The index is based on various sources of information, such as macro statistical data, Alibaba business platform data, and summary data from related websites, to provide a comprehensive assessment of the overall status of county-level digital village construction.

Control variables

We selected a series of factors that may affect rural households' subjective well-being at the individual, family, and regional levels as control variables. At the individual level, the control variables include the age, gender, marital status, education level, health status, insurance participation, and political affiliation of the household head. At the family level, the control variables include family size, family

Tab. 1: Definitions and descriptive statistics of variables

Variables	Definitions	Mean	Standard deviation
<i>Subjective well-being</i>	Extremely happy = 5, happy = 4, average = 3, unhappy = 2, extremely unhappy = 1	2.05	0.898
<i>Digital village construction</i>	The Index of digital rural county/100	0.53	0.101
<i>Age</i>	The age of the household head (years)	57.87	11.764
<i>Gender</i>	The gender of the household head: male = 1, female = 0	0.85	0.360
<i>Marital status</i>	The marital status of the household head: married = 1, other = 0	0.86	0.351
<i>Education</i>	The educational attainment of the household head (years)	7.02	3.459
<i>Health</i>	Extremely good = 5, good = 4, average = 3, poor = 2, extremely poor = 1	2.96	1.044
<i>Insurance</i>	Whether the household head has pension insurance: yes = 1, no = 0	0.80	0.402
<i>Political affiliation</i>	Whether the household head is a party member: yes = 1, no = 0	0.12	0.328
<i>Family size</i>	The total number of individuals in the household (persons)	3.62	1.842
<i>Family support</i>	The ratio of unemployed individuals in the household to the total household size	0.42	0.326
<i>Debt</i>	The ratio of the household's debt to its assets	0.17	0.604
<i>Housing</i>	The type of housing in which the household resides: self-owned = 1, other = 0	0.93	0.252
<i>Social connection</i>	Whether the household has personal relationship expenses: yes = 1, no = 0	0.54	0.499
<i>Economic development</i>	The natural logarithm of the per capita gross domestic product within the region	10.77	0.469
<i>Economic growth rate</i>	The regional gross domestic product growth rate	0.07	0.019
<i>Environmental pollution</i>	The annual average concentration of inhalable particulate matter in the region (micrograms per cubic meter)	36.17	13.530
<i>Medical resources</i>	The natural logarithm of the number of hospital beds in medical and health institutions within the region	9.99	0.814

Source: own

support status, debt level, housing situation, and social connections. The control variables at the regional level include regional economic indicators, environmental pollution conditions, and medical resource levels. To mitigate the impact of outliers on the research findings, we trimmed the tails of continuous variables reflecting regional characteristics at the 1% level. The definitions and descriptive statistics of the variables are presented in Tab. 1.

3. Research results
3.1 Ordered probit model
Baseline regression

Our goal is to shed light on the impact of digital village construction on the subjective well-being of rural households. We begin the analysis with the ordered probit model as the subjective well-being is an ordered discrete variable. The first three columns in Tab. 2 present the results for the full, urban, and rural samples, respectively. We observed significant positive

coefficients on digital village construction for the full and rural samples, although the coefficients are significantly negative for urban samples. A comparison of the results reveals that rural households are more likely to benefit from digital village construction in terms of augmenting subjective well-being. The last three columns in Tab. 2 add control variables reflecting the characteristics of individuals, families, and regions sequentially to the rural samples. The results remain similar, indicating that adding control variables at the individual, family, and regional levels does not significantly impact the regression results. The coefficients of digital village construction remain significantly positive at the 1% level, indicating that an increase in the digital rural index is associated with a higher probability of rural households reporting higher levels of happiness. This suggests that digital village construction can significantly increase the subjective well-being of rural households, consistent with *H1*.

Tab. 2: Baseline regression results – Part 1

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	All	Urban	Rural			
Digital village construction	0.349*** (0.080)	-0.053*** (0.115)	0.644*** (0.111)	1.071*** (0.116)	1.090*** (0.117)	1.335*** (0.143)
Age				-0.018*** (0.001)	-0.018*** (0.001)	-0.017*** (0.001)
Gender				-0.054 (0.037)	-0.052 (0.037)	-0.070* (0.037)
Marital status				-0.133*** (0.039)	-0.102*** (0.040)	-0.090** (0.040)
Education				0.005 (0.004)	0.006 (0.004)	0.007* (0.004)
Health				0.205*** (0.013)	0.193*** (0.013)	0.190*** (0.013)
Insurance				-0.091*** (0.030)	-0.076** (0.030)	-0.059* (0.030)
Political affiliation				-0.164*** (0.037)	-0.166*** (0.037)	-0.171*** (0.037)
Family size					-0.013 (0.008)	-0.015* (0.008)

Tab. 2: Baseline regression results – Part 2

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	All	Urban	Rural			
<i>Family support</i>					0.083**	0.063
					(0.040)	(0.040)
<i>Debt</i>					0.139***	0.138***
					(0.023)	(0.023)
<i>Housing</i>					0.027	0.028
					(0.051)	(0.051)
<i>Social connection</i>					-0.011	-0.016
					(0.025)	(0.025)
<i>Economic development</i>						-0.001
						(0.032)
<i>Economic growth rate</i>						0.483
						(0.696)
<i>Environmental pollution</i>						-0.007***
						(0.001)
<i>Medical resources</i>						-0.050***
						(0.017)
Observations	15,621	7,416	8,205	8,205	8,205	8,205
Pseudo-R²	0.001	0.000	0.001	0.029	0.031	0.035

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

Robustness analysis

Next, we performed a robustness analysis of the impact on rural households' subjective well-being, conducting three tests: replacing

the regression model, replacing the dependent variables, and changing the sample size. The results are reported in Tab. 3.

Tab. 3: Robustness analysis results

Variables	(1)	(2)	(3)	(4)
	OLS	Probit		Order probit
<i>Digital village construction</i>	1.038***	1.161***	1.444***	1.799***
	(0.224)	(0.179)	(0.272)	(0.200)
Controls	Yes	Yes	Yes	Yes
Observations	8,205	8,205	8,205	6,166
R²/Pseudo-R²	0.084	0.050	0.097	0.037

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

First, we use the OLS model, whose estimated results and significance slightly differ from those of the ordered probit model (Ferrer-i-Carbonell & Frijters, 2004). To account for the potential impacts of unobserved variables such as social development and regional policy differences on rural households' subjective well-being, we provide cluster robust standard errors at the county level for the OLS regression analysis.

Second, we replaced the sorted discrete variable in baseline model by the binary variable of family happiness. The responses of "very happy" and "happy" are defined as "happy family" and assigned a value of 1, while responses of "unhappy" and "very unhappy" are defined as "unhappy family" and assigned a value of 0. Column (2) in Tab. 3 presents the regression results using the probit model in which "average" belongs to "happy family" and is assigned a value of 1. Column (3) presents the regression results in which "average" belongs to "unhappy family" and is assigned a value of 0.

Third, we performed baseline model regression by excluding county-level city samples. Considering the significant variations in development across counties in China, county-level cities have a higher level of economic and social development compared with ordinary counties. To prevent sample bias from interfering with the results of the baseline model regression, we retested the impact on rural households' subjective well-being without the county-level city samples.

All the results in Tab. 3 indicate that the coefficients of digital village construction are significantly positive at the 1% level, consistent with the result of the baseline regression, and therefore, the original conclusion remains robust.

Endogeneity discussion

To minimize the possibility of omitting important variables, we introduced control variables at the individual, family, and regional levels in the baseline model. However, the digital village construction may be endogenous in the baseline model. First, there might be measurement errors in the Index of digital rural county, and the micro-survey data might not capture all the details about households and household heads. This can result in a connection between indicators representing digital village construction and hidden factors that impact rural households' subjective well-being. As a result, it could

affect the results of the baseline model. Second, the impact of digital village construction can be affected by the level of infrastructure and human capital. Families that experience higher levels of happiness often tend to have greater financial resources, live in regions with well-developed digital economies, and possess higher levels of human capital, resulting in reverse causality. Therefore, we attempt to mitigate potential endogeneity problems using the instrumental variable method. We select "the Internet penetration rate in 2008" and "the average value of third-party payment accounts held by other households in the village" as instrumental variables for digital village construction. The popularity of the Internet has a direct impact on the effect of digital village construction, which is consistent with the correlation of instrumental variables. Meanwhile, the Internet penetration rate in 2008 reflects past Internet adoption, which has no direct impact on rural households' subjective well-being during the sample period, thereby satisfying the exogeneity of the instrumental variables. The average holdings of third-party payment accounts can reflect the development level of the digital economy in the village. As the digital economy becomes more developed, the impact of digital village construction may potentially diminish. However, the average value of holding a third-party payment account among other households is not directly related to the subjective well-being of a single household. Therefore, it meets the two conditions necessary for being an effective instrumental variable. The discussion of endogeneity reveals that the weak instrumental variable test indicates a Cragg-Donald Wald F statistic of 915.412, significantly exceeding the critical value of the weak instrumental variable test at the 5% bias level. Furthermore, the F statistic of the first stage is 13.37, exceeding the critical value of the empirical rule of 10. This provides compelling evidence that instrumental variables have a significant impact on the endogenous variables.

We used two-stage least squares (2SLS) and IV probit models to perform instrumental variable regression. When using the IV probit model, family happiness was transformed into a binary variable. The results of both models in the first stage are similar. Columns (1–2) in Tab. 4 demonstrate the estimated results of the 2SLS model, while columns (3–4) show

Tab. 4: Instrumental variable regression results

Variables	(1)	(2)	(3)	(4)
	2SLS		IV probit	
	Digital village construction	Subjective well-being	Digital village construction	Subjective well-being
<i>Digital village construction</i>		1.232***		1.370***
		(0.261)		(0.424)
<i>Internet penetration rate</i>	0.265***		0.265***	
	(0.011)		(0.011)	
<i>Third-party payment account status</i>	-0.219***		-0.219***	
	(0.008)		(0.007)	
Controls	Yes	Yes	Yes	Yes
Observations	8,205	8,205	8,205	8,205

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

the estimated results of the IV probit model. The first-stage regression results in columns (1) and (3) are consistent with expectations, indicating that the marginal effect of digital village construction on subjective well-being is greater in areas with higher Internet penetration rates and relatively low levels of digital economy development. Columns (2) and (4) present the estimated results using instrumental variable regression. The coefficients of digital village construction remain significantly positive, consistent with the baseline regression. Given the careful consideration of the potential endogeneity issue, the results of the baseline regression remain unchanged.

Heterogeneity analysis

First, the imbalanced development in China not only manifests a dual structure but also highlights the disparity in rural development among regions. To address this issue, the sampled provinces were categorized into three groups – eastern, central, and western (according to their geographical locations). The results of the heterogeneity test based on geographic location are presented in the first three columns of Tab. 5. Column (1) reports a significantly positive coefficient of digital village construction at the 10% level, while the coefficient in column (2) is not significant. Column (3) shows that the coefficient of digital village construction is 2.595, which is

significantly larger than the coefficient observed in baseline model and is statistically significant at the 1% level, suggesting that digital village construction has a more positive impact on the subjective well-being of rural households in the western region. One possible explanation for this result is that the eastern region has a higher level of digital economic development, resulting in a relatively smaller impact of digital village construction. In contrast, the western region, with a larger “digital gap,” benefits greatly from digital village construction, upgrading rural digital infrastructure, which positively affect the subjective well-being of rural households.

Second, human capital is recognized as a key factor that affects the difference in digital technology usage between urban and rural areas (Sun et al., 2023). To investigate the impact of human capital, we divided the rural household samples into two groups based on the education level of the household heads: high human capital (junior high school and above) and low human capital (primary school and below). The results of the heterogeneity test based on human capital are reported in the last two columns of Tab. 5. We observed significant positive coefficients on digital village construction for both groups. However, the coefficient value in column (4) is larger, indicating that rural households with higher human capital gain more subjective well-being from digital village construction.

Tab. 5: Heterogeneity test results

Variables	(1)	(2)	(3)	(4)	(5)
	Eastern region	Central region	Western region	High human capital	Low human capital
<i>Digital village construction</i>	0.440*	0.412	2.595***	1.742***	0.669***
	(0.254)	(0.408)	(0.286)	(0.187)	(0.226)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	2,658	2,863	2,684	3,864	4,341
Pseudo- <i>R</i> ²	0.043	0.035	0.048	0.042	0.032

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

This suggests that the development of the rural digital economy relies on high-level human capital, where skilled and educated individuals play a crucial role. Consequently, rural households with higher human capital can experience greater benefits from digital village construction, leading to a boost in their subjective well-being.

3.2 Mediation model

Since the baseline model regression employs an ordered probit model, certain variables, such as household per capita income, urban-rural income gap, and non-farm employment ratio, are not discrete in nature. Therefore, we used the OLS model to examine how digital village construction affects rural households' subjective well-being. The robustness tests indicate that the OLS model may exhibit heteroscedasticity and present challenges in interpreting the predicted values. Nonetheless, these issues do not compromise the consistency and unbiasedness of the estimate (Ferrer-i-Carbonell & Frijters, 2004). We used stepwise regression with Equations (2–3) to investigate how household per capita income, family employment choices, and rural governance level impact the subjective well-being of rural households.

Household income

We examined the impact of digital village construction on the subjective well-being of rural households, mediated by per capita income. The logarithm of per capita income is used as the intermediary variable. The results in columns (1) and (2) of Tab. 6 show that digital

village construction significantly increases per capita income. Introducing rural household per capita income, both digital village construction and income positively affect subjective well-being, indicating that digital village construction augments rural households' subjective well-being by increasing their income.

Digital village construction aims to bridge the urban-rural “digital divide” and narrow the income gap caused by the development of the digital economy. We used the ratio of per capita disposable income between urban and rural areas as a mediator to examine if digital village construction can mitigate the widening urban-rural income gap and enhance the subjective well-being of rural households. The results in columns (3) and (4) reveal that digital village construction significantly narrows the income gap. Introducing the ratio of per capita disposable income, we observed that both coefficients are significantly positive, indicating that the urban–rural income gap does not play the expected mediating role in the relationship between digital village construction and rural households' subjective well-being. Other factors beyond the urban-rural income gap, such as disparities in the household registration system, social security, and medical resources, may play a significant role in influencing the subjective well-being of rural households.

Family employment

We used the ratio of non-farm employment in rural households as an intermediary variable to investigate if digital village construction can promote their subjective well-being

Tab. 6: Mechanism test results based on household income

Variables	(1)	(2)	(3)	(4)
	Per capita income	Subjective well-being	Urban-rural income gap	Subjective well-being
<i>Digital village construction</i>	0.614***	1.006***	-0.965***	1.098***
	(0.152)	(0.101)	(0.031)	(0.119)
<i>Per capita income</i>		0.080***		
		(0.013)		
<i>Urban-rural income gap</i>				0.062*
				(0.038)
Observations	8,205	8,205	8,205	8,205
R²	0.155	0.086	0.405	0.084

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

by increasing non-farm employment. The results in columns (1) and (2) of Tab. 7 show that digital village construction significantly increases the ratio of non-farm employment. Introducing the intermediary variable, both digital village construction and the non-farm employment rate positively affect subjective well-being, indicating that digital village construction increases rural households' subjective well-being by promoting non-farm employment.

In recent years, rural e-commerce growth has led to a significant influx of talents returning to their hometowns. We employed whether rural households start entrepreneurship as an intermediary variable to measure the effects of digital rural construction. The results in column (3) indicate a significant positive relationship between digital village construction and rural household entrepreneurship. In column (4), digital village construction continues to have

Tab. 7: Mechanism test results based on family employment choices

Variables	(1)	(2)	(3)	(4)
	Non-farm employment rate	Subjective well-being	Start businesses	Subjective well-being
<i>Digital village construction</i>	0.319***	1.011***	1.076***	1.179***
	(0.032)	(0.113)	(0.241)	(0.179)
<i>Non-farm employment rate</i>		0.083**		
		(0.041)		
<i>Start businesses</i>				-0.077*
				(0.046)
Observations	8,205	8,205	8,205	8,205
R²/Pseudo-R²	0.175	0.085	0.076	0.050

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

Tab. 8: Mechanism test results based on rural governance

Variables	(1)	(2)	(3)
	Evaluation of public service	Subjective well-being	Subjective well-being
<i>Digital village construction</i>	0.832**	0.921***	
	(0.274)	(0.149)	
<i>Evaluation of public service</i>		0.036***	
		(0.005)	
<i>Degree of digitalization of rural governance</i>			0.307***
			(0.049)
Observations	4,716	4,716	8,205
R ² /Pseudo-R ²	0.003	0.043	0.079

Note: The standard errors in parentheses below the estimated coefficients represent robust standard errors; *, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

Source: own

a significant positive impact on subjective well-being, but starting a business has a negative effect, implying that while digital village construction promotes entrepreneurship, it reduces their subjective well-being. One possible explanation is that starting a business in rural areas requires substantial resources and manpower, leading to financial burdens that can cause unhappiness among rural households. Moreover, the uncertainties and challenges associated with starting a business can negatively impact their subjective well-being.

Rural governance

We used the evaluation of public service work in rural villages as an intermediary variable to examine the impact of digital village construction on enhancing rural households' subjective well-being through strengthening rural governance. The results in columns (1) and (2) of Tab. 8 show that digital village construction augments rural households' satisfaction with public services, thus strengthening governance. Introducing the intermediary variable, both digital village construction and public service evaluation positively affect subjective well-being, indicating that digital village construction boosts rural households' subjective well-being by strengthening rural governance.

Additionally, the digital rural county index incorporates specific indicators that reflect the utilization of third-party payment accounts for government affairs and public services

provision, thereby measuring the level of digitalization in rural governance. We examined the impact of rural governance digitalization on the subjective well-being of rural households, with a focus on the degree of digitalization as the core explanatory variable. The results in column (3) show a significant positive coefficient at the 1% level, implying that facilitating the digitalization of rural governance can elevate rural households' subjective well-being. This suggests that digital village construction upgrades rural governance measures, thereby positively impacting rural households' subjective well-being.

We further investigated the mechanisms through which digital village construction can boost rural household income, non-farm employment opportunities and participation in rural governance. These factors collectively enhance rural households' subjective well-being, supporting H2.

Conclusions

Digital village construction has emerged as a vital strategy aimed at propelling agricultural and rural development. It focuses on bolstering rural digital infrastructure, fostering the growth of the digital economy, delivering essential information services to rural households, and advancing digital governance. This promotes rural revitalization, fosters urban–rural integration, and ultimately elevates the overall well-being of rural households. This paper examines

the impact and mechanisms of digital village construction on rural households' subjective well-being and draws the following conclusions. First, digital village construction upgrades rural digital infrastructure, transforming rural livelihoods, governance, and economy, thus promoting the subjective well-being of rural households. Second, the benefits are prominent in the western region, with a significant increase in subjective well-being compared with the eastern and central regions. Third, rural households with higher human capital experience a greater increase in subjective well-being. Fourth, digital village construction contributes to individual income growth, non-farm employment, and empowered rural governance, effectively promoting subjective well-being. Overall, digital village construction aligns with the objectives of the rural revitalization strategy, aiming to improve rural households' subjective well-being.

The findings of this paper hold significant implications for boosting digital village construction. First, strengthening digital infrastructure is vital to bridge the urban-rural divide. Digital village construction can drive agricultural modernization and benefit underdeveloped regions the most. Leveraging it can reduce regional disparities, boost the rural digital economy, and improve the subjective well-being of rural households. Second, efforts should be made to elevate farmers' information skills for rural revitalization. In the digital economy era, knowledge and information skills are crucial for farmers' income and employment opportunities. Digital village construction bolsters rural development infrastructure, but skilled talents are needed for digital economic dividends. It is essential to promote the integration of digital technology, cultivate farmers' information skills, and attract talents to start businesses in their hometowns through digital village construction. Third, promoting the coordinated development of digital villages is crucial for enhancing the subjective well-being of rural households. Efforts should be focused on promoting farmers' employment, increasing their income, and developing rural digital infrastructure. In prioritizing the goal of improving rural households' subjective well-being, the strategy of rural revitalization and prosperity should address livelihood and employment issues while leveraging the potential of digital village construction to elevate living standards and well-being.

This paper examines the impact of digital village construction on subjective well-being using micro-survey data. However, limitations arise when relying on self-reported subjective well-being, which may be influenced by respondents' mood swings and result in potentially unreliable evaluations. Meanwhile, the Likert scale may exhibit bias towards certain opinions or attitudes and may overlook factors related to participants' background and context. Therefore, it is essential to use more comprehensive means to evaluate subjective well-being. Nonetheless, it is important to analyze the actual effects of digital village construction, such as its potential contribution to enriching education and healthcare resources in rural areas. The influence of China's official policies on rural education and healthcare, as well as the limited market demand for remote education and healthcare, should also be considered (Wang et al., 2022; Xue et al., 2023). The applicability of this study's findings to other countries remains uncertain, but the mediation model illustrates the potential mechanisms through which digital village construction can exert its effects, such as increasing income, promoting employment, and improving governance. In regions with significant income disparities, high costs of workforce flow, and low levels of government governance, the application of digital technologies can effectively address these livelihood issues. Consequently, it has the potential to further improve livings and enhance residents' subjective well-being. Even in Europe, the development of digital technologies are characterized by inequality, manifesting spatially as a Northwest-Southeast pattern (Lucendo-Monedero et al., 2019). Evidence from a cross-national perspective suggests that improvements in digital infrastructure are expected to expand economic opportunities for previously underserved populations (Richmond & Triplett, 2018). Research using Eurostat data demonstrated a statistically significant correlation between digital literacy and employment rates in the EU (Bejaković & Mrnjavac, 2020). Therefore, to accurately demonstrate the effects of digital village construction, future research should consider practical technology applications and exclude non-market factors. Additionally, the development of global versions of this scale to accommodate different backgrounds is suggested.

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A policy-oriented framework for social cost analysis of gambling: Evidence from the Czech Republic

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Abstract: This paper introduces a new framework for calculating the social costs of gambling, distinguishing between private costs, externalities, and public expenditures. By focusing only on externalities and public expenditures, which are relevant to policy-making, this approach aligns with economic theory and allows for a more targeted political response. The practical application of this framework is demonstrated by calculating the social cost of gambling in the Czech Republic in 2022 using the best available data. Our findings estimate private costs to be between CZK 91.1–102.3 billion (Lie/bet scale) or CZK 89.3–105.0 billion (PGSI scale), externalities between CZK 2.6–4.8 billion or CZK 2.2–5.3 billion, and public expenditures between CZK 5.6–8.0 billion or CZK 9.6–12.1 billion (exchange rate 1 EUR = 24.48 CZK). However, quality of the calculation is heavily dependent on the quality of data and in our case serves as a practical application of the new framework. Private costs thus make the most of the total costs, but the externalities and the public expenditures are not negligible. The framework's novel approach addresses long-standing flaws in the traditional calculations of gambling's social costs. It proposes a division of total impacts into three distinct categories, allowing for a methodological unification and introducing rationality to political decision-making concerning gambling. By isolating externalities, private and public expenditures, this paper pioneers a pragmatic economic approach to policy intervention aimed at mitigating the social harm of gambling not reflected in its market price. Future research should incorporate this framework into regulatory impact assessments for gambling policies, which could significantly improve their quality. The study's main limitation is the lack of Czech-specific and overall better-fitted data, especially on the psychological effects of gambling. Future research should improve data collection and consider not only the costs but also benefits of gambling to help to produce more comprehensive policy assessments.

Keywords: Gambling economics, social cost analysis, public policy impact, externalities, regulatory impact assessment.

JEL Classification: D62, H23, I18, L83.

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Introduction

Gambling at the micro level is an activity that has been practiced since the beginning of human civilization, e.g., the playing of a wide variety of games, the outcome of which depends on chance, for monetary or other material prizes. With technological developments, the spectrum of ways to gamble is also growing, and land-based establishments (gambling halls and casinos) have been joined by the option of online gambling, which has grown massively in popularity in recent years. At a macro level, gambling is an established part of the entertainment industry, catering to the needs of many casual and professional gamblers while generating tax revenues for local economies. The downside associated with gambling, however, is the social and economic impact on the individual, their immediate vicinity, and by extension, the entire region. These impacts stem from the addiction that gamblers can fall into, which in turn motivates them, among other things, to go into debt, obtain money illegally, take money from family, etc. Since the 1990s, there has been an ongoing expert and political debate about the social impacts of gambling and the effective regulation of the industry. The social costs of gambling, conducted in the Czech Republic by Winkler et al. (2017) and abroad by the Productivity Commission (1999, 2010) or OHID (2023), are a frequent basis for this debate, with the aim of quantifying the impact of this activity on society. However, the methodology of these calculations is often based on inconsistent assumptions and fragmented methodology (Wynne & Schaffer, 2003), making the results incomparable and sometimes even subject to the biases of their authors (Eadington, 2003). Because of this situation, both opponents and proponents of gambling regulation can easily obtain a result in their favor.

The first objective of this paper is to present a definition and methodology for calculating the social costs of gambling. Although the authors of previous studies have mostly good epidemiological data, there is a distinct lack of a standard economic approach in the current literature (see Walker (2003) for a critique). This is reflected primarily in the misattribution and misjudgment of certain items as social cost. While economics is not the only or even the primary discipline to examine the effects of addictive behavior, it has a well-established toolkit to analyze costs and benefits, offers

insight into the effects of policy measures, and, above all, is not burdened with value judgments against potentially harmful activities (Eadington, 2003).

The second objective is to implement this approach and calculate the social costs (i.e., private costs, externalities and public expenditures) of gambling in the Czech Republic. In this respect, we will follow the already mentioned study by Winkler et al. (2017), which represents the most comprehensive similar research in the Czech Republic (the results were mentioned in the explanatory memorandum to the Act No. 186/2016 Coll.), working with updated data and, above all, with the updated methodology mentioned above. At the same time, the study continues the work of Žofčák and Šíma (2022), who revised the calculation and categories of Winkler et al. (2017).

The third key objective is to formulate conclusions and recommendations for economic policy from this calculation.

1. Defining the social costs of gambling

Although more than 30 years have passed since the pioneering studies and articles that first began to address the definition and calculation of social costs, contemporary authors still refer to these studies very frequently. So, even though present-day gambling is sometimes subject to different trends (especially when it comes to online gambling), these studies are still relevant at the level of basic definitions and concepts. One of the most important and most cited studies by the Australian Productivity Commission (1999, 2010) defines social costs as “the benefits and costs that are relevant as a basis for possible government intervention in private decisions” (Chapter 4, box 4.1). However, this is a circular definition, as governments can have virtually any motives for intervention. Markandya and Pearce (1989) came up with a rather vague definition that private costs are borne by the consumer or producer and social costs by society, but it is not defined as which costs actually belong to the individual and which belong to society. This definition was adopted by Collins and Lapsley (2003) in their similarly influential study. It is worth noting the widespread practice of adopting the methodology and definitions of studies of the social impacts of tobacco and alcohol – the pioneering study by Ladouceur et al. (1994) was thus inspired by the study of the social costs of alcohol

consumption by Rice et al. (1991). The problems with defining and calculating the social costs of gambling are summarized in the results of The Whistler Symposium (Wynne & Shaffer, 2003), which included sixty researchers, economists, policy-makers, public sector representatives and gaming operators from North America, Europe and Australia. Despite the best efforts of the participants, there was wide disagreement on the philosophical perspective and conceptual framework, definition and method of calculating private and social costs.

Although two decades have passed since the symposium, the current state of affairs is not much better – even recent studies, such as Wardle et al. (2018), have struggled with the problematic definition, and while they come up with innovative twists, their approach is still highly problematic from an economics perspective. According to Winkler et al. (2017, p. 1295): “Social costs arise only when some activity leads to society as a whole getting poorer. That is in cases where any individual or group of individuals is losing without anyone else gaining,” but their methodology is inconsistent with this definition (Žofčák & Šíma, 2022).

Our starting point for establishing an economically compatible definition of the social costs of gambling and methodology is the research of Walker and Barnett (1999), Walker (2003, 2007). A social cost arises when a member of society is worse-off without another member being better-off. The measure of such a cost is the transfer to compensate the individual who is worse-off (Walker, 2003). This definition is also appropriate for the current gambling environment (different from the year in which the definition was created) as it can be applied to the issue of online gambling. Walker (2007) further criticizes researchers who project their biases into their methodologies and, subsequently, the results of their studies – this includes the study by Grinols and Mustard (2006).

Closely related to the definition of social costs is the identification of relevant categories, Walker and Barnett (1999) and Walker (2007) come up with four principles to follow in this regard. Firstly, the cash transfers must be excluded as society has not actually lost this amount, the money has merely changed hands. An example would be the money lost or the gambler's debt – only secondary effects, such as the cost of collecting this debt, should be included in the social cost. Second, internalized costs (e.g., loss of employment

or labor productivity – should not be counted, as these costs are borne by the gambler. The third principle is the distinction between technological and pecuniary externalities, whereby only technological externality (reduction in the ability of an entity to produce the same amount of output) is included in social costs (pecuniary externality arises, e.g., due to competitive pressure when opening a casino, a nearby restaurant has to reduce prices). The last and most complicated problems are comorbidities, i.e., the common causes of a given problem (in medical terms). Especially in the case of gambling, it is very difficult to distinguish whether, for example, depression is due to gambling or vice versa. A study by WEFA (1997) and Thompson et al. (1996) describing a wide range of psychological problems in addicted gamblers is illustrative in this respect. According to these studies, gambling is related to alcoholism, drugs, or compulsive shopping, which is also confirmed by recent studies (e.g., Loo et al., 2019).

Regarding the economic perspective, the Palgrave Dictionary (De Graaff, 2018) states that a man initiating an action does not necessarily bear all the costs (or reap all the benefits) himself. Those that he does bear are private costs; those he does not are external costs. The sum of the two constitutes the social cost. The social cost is thus the sum of the internalized private costs and the external cost, which are considered market failures (and should be subject to government intervention). Since the standard role of government is not to compensate for privately incurred costs, it is necessary to strictly separate the sum of social costs and external costs. The situation is made even more confusing by the fact that the gambling literature described above confuses the concept of social costs with external costs.

Regarding classical authors, Coase (1960) does not define social costs and only refers to the defining work of Pigou (1932). Pigou (1932, p. 135) works with the concept of marginal social net product and defines it as: “The total net product of physical things or objective services due to the marginal increment of resources in any given use or place, no matter to whom any part of this product may accrue.” Pigou (1932, p. 135) goes on to explain the value of social costs: “The value of the marginal social net product of any quantity of resources employed in any use or place is simply the sum of money which the marginal social net product is worth in the market.”

But if we follow these definitions and the textbook definition of social cost, then:

$$\text{Social cost} = \text{private cost} + \text{external cost} \quad (1)$$

While external costs are a market failure and one way to address them may be government intervention. Buchanan and Stubblebine (1962) defined an externality as a situation where the existence of Y_1 changes the utility of u^A , either positively or negatively.

$$u^A = u^A(X_1, X_1, \dots, X_m, Y_1) \quad (2)$$

The externality is created by consumption or production Y_1 , but not through prices P_1 to P_m . This is emphasized in some definitions of externalities so that the purchase of any good is not an externality because the purchase of any good changes the relative prices of all other goods. Thus, in Buchanan and Stubblebine's (1962) definition, government spending (or other government expenditures) to address an externality cannot itself be an externality because such a solution either makes some government services more expensive and thus changes the prices of the goods consumed, or changes present or future disposable income through taxation or debt.

Nevertheless, it is clear that gambling creates additional costs for the government and thus indirectly increases the price of some public services or reduces the disposable income of households due to higher taxes. Normally, these costs are classified as social costs, but the above suggests that alongside Equation (1), it is appropriate to include Equation (3):

$$\begin{aligned} \text{Total cost} &= \text{social cost} + \text{policy cost} = \\ &= \text{private cost} + \text{external cost} + \text{policy cost} \end{aligned} \quad (3)$$

Through the Pigou tax, the government can typically address external costs, but not policy costs, otherwise it would again shift the social costs away from the private costs, only to the other side. But of course, the government can levy other taxes to cover the policy cost, so it is a cost it has to account for, and it is essential for the government.

2. Categories of social costs of gambling

The inconsistent definition of social costs is also tied to the lack of clarity on what to include in these costs. This section illustrates

the evolution of the framework in which different authors calculated the social costs of gambling. A pioneering study by Ladoceur et al. (1994) included the costs of treatment for other addictions, the sum of wagers and debts, reduced work productivity and other employment-related factors, correlations with alcoholism and other addictions, and illegal activities associated with the financing of gambling. The authors obtained the data through guided interviews with 60 anonymous gamblers within four Canadian cities. Another influential study by Thompson et al. (1997) accounted for employment-related effects (lost labor productivity and unemployment benefits), debt, justice costs, prosecution, detention and incarceration, therapy costs, and government transfers. The aforementioned highly influential study by the Productivity Commission (1999, 2010) included in these categories' financial costs (family debt and bankruptcies), effects associated with work productivity, unemployment, crime, personal and family impacts (specifically, costs of divorce and separation, depression and suicide), and costs associated with gambling addiction treatment. Fong et al. (2011), who calculated the social costs of gambling in Macau, accounted for treatment costs, prevention costs, psychological costs to family and friends, legal costs, rent-seeking costs, regulatory costs, and public expenditures on training, promotion and research. When calculating the social costs of gambling in the Czech Republic, Winkler et al. (2015, 2017) followed the authors of the Productivity Commission and accounted for the costs of medical treatment, bankruptcies, reduced work and household productivity, the costs of unemployment, crime, relevant police, justice and prison interventions, personal costs (depression, suicide attempts, family costs, etc.) and completed suicides. These costs were revised first by Schwarz et al. (2015) and later by Žofčák and Šíma (2022), who reduced the resulting figure from EUR 541.6–619.6 million to EUR 88.6–99.9 million, based on the aforementioned Walker methodology; Žofčák and Šíma (2022) only revised the items included but did not come up with a new calculation.

In terms of more recent studies, Wardle et al. (2018) proposed a framework of key metrics relating to gambling-related harms based on a broad search of previous studies, covering three groups: resources (work and employment, money and debt and crime), relationships

(harmed relationships with partners, families and friends and community) and health (physical, mental and psychological distress). The Office for Health Improvement & Disparities (OHID, 2023) has calculated the social cost of gambling in the United Kingdom. The authors chose financial costs (individual costs and homelessness), health impacts (suicide, depression and alcohol and drug dependence), employment and education, and criminal activity as cost categories. They subsequently divided these categories into public expenditure and social costs, but only for a few items. Hofmarcher et al. (2020) calculated the social costs of gambling in Sweden – they

considered direct costs (treatment and care, debt counseling and management, crime and legal costs, prevention, research and regulation, divorces, recruitment and homelessness), indirect costs (reduced workplace productivity, absence from work, unemployment) and intangible costs (physical violence, emotional distress and harm to crime victims).

Although all the categories and items listed are relevant effects of gambling, not all are relevant externalities. They are either private (internalized) costs or public expenditures. Therefore, our methodology follows firstly the findings of Walker and Barnett (1999) and

Tab. 1: Categories of private costs, externalities, and public expenditure related to gambling in the Czech Republic

Category	Item
Private costs	Value of money lost from gambling
	Interest on gambling-related debts
	Costs of treatment for gambling addiction that do not come from public budgets
	Reduced labor productivity due to gambling
	Reduced household productivity due to gambling
	Cost of lost wages in unemployment associated with gambling
	Cost of finding new employment due to gambling
	Costs to employers of finding a new employee due to gambling
	Cost of incarceration due to gambling paid by the prisoner
	Harm to family members of gamblers
	Breakdown of the gambler's relationships
	Divorces of gamblers
	Psychological costs to gamblers
	Suicide attempts by gamblers
	Suicides related to gambling
Externalities	Noise and light from casinos and gambling halls
	The cost of violent crime due to gambling
	Effects on children of gamblers
Public expenditure	Subsidies for the treatment and prevention of gambling addiction
	Public expenditure on personal bankruptcies of gamblers
	Public expenditure on gambling-related failed distraints
	Public expenditure on police interventions related to gambling
	Public expenditure on gambling-related lawsuits
	Public expenditure on prison stays due to gambling
	Public expenditure on unemployed gamblers

Source: own

Walker (2007) and secondly the aforementioned economic authors. We thus divide the costs associated with gambling in the Czech Republic into three categories: private costs, externalities and public expenditures. The categories are summarized in Tab. 1.

The amount of money lost and the interest on debts are transferred and internalized, i.e., private costs; the treatment and the incarceration are partly private costs and partly public expenditures (the prisoners partly pay for the prison themselves). The popular item of productivity (or job) loss is also not an externality – it is compensated by the employer (who has a voluntary relationship with the worker-gambler, see Walker (2007)) with lower wages or a lay-off, and thus falls on the gambler himself. The most problematic items in this category are the psychological costs and the costs falling on the gambler's partner. Although this topic is extremely sensitive, the gambler's partner is in a voluntary relationship with the gambler from an economic perspective (Walker & Barnett, 1999). The costs of relationship breakdown, divorce, harm to adult family members, etc., are internalized costs (analogous to harm to the employer). The same is true in the case of a gambler's attempted or completed suicide. Thus, the only economically based externalities of gambling in this respect are noise and light pollution, the impact of violent crime, and the impact on minor children (whose relationship with the gambler cannot be considered voluntary). Public expenditure includes the remaining items in Tab. 1.

This decomposition of costs is quite different from that of the authors mentioned above, in particular by a different understanding of the concept of social costs itself. Indeed, if we want to examine this issue in the context of economic and fiscal policy, it is necessary to embed this framework in clearly defined economic concepts. The implications of this methodology will be discussed below.

3. Calculation of social costs

In calculating the individual items, we will mainly use the comprehensive epidemiological and addictological data summarized in the Report on gambling in the Czech Republic 2023 (Chomynová et al., 2023), and we will also use raw data from the Pathological gamblers in treatment 2021 (NMS, 2021) study, kindly provided for the purposes of this study by the National

Monitoring Centre for Drugs and Addictions (NMS). The gambling report (Chomynová et al., 2023) is an annual publication of the NMS that summarizes relevant data related to gambling in the Czech Republic and is the most comprehensive relevant source in this respect. The pathological gamblers in treatment study is the fifth in a series of studies conducted on gamblers who have undergone treatment for pathological gambling addiction. The last survey was conducted in 2021 and included a total of 248 gamblers in treatment across 38 facilities. Although this is a relatively small sample of gamblers (there are tens of thousands of high-risk gamblers in the country) and a non-representative sample of the population, it is the best available source of information on this group of people and is used by other studies. In the first year of the survey (NMS, 2013), this survey contained many relevant questions that were discarded in subsequent years, so these older data will be used in some cases. Regarding the methodology, in some items, we follow the study conducted by Winkler et al. (2015, 2017) despite its shortcomings summarized by Žofčák and Šíma (2022). However, we work with updated data and calculation procedure.

In order to extrapolate the results to the entire population of gamblers, we work with two standard scales to measure gambling addiction – the Lie/bet scale and the PGSI scale. While the Lie/bet contains only two questions about lying to gamble and the need to gamble for more and more money, the PGSI scale contains a total of nine questions where the respondent is asked about gambling-related health problems, financial problems, anxiety, etc. In addition to these two scales, we will work (following Winkler et al. (2015) and Winkler et al. (2017)) with two groups of gamblers: problem gamblers (140–250 thousand gamblers according to the Lie/bet scale and 400–500 thousand gamblers according to the PGSI scale) and high-risk gamblers (60–110 thousand gamblers according to the Lie/bet scale and 50–120 thousand gamblers according to the PGSI scale) (Chomynová et al., 2023). Winkler et al. (2015, 2017) worked only with the Lie/bet scale. As a measure of comorbidity, many studies have used a simple subtraction of an arbitrary fixed percentage. For example, Productivity Commission (1999, 2010), Winkler et al. (2015, 2017), and Hofmarcher et al. (2020) subtracted 20%. In our calculations, we use

the NMS (2021) figure that 31.6% of gamblers in treatment gambled to escape depression. This is far from a figure that encompasses all the comorbidities that can affect gamblers, but it is the best approximation of reality we have. We will, therefore, subtract this percentage of gamblers for relevant items.

Regarding psychological costs, various approaches can be found in the literature – for example, OHID (2023) used quality-adjusted life years (QALYs) lost due to the effects of gambling as a measure of the negative impact of depression. While this approach is one of the most sophisticated that we have found in the gambling literature, it is demanding of specific data that is lacking in the Czech Republic so far. A second noteworthy approach was carried out by Hofmarcher et al. (2020), who approximated emotional distress and physical violence through the average victim compensation paid by the Swedish Crime Victim Compensation and Support Authority (EUR 2,250). This approach is not suitable for us either. Firstly, because of the different system of compensating victims in the Czech Republic. Secondly, it is questionable whether the amount awarded by the court is a good proxy for such a cost. Thus, we opt for a compromise where we follow the methodology of Winkler et al. (2015, 2017), who used the unit psychological costs of the Productivity Commission study (1999, 2010), updating these values for inflation.

The impact on children of gamblers is even more complicated and more sensitive, as shown by the fact that the vast majority of studies have not even attempted to quantify it, even though it is the most important economic externality associated with gambling. The effects of parental gambling on their offspring are undeniable. For example, Suomi et al. (2023), based on a survey of 211 adults who had experienced parental gambling in childhood, found that 58.1% had suffered emotional distress, 50% had been left unsupervised, 51.4% experienced economic problems, 48.1% verbal abuse, 17.1% physical abuse and 34.8% had witnessed violence. These factors, according to the authors, contributed significantly to the problems these children experienced in adulthood in the form of depression, PTSD, addictions, etc. The impact on mental and physical health and later development has been summarized by many other authors in their studies, but virtually none of them has

come up with a specific cost calculation. While the social costs of childhood trauma can be found in the literature (e.g., Gilad & Gutman, 2019), these are too tied to the U.S. education and healthcare systems. In the Czech Republic, calculations of the economic impact of domestic violence are available (Všetičková et al., 2017), but these do not explicitly include unit costs associated with children. Thus, again, we do not have a more applicable unit cost than the one provided by Productivity Commission (1999, 2010).

Based on this data and methodology, the total private costs, externalities and public expenditures associated with gambling in the Czech Republic in 2022 will be calculated. We are very aware of the limitations of the interpretation of the results below due to imperfect or potentially outdated data. However, the main added value of this paper is the novel social cost calculation framework and overall methodology. The calculations serve as a demonstration of the practical application of this approach and can certainly be improved with new or more accurate data. The data used in the calculations are the most recent data available at the time of writing this study.

According to calculations below, the total private costs of gambling in the Czech Republic in 2022 amounted to CZK 91.1–102.3 billion (Lie/bet scale), or CZK 89.3–105.0 billion (PGSI scale) respectively, externalities CZK 2.6–4.8 billion, or CZK 2.2–5.3 billion respectively and public expenditure CZK 5.6–8.0 billion, or CZK 9.6–12.2 billion respectively (the exchange rate on the day of submitting this article was 1 EUR = 24.48 CZK). The detailed breakdown of the results is summarized in Tab. 2.

3.1 Value of money lost from gambling

The annual report (Chomynová et al., 2023) shows that Czech gamblers lost a total of CZK 53.8 billion on all gambling activities in 2022.

3.2 Interest on gambling-related debts

The annual report (Chomynová et al., 2023) shows that 88% of high-risk gamblers were in debt in 2022, with an average debt of CZK 815,000. It is difficult to determine the average interest rate that gamblers were paying on their debts, but the most frequent debts were with non-bank institutions, and according to Broker Consulting

Tab. 2: Social cost of gambling in the Czech Republic in 2022 (CZK; exchange rate 1 EUR = 24.48 CZK)

	Lower limit (Lie/bet)	Upper limit (Lie/bet)	Lower limit (PGSI)	Upper limit (PGSI)
Private costs	91,144,092,272	102,310,700,579	89,264,245,922	104,978,696,626
Value of money lost from gambling	53,833,000,000	53,833,000,000	53,833,000,000	53,833,000,000
Interest on gambling-related debts	7,943,707,200	14,563,463,200	6,619,756,000	15,887,414,400
Costs of treatment for gambling addiction that do not come from public budgets	Negligible	Negligible	Negligible	Negligible
Reduced labor productivity due to gambling	909,520,238	2,784,245,626	2,598,629,251	5,568,491,251
Reduced household productivity due to gambling	20,810,655	63,706,088	59,459,016	127,412,176
Cost of lost wages in unemployment associated with gambling	2,400,259,680	4,400,476,080	2,000,216,400	4,800,519,360
Cost of finding new employment due to gambling	90,058,922	165,108,024	75,049,102	180,117,844
Costs to employers of finding a new employee due to gambling	705,047,616	1,259,013,600	2,014,421,760	2,518,027,200
Cost of incarceration due to gambling paid by the prisoner	29,221,116	29,221,116	29,221,116	29,221,116
Psychological costs related to gambling	23,131,995,891	23,131,995,891	20,300,767,483	20,300,767,483
Suicides related to gambling	2,080,470,954	2,080,470,954	1,733,725,795	1,733,725,795
Externalities	2,646,842,056	4,847,342,481	2,206,741,972	5,287,442,566
Noise and light from casinos and gambling halls	6,241,547	6,241,547	6,241,547	6,241,547
The cost of violent crime due to gambling	628,641,672	1,152,509,732	523,868,060	1,257,283,344
Effects on children of gamblers	2,011,958,838	3,688,591,202	1,676,632,365	4,023,917,675
Public expenditure	5,570,236,114	8025396,487	9,616,611,657	12,184,970,891
Subsidies for the treatment and prevention of gambling addiction	22,789,796	22,789,796	22,789,796	22,789,796
Public expenditure on personal bankruptcies of gamblers	37,164,000	68,134,000	30,970,000	74,328,000
Public expenditure on gambling-related failed distraints	0	0	0	0
Public expenditure on police interventions related to gambling	2,252,613,711	4,022,524,484	6,436,039,175	8,045,048,969
Public expenditure on gambling-related lawsuits	225,681,817	225,681,817	225,681,817	225,681,817
Public expenditure on prison stays due to gambling	2,246,851,269	2,246,851,269	2,246,851,269	2,246,851,269
Public expenditure on unemployed gamblers	785,135,520	1,439,415,120	654,279,600	1,570,271,040

Source: own

(2023), the average interest rate on bank consumer loans in October 2023 was 9.23%. In the Czech Republic, non-bank loans are generally more expensive, but it depends mainly on the volume and length of repayment. The data on the average interest rate on non-bank loans is not known, but if we assume that

part of the loans will be with a bank and part with non-bank entities, the average interest rate must be higher. In our case, we assume an average interest rate of 18.46%, i.e., twice the Broker Consulting average.

The interest on the debts of high-risk gamblers in 2022 amounted to CZK 7.9–14.6 billion

(Lie/bet scale) and CZK 6.6–15.9 billion (PGSI scale).

3.3 Costs of treatment for gambling addiction that do not come from public budgets

In the Czech Republic, the share of private costs and costs of households on health care is 15% of total expenditure (CZSO, 2023a). This amounts to about CZK 625 per month per capita, with half of this amount going to medicaments not paid for by health insurance and the second highest item being dental care. The private cost of treatment for gambling addiction is, therefore, negligible in the Czech system of free public health care.

3.4 Reduced labor productivity due to gambling

In this item, we follow the methodology of Winkler et al. (2015, 2017), who adopted the figure from the 2013 Pathological gamblers in treatment study (NMS, 2013) that 29.9% of employed gamblers in treatment experienced a 7%–12% decline in work productivity. As subsequent pathological gamblers in treatment studies do not include this question, this is the best available figure. The Pathological gamblers in treatment 2021 study (NMS, 2021) shows that 64.1% of gamblers are employed, and the average annual wage in 2022 was CZK 484,236 (CZSO, 2023b).

The total loss of labor productivity of problem gamblers due to gambling in 2022 was, therefore, CZK 0.9–2.8 billion (Lie/bet scale) and CZK 2.6–5.6 billion (PGSI scale).

3.5 Reduced household productivity due to gambling

The lost household productivity can be calculated in a similar way. The Pathological gamblers in treatment 2021 study (NMS, 2021) shows that 4.4% of gamblers in treatment are employed at home (on maternity leave, working home, or on disability/retirement). We assume the same proportion of gamblers and the same reduced productivity, and according to the Productivity Commission (1999, 2010), productivity in the home is one-third that in employment.

The total loss of household productivity of problem gamblers due to gambling in 2022 would thus amount to CZK 0.02–0.06 billion (Lie/bet scale) and CZK 0.06–0.1 billion (PGSI scale), respectively.

3.6 Cost of lost wages in unemployment associated with gambling

The cost of gambling-related unemployment is divided into private costs (i.e., lost wages minus unemployment benefits) and public costs (unemployment benefits). The lost annual wage in 2022 was the aforementioned CZK 484,236 (CZSO, 2023b), but the unemployment benefit received must be subtracted, which in 2022 amounted to a maximum of CZK 99,579 (with an average wage of CZK 40,353 per month, an age below 50 years and a notice from the employer). According to the Pathological gamblers in treatment 2013 study (NMS, 2013), 10.4% of gamblers in treatment (i.e., at high risk) changed jobs as a result of gambling, a more recent figure is not available.

The private cost of unemployment caused by gambling in 2022 was, therefore, CZK 2.4–4.4 billion (Lie/bet scale) and CZK 2.0–4.8 billion (PGSI scale).

3.7 Cost of finding new employment due to gambling

Productivity Commission (1999, 2010) estimated the cost of finding a job to be half the cost of having a specialized agency to do so. Winkler et al. (2015, 2017) contacted several such Czech agencies and estimated this amount at CZK 10,584 in 2012 (unfortunately, a more recent figure is not available). With an average annual inflation of 3.15%, this unit cost was CZK 14,433 in 2022, and this again applies to the 10.4% of high-risk gamblers who changed jobs for employment.

The total cost of finding a new job as a result of gambling would, therefore, be CZK 0.09–0.2 billion (Lie/bet scale) and CZK 0.08–0.2 billion (PGSI scale) in 2022.

3.8 Costs to employers of finding a new employee due to gambling

These costs are calculated in the same way as for finding a new job, except that the unit cost of finding a new employee is one-tenth of the employee's annual wage, according to the Productivity Commission (1999, 2010). In the Czech Republic, this was CZK 48,424 in 2022 (CZSO, 2023b).

The total cost to employers of finding new employees to replace laid-off gamblers in 2022 was, therefore, CZK 0.7–1.3 billion (Lie/bet scale) or CZK 2.0–2.5 billion (PGSI scale).

3.9 Cost of incarceration due to gambling paid by the prisoner

As with the costs of unemployment, the costs of incarceration are split between the private costs of the incarcerated gambler and public expenditures. 55.2% of prisoners are working in prisons (PSCR, 2022) and 23% of this salary (reduced by social and health insurance) is used to pay for the costs of incarceration (PSCR, 2023). The average gross annual salary of convicts in prison in 2022 was CZK 74,634 (PSCR, 2022), so after subtracting the levies, the average amount that prisoner pays for the incarceration (the aforementioned 23%) is CZK 15,051 per year. In 2022, a total of 17,498 people were in Czech prisons (PSCR, 2022) and, according to the annual report (Chomynová et al., 2023), 20.1% of prisoners committed crimes related to gambling, so this item concerns a total of 3,517 prisoners, of whom 1,941 were working in prison.

The total private cost of prisoners imprisoned in relation to gambling in 2022 was, therefore, CZK 0.03 billion.

3.10 Psychological costs related to gambling

As noted above, in these costs we follow Winkler et al. (2015, 2017) and Productivity Commission (1999, 2010), respectively. Tab. 3

summarizes the inflation-adjusted unit costs and the shares of relevant high-risk gamblers.

In terms of the number of people affected, the emotional harm to family members and the cost of suicide attempts to the family affects only the gambler's partner (harm to children is calculated separately), the cost of relationship breakdown and divorce is calculated for two people (gambler + partner), and the cost of suicide attempts to the gambler's parents is calculated with an average of 1.8 parents (Productivity Commission, 1999; Productivity Commission, 2010). As a conservative approach, Winkler et al. (2015, 2017) considered a lower threshold of high-risk gamblers, i.e., 60,000 gamblers in our case. We subtract comorbidities of 31.6% for each item.

Adding together the costs of emotional harm to partners, relationship breakdowns, divorces, depression, suicidal thoughts and suicide attempts, the total psychological costs of gambling are CZK 23.1 billion (Lie/bet scale) and CZK 20.3 billion (PGSI scale).

3.11 Suicides related to gambling

In the Czech Republic, 1,224 people committed suicide in 2020 (latest available data) (CZSO, 2020a), which represents a 0.0141% suicide rate in a total population of 8,694,474 (CZSO, 2020b). The Productivity Commission (1999,

Tab. 3:

Unit psychological costs (CZK; exchange rate 1 EUR = 24.48 CZK) and relevant proportion of gamblers

Item	Unit cost	Relevant proportion of players at high risk (%)
Harm to family members of gamblers	116,044	48.2*
Breakdown of gamblers' relationships	116,044	16.5*
Divorces of gamblers	348,130	26.6**
Depression of gamblers	70,120	14.8**
Suicidal thoughts of gamblers	696,259	8.8***
Attempted suicide (impact on the gambler)	1,160,391	10.4**
Suicide attempt (impact on family)	696,259	10.4**
Suicide attempt (impact on parents)	116,044	10.4**

Notes: * percentage derived from the Pathological gamblers in treatment 2013 study (NMS, 2013), more recent figure not available; ** Gamblers in treatment 2021; *** proportion of gamblers from the Pathological gambler in treatment 2021 study adjusted for gamblers who attempted suicide.

Source: own

2010) estimated that gamblers commit suicide up to 10 times more often than the general population, so the proportion of suicides among high-risk gamblers is 0.141%, which needs to be further reduced by comorbidity, i.e., 31.6%. Among suicide victims, 81% are men and 19% are women, according to CZSO (2020c), with a unit cost of CZK 37,878,197 for a male suicide and CZK 27,745,604 for a female suicide (both amounts inflated for inflation) according to Kinchin and Doran (2017). As in Winkler et al. (2015, 2017), we only account for a lower number of high-risk gamblers, i.e., 60,000 people.

Kinchin and Doran (2017) calculated costs of suicide using incidence-based approach and categorized them into production disturbance costs (lost production and staff turnover), human capital costs (loss of potential future earnings), medical costs (treatment expenses), administrative costs (investigation and funeral expenses), other costs (carers, aids, and post-vention services), and transfer costs (dead-weight loss of taxation).

The total cost of suicide due to gambling in 2022 was, therefore, CZK 2.1 billion (Lie/

bet scale) and CZK 1.7 billion (PGSI scale) for both sexes combined.

3.12 Noise and light from casinos and gambling halls

According to Gallaway et al. (2010), a single land-based gambling establishment in the USA generates light pollution of 318 CZK per capita (after PPP and inflation adjustment), and we assume the same cost connected to noise pollution. Regarding light pollution, the regulation (Act No. 186/2016 Coll.) has managed to remove this externality (no light advertisement can be located on the building where the gaming area is located, windows and entrances must be secured against peeping, etc.). However, gambling halls and casinos can produce noise, as noisy visitors tend to cluster at their entrances. We combined data about the location of gambling halls and casinos with a choropleth map and discovered that, on average, they are located in places with a higher population density (500–1,000 people per km²). We assume that the noise from each gambling hall and casino will annoy the inhabitants

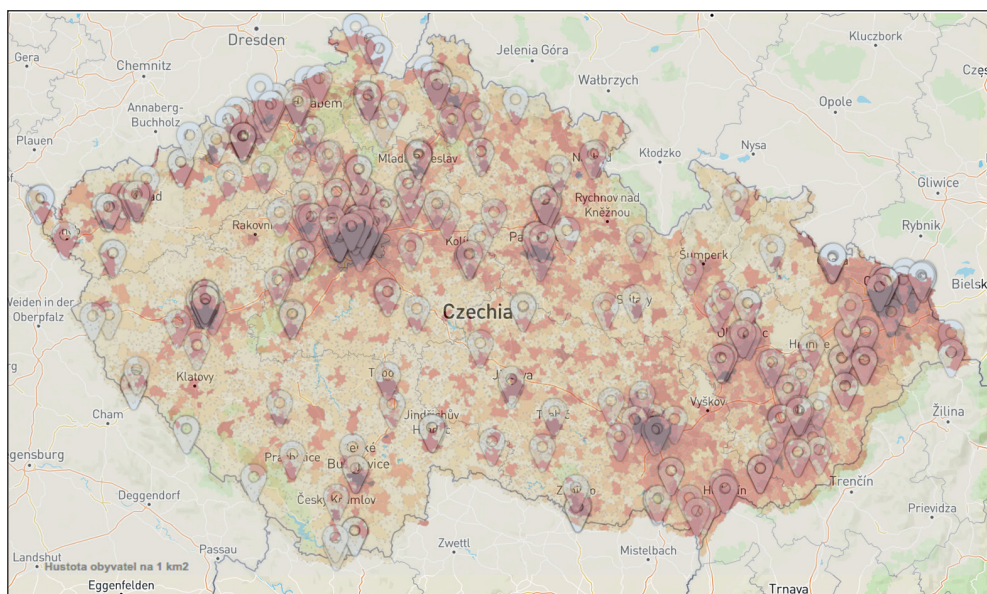


Fig. 1: Choropleth of the Czech Republic and gambling locations

Source: own (based on open data (Digital and Information Agency, 2024) from Czech Statistical Office and Ministry of Finance)

in a circle with an average radius of 100 m (i.e., 0.031 km²).

Since, according to the annual report (Chomynová et al., 2023), there were 362 gambling halls and 472 casinos in the Czech Republic in 2022, the total cost of light and noise pollution is CZK 0.006 billion. However, it should be noted that part of these costs is already included in the price of the property (or the rent).

3.13 The cost of violent crime due to gambling

According to the Pathological gamblers in treatment 2013 study (NMS, 2013), 13.2% of gamblers in treatment were aggressive or had physically assaulted someone (more recent data not available). The unit cost of violent acts (CZK 116,044 adjusted for inflation) is taken from the Productivity Commission study (1999, 2010) and the total still needs to be reduced by comorbidities, i.e., 31.6%.

The total cost of violent acts due to gambling in 2022 was, therefore, CZK 0.6–1.2 billion (Lie/bet scale) and CZK 0.5–1.3 billion (PGSI scale).

3.14 Effects on children of gamblers

We use the Productivity Commission (1999, 2010) unit cost of emotional distress of a family member (Tab. 3) of CZK 116,044. According to the Pathological gamblers in treatment 2021 study (NMS, 2021), 52.8% of gamblers in treatment had children and 48.2% of respondents in the Pathological gamblers in treatment 2013 study (NMS, 2013) indicated that gambling affects their immediate family (including offspring) (Tab. 3).

If the average number of children per mother in 2022 was 1.66 (CZSO, 2023c), and the total impact on children of high-risk gamblers after subtracting comorbidities was CZK 2.0–3.7 billion (Lie/bet scale) and CZK 1.7–4.0 billion (PGSI scale), respectively.

3.15 Subsidies for the treatment and prevention of gambling addiction

Due to the rather complicated network of addiction services, it is very difficult to determine the amount of state funds spent on tackling gambling-related problems. These services target various addictions, especially drug addiction.

According to Černíková et al. (2022), a total of CZK 291.5 million was allocated in the Czech Republic in 2022 under the Czech Government

Office's subsidy procedure for: prevention programmes (CZK 20.9 million), addiction services for risk minimization (CZK 115.8 million), outpatient services and counselling (CZK 98.6 million), residential services (CZK 52.2 million) and information and research projects (CZK 4 million). Prevention programmes and information and research projects are not relevant to gambling. While addictological risk minimization services do include gambling issues (e.g., outreach programmes in gambling halls), it is not possible to determine a relevant amount, so we will use a conservative estimate of 10% of total expenditure (as these services mainly target drug addicts). Outpatient services and counselling services, according to Černíková et al. (2022), covered 3,090 individuals with non-substance dependence (which includes gamblers) out of a total of 28,039 individuals, i.e., 11% of the total expenditure and only 0.7% for residential services (15 clients out of 2,270 individuals).

The total amount of subsidies for the treatment and prevention of gambling was, therefore, CZK 0.02 billion.

3.16 Public expenditure on personal bankruptcies of gamblers

According to the Pathological gamblers in treatment 2013 study (NMS, 2013), 11.4% of high-risk gamblers went into personal bankruptcy (more recent data not available). The average debt of a gambler in 2022 was CZK 815,000 according to the annual report, while according to Act No. 549/1991 Coll., the court fee for lawsuits for monetary claims in excess of CZK 20,000 was 5% of the total amount, i.e., on average CZK 40,750. However, since 11.4% of gamblers have had a bankruptcy at some point in their lives, this percentage should be divided by the average number of years of gambling, i.e., seven and a half years (Chomynová et al., 2023).

The total public expenditure on personal bankruptcies due to gambling in 2022 was, therefore, CZK 0.04–0.07 billion (Lie/bet scale) and CZK 0.03–0.07 billion (PGSI scale).

3.17 Public expenditure on gambling-related failed distraints

According to the Pathological gamblers in treatment 2021 study (NMS, 2021), 32.4% of high-risk gamblers have had a distraint imposed on their property, with an average of 70% of distraints

enforced through bailiffs being unsuccessful (EKCR, 2020). The average amount recovered per obligor in the Czech Republic in 2022 was CZK 515,800, and we consider the cost of a single execution to be 15% of the amount paid by the state to bailiffs. Since 32.4% of gamblers have had a distraint at some point in their lives, the total amount should be divided by the aforementioned seven and a half years and the average duration of the distraint (we assume an average of three years, since distraints are legally stopped after six years).

The total public expenditure on failed distraints in 2022 was, therefore, CZK 0.42–0.77 billion (Lie/bet scale) and CZK 0.35–0.84 billion (PGSI scale).

3.18 Public expenditure on police interventions related to gambling

The total cost of the police in 2022 was CZK 49,659 million (Police of the Czech Republic, 2023). According to Zábranský et al. (2001), 86.06% of police costs are spent on fighting crime, of which 53.3% goes to major offences and 46.7% to minor offences. The relevant amount associated with major offences was, therefore, 22,778,573,368 CZK and 18,675,865,970 CZK with minor offences.

According to the Pathological gamblers in treatment 2013 study (NMS, 2013), 11.7% of gamblers came into contact with the police for major offences and 6.2% for minor offences (more recent data not available). If we assume that a given problem gambler committed one major offence or minor offence in a given year, this means that 16,380–29,250 major offences and 8,680–15,500 minor offences were committed in relation to gambling in 2022. If a total of 181,991 major offences (Police of the Czech Republic, 2022) and 800,760 minor offences were committed in 2022 (the number of minor offences was estimated based on the number of major offences), this means that a total of 9.0–16.1% of all major offences and 1.1–1.9% of all minor offences were committed in relation to gambling.

Using the Lie/bet scale, the total public expenditure on gambling-related major offences was, therefore, CZK 2.1–3.7 billion and expenditure on minor offences was CZK 0.2–0.4 billion. Using the PGSI scale, the respective expenditure was CZK 5.9–7.3 billion and CZK 0.6–0.7 billion.

3.19 Public expenditure on gambling-related lawsuits

The total cost of the Czech judiciary in 2022 was CZK 15,945,390,000, and according to Zábranský et al. (2011), 26.1% of this amount is related to criminal law. In 2022, a total of 3,517 people were imprisoned for gambling-related offences, the share of these prisoners in the total number of 17,498 convicted people was, therefore, 5.42%, and this is also the share of criminal justice expenditure related to high-risk gamblers.

The total public expenditure on the judiciary in connection with gambling in 2022 was, therefore, CZK 0.2 billion.

3.20 Public expenditure on prison stays due to gambling

As noted above, working prisoners who were incarcerated in connection with gambling paid CZK 0.03 billion (exactly CZK 29,221,116) in 2022 in incarceration costs. However, the total annual cost of these prisoners was CZK 2,276,072,385, as a total of 3,517 people were incarcerated in connection with gambling and the average annual expenditure per prisoner was CZK 647,145 (daily expenditure of CZK 1,773 (PSCR, 2022) times 365 days). The difference between the total annual cost and the private cost is, therefore, public expenditure.

The total public expenditure for prisoners who were in prison in connection with gambling in 2022 was, therefore, CZK 2.2 billion.

3.21 Public expenditure on unemployed gamblers

Unemployment benefits that were deducted from the lost wages of gamblers fired from their jobs in 2022 amounted to CZK 99,579. The annual health insurance payments paid by the state on behalf of the unemployed must be added (12 times the minimum monthly health insurance contributions, which in 2022 amounted to CZK 2,187), i.e., CZK 26,244.

If 10.4% of high-risk gamblers changed jobs in 2022 due to gambling (Chomynová et al., 2023), the total public expenditure on unemployed gamblers in that year would be CZK 0.8–1.4 billion (Lie/bet scale) and CZK 0.7–1.6 billion (PGSI scale), respectively.

4. Policy implications and recommendations

At this point, it would be useful to compare our results with the social costs of neighboring countries, ideally the Visegrad Four countries (i.e., Slovakia, Poland and Hungary). Unfortunately, as far as we know, no sophisticated calculation of the social costs of gambling has been carried out in any of these countries, and even if it had been carried out, the results would probably be difficult to compare with our results. This is due to the aforementioned concept of dividing social costs into three categories, which other authors usually add together. Therefore, it does not make much sense to compare the social costs of gambling in the Czech Republic with those in the European Union. Again, we note that the main contribution of our study should be seen in the definition of a new framework for allocating social costs to the three categories mentioned above. The quality and robustness of the specific results depend on the quality of the data used.

Recognizing the distinction between externalities, transfers, and public expenditures is not just an academic exercise. It is a critical step towards formulating targeted and effective public policies. The principle of targeted taxation, here in the context of gambling, rests on the foundation that only externalities should be the focus of taxation. This approach is rooted in the above-mentioned Pigouvian tax theory, which advocates for taxing activities that generate negative externalities to correct market imbalances (Pigou, 1932).

By applying this theory to gambling, we can align tax policies with the objective of mitigating social harm. The concept of targeted taxation in gambling derives its rationale from the need to address the externalities. Baumol's (1972) seminal analysis asserts that in situations where externalities resemble public goods, such as typical pollution issues, optimal resource allocation does not necessitate compensating or taxing those affected by the externality. Instead, focusing on the source of the externality (gambling) is key. Baumol (1972) also acknowledges the practical limitations of Pigouvian proposals when implemented directly as per the theoretical framework. He suggests a modified approach emphasizing effectiveness over theoretical perfection. This involves setting acceptable standards for externalities and designing taxes and charges to achieve these standards.

In the context of gambling, this implies that taxation should be aimed at the specific externalities. By setting standards of what is considered acceptable levels of these negative impacts, governments can formulate taxes or charges that are effective in mitigating these externalities. This approach, while not perfect, offers a more pragmatic and potentially effective way of using taxation to manage the social costs of gambling, ensuring that the tax system is equitable and targets the actual sources of social harm. Thus, the need for well-defined social costs and clear identification of transfers and public costs.

Implementing targeted taxation requires a careful analysis of the gambling industry and its various impacts. This is exactly what we did. This quantification not only aids in setting appropriate tax rates but also ensures that the revenue collected is directly channeled toward addressing the relevant issues.

The government's involvement in endorsing merit goods and controlling demerit goods stems from political and social value judgments rather than direct economic externalities. Merit goods, such as education and healthcare, are considered inherently valuable and beneficial for society. The government promotes these goods through subsidies and public provision, reflecting a societal consensus on their positive role. Demerit goods, on the other hand, like gambling, tobacco, and alcohol, are deemed less desirable by social standards. The government's regulation or taxation of these goods is a policy decision aimed at discouraging their consumption based on the belief that their use is detrimental to individuals or society. This approach is distinct from addressing externalities; it is a conscious political choice reflecting social values and priorities.

It is important to recognize the government's legitimate authority to levy taxes for revenue collection to fund various public services and initiatives. This taxation, aimed at raising funds for government expenditure, differs fundamentally from Pigouvian taxation, which is specifically designed to correct market failures due to negative externalities. Pigouvian taxes are targeted and seek to internalize external costs.

The government's policies regarding merit and demerit goods are driven by social values and priorities, distinct from externalities, and are still relevant today (Desmarais-Tremblay,

2016). Its role in taxation for revenue collection stands separate from the principles of Pigouvian taxation, emphasizing the diverse aspects of government intervention. Calabresi (2016) proposes a compelling perspective on merit goods. He challenges the approach that is centered on the discomfort people feel about certain goods being traded for money and advocates for a more rational framework. His shift from emotions to a more reasoned conceptualization allows for a more rational allocation of goods in society, examining the underlying reasons and institutional dynamics rather than simply relying on emotional responses to market transactions. A good example is the Czech regulation of light pollution in gambling halls, which directly targeted a clearly defined externality and eliminated it.

The ex-post regulatory impact assessment (RIA) for gambling legislation in the Czech Republic (MFCR, 2021), specifically for Acts No. 186/2016 Coll. and No. 187/2016 Coll., discusses externalities in several contexts. In Annex 9, it highlights the need for stable, professional entities in gambling due to negative externalities associated with this activity. It emphasizes stricter compliance and supervision requirements during license granting. Annex 14 delves into taxation of externalities, pointing out that, like other taxes targeting externalities (environmental or health-related), fiscal criteria are not the only consideration. It explains that regulatory functions, which limit consumption of such products, are also crucial. It also notes that the concept of the Laffer curve remains relevant for expected revenue trends when setting tax rates.

The RIA's treatment of externalities in gambling regulation and taxation, however, lacks a precise definition and quantification of these externalities. Without a clear understanding of the specific externalities associated with gambling, policy-making becomes challenging.

As discussed earlier, accurately defining and quantifying externalities is crucial for rational policy formulation. It ensures that taxes or regulations are proportionate to the actual social costs incurred, avoiding over- or under-regulation. While the state has the authority to tax for revenue collection and to regulate demerit goods, such measures should ideally be based on a thorough understanding of the externalities involved.

To summarize, defining externalities accurately is crucial. A pure Pigouvian tax, based

on our calculations, would be lower than when including transfers and public expenditures in social costs. The government is certainly within its rights to set higher taxes, but a proper RIA should clarify which portion of the tax is for revenue collection, which addresses demerit goods, and not solely attribute it to externalities. This distinction is crucial for transparent and effective policy-making.

We, therefore, suggest that any future RIA, in addition to calculating social costs, should rely on a clear definition of them and, together with theory, tax externalities only up to their actual amount, whereby higher taxation may be justified by the need for tax revenue or by an arbitrary government decision to restrict some part of the population's economic activity.

Finally, we believe that a complete economic analysis of any phenomenon should not only look at the costs of an activity, but also its benefits. Estimating the benefits of gambling is an interesting topic for future studies.

Conclusions

While the social cost of gambling is a popular analytical tool for assessing the impact of the activity and for setting policies, the specific calculations are, in the vast majority of cases, methodologically flawed. This paper, therefore, presents a new framework for determining cost items, where the total impacts of gambling are divided into private costs, externalities and public expenditures. First, this categorization is compatible with economic science, and second, it allows a given political establishment to focus only on the relevant components of the impact of gambling (externalities and public expenditures). After several decades of research, this approach finally makes it possible to unify the methodology for calculating the social costs of (not only) gambling, but also to bring rationality to political decision-making on gambling.

Although the main added value of the study lies in this framework, we demonstrate its practical application by quantifying the private costs, externalities and public expenditures of gambling in the Czech Republic in 2022 using the best available data possible. The result is a sum of CZK 91.1–102.3 billion (on the Lie/bet scale) or CZK 89.3–105.0 billion (on the PGSI scale) for private costs, CZK 2.6–4.8 billion or CZK 2.2–5.3 billion

for externalities and CZK 5.6–8.0 billion or CZK 9.6–12.2 billion for public expenditure. This amount is difficult to compare with other studies, as most authors confuse the three categories. However, it is the amount of externalities that local government should seek to eliminate through state intervention, as it represents a social harm that is not included in the price of gambling. This approach allows for the application of a purely economic pragmatic approach instead of the ad hoc measures that existing social cost calculations lead to – the effectiveness of a given measure can be assessed by comparing its costs and the reduction of these externalities. Future RIAs should clearly outline and tax social costs of gambling only as much as their true extent, unless additional taxation is needed for revenue or to deliberately curb economic activities.

The quality of the calculation of individual social cost items is closely related to the methodology and the quality of the data available. While for some items we had specifically tailored data available, for other items we had to resort to adopting the methodology of other studies or using somewhat outdated or otherwise non-optimal data, which introduces problems that we cannot otherwise resolve. In particular, intangible and psychological costs are extremely difficult to tackle and, for example, in the case of the impact of parental gambling on children, we are one of the first studies to attempt this calculation. Nevertheless, this is the best available data for this phenomenon in the Czech Republic and, as already mentioned, the main added value is the definition of the framework and methodology itself.

Therefore, the main limitation of our work is the lack of Czech-specific data, especially regarding the psychological effects of gambling (e.g., calculation of QALYs), but also regarding the current behavior of gamblers, their attitudes, etc. This problem is particularly acute for the impact on underage children of gamblers. Besides the data, further research could find additional costs and improve the methods for calculating them. Above all, this framework needs to be incorporated into key regulatory impact assessments of future gambling policies. In a broader sense, another significant gap in research (not only in the Czech Republic) is the absence of social benefits of gambling. These are essential for a comprehensive assessment of social impact

and should be subject to the same methodology as social costs.

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Impulse response of auction price by practicing auction scheme for solar PV generation to generation quantity, investment and Brent crude oil price

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Abstract: Energy is crucial for economic progress worldwide, regardless of a country's development status. However, the negative impacts of traditional energy sources have prompted global policymakers to reconsider fossil fuel consumption patterns. In addition to these harmful effects, regional conflicts such as the Russia-Ukraine war and tensions involving Israel, Palestine, and Iran are contributing to instability in the global energy market, which in turn affects general market stability. Consequently, global leaders are focusing on country-specific energy policies that prioritize the transition to renewable energy sources in future energy strategies. To ensure the widespread and cost-effective use of solar photovoltaic energy, many countries, including those in the European Union and beyond, are increasingly utilizing renewable energy auction techniques. Thus, the primary focus of this study is to evaluate the impact of a competitive auction technique on the expansion of solar PV generation and the potential reduction (or stabilization) of Brent crude oil prices (i.e., West Texas intermediate oil price). This is particularly relevant given the shifting investment trends in the renewable energy sector, with a specific emphasis on seven open and dynamic economies within the EU. To conduct this analysis, the authors employed a panel vector autoregression (VAR) model, utilizing annual data spanning from 2000 to 2021. The result indicates that the competitive auction value for solar PV accelerates the generation of solar PV in the selected EU countries and the countries are likely to decrease their reliance on fossil fuel-based sources for electricity generation. Because, the auction price is becoming competitive to the Brent crude oil price. Further, the investment in the solar PV sector is not sufficient yet.

Keywords: Auction value, funds, panel VAR model, photovoltaic, West Texas intermediate oil price.

JEL Classification: C32, C62, Q42, Q48.

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Introduction

Policies play a crucial role in fostering sustained and lasting development across various sectors, and the solar photovoltaic (solar PV)

as a source of renewable energy sector is no exception to this fundamental principle. In the face of global efforts to address climate change, there is a projected 50% surge

in energy demand by 2050, with the energy sector responsible for two-thirds of global emissions (IEA, 2018; IRENA, 2020). In 2019, global subsidies for renewable energy amounted to USD 170 billion. It is noteworthy that subsidies for fossil fuels during the same period were nearly twice that amount (REN21, 2019). Nevertheless, numerous renewable projects continue to rely on governmental subsidies for their implementation.

Decision-makers establish country-specific objectives based on energy policies to actualize a nation's energy vision. This approach contributes to market stability, boosts investor confidence, and facilitates the realization of energy support goals. In light of the adverse effects associated with conventional energy sources, there is a growing emphasis on shifting towards renewable energy sources (RES) in future energy strategies. According to Andrews-Speed (2016), the concept of a low-carbon energy transition stems from the understanding that energy and its consumption patterns are deeply ingrained in societies. Government intervention becomes imperative in the adoption of expensive energy transition technologies to ensure long-term public benefits. As a viable alternative energy source on a global scale, renewable energy (RE) as low-carbon energy is gaining prominence in response to challenges posed by climate change, the depletion of fossil fuels (FF), concerns about energy security, technological advancements, and the increasingly volatile prices of petroleum-based fuels (Do et al., 2020; Ferrer et al., 2018).

In facilitating the shift towards a low-carbon future, governmental authorities must find a harmonious equilibrium between internal and external factors and room to maneuvers. The former involves decisive actions taken by the government, while the latter entails employing strategic settings to guide the transition (Smith & Stirling, 2007). Corroborating the initial assertion, Andrews-Speed and Zhang (2015) affirm that advancing RE demands the establishment of limits, substantial financial backing from the state, and the implementation of robust administrative measures. These measures are essential to effectively circumvent the need for elusive strategic instruments.

In the early 21st century, renewable sources of energy (especially solar PV) assumed a more prominent position. Notably, from 2004 to 2017, there witnessed a rapid surge in investments

in clean energy, with the funding escalating from USD 62 billion to USD 280 billion (Pham, 2019). While Brent crude oil remains a prevalent fossil fuel for energy generation, growing interest and investments in renewable energy sources as alternatives to fossil fuels have motivated researchers to explore potential relationships among various variables (Wu & Chen, 2019). The most recent Monthly electricity statistics report from the International Energy Agency (IEA), covering data up to October 2023, indicates a sustained upward trajectory in the utilization of renewable sources. There was a notable 7.0% year-on-year growth, primarily propelled by increased generation from solar (registering a substantial +15.8% year-on-years).

The Renewable energy directive (European Union, 2018) mandates that 32% of the energy consumed within the European Union must come from renewable sources by 2030. This directive, aligned with the European Green Deal, highlights the need for stronger climate action and environmental goals, focusing on energy's role in achieving net-zero emissions. To support these goals, the European Green Deal Investment Plan, launched in January 2020, aims to mobilize at least EUR 1,000 billion over the coming decade (European Commission, 2020). In the spread of renewable energy four barriers can be defined based on Sisodia et al. (2016): still higher costs compared to traditional energy sources, market share, governments' policy, and until the development of energy storage the matching demand for the energy produced.

To promote the expansion of solar PV, various governments implement policy supports and set targets with a focus on reducing emissions, ensuring energy supply security, and making energy sources more accessible (REN21, 2009; REN21, 2007). Despite the existence of diverse support schemes, governments frequently modify their choices due to factors such as changing political and institutional environments, the tightening of local or global targets, technological advancements, or challenges in providing support during financial crises (Boomsma et al., 2012). The political and economic necessities of the energy sector contribute significantly to the governance of this domain, with policy paradigms playing a crucial role (Helm, 2007; Kuzemko, 2013; Mitchell, 2008). Additionally, the resolution of prices and support policies assumes a critical role in this context (Butler & Neuhoff, 2008).

Globally, the three primary and widely employed RE schemes include feed-in-tariff (FiT), quota allocation, and more recently, competitive auction/tender systems (Hansen et al., 2020; IRENA, 2017; Kreiss et al., 2017; Toke, 2015; Yalili et al., 2020). Auction theory, as outlined by Klemperer (1999), is considered an applied branch of economics that explores the role of bidders in the auction market. This branch focuses on achieving optimal outcomes based on market forecasts.

The primary focus of this study is to evaluate the impact of a competitive auction scheme on the expansion of solar PV generation and the potential reduction (or stabilization) of Brent crude oil prices (i.e., West Texas intermediate oil price). This is particularly relevant given the shifting investment trends in the renewable energy sector, with a specific emphasis on seven open and dynamic economies within the European Union (EU). The significance of this investigation lies in recognizing crude oil as a crucial production factor, as any upward movement in its prices invariably results in increased production costs. These elevated costs are ultimately transferred to consumers through higher product prices, thereby creating inflationary pressures that dampen aggregate demand. Such economic repercussions can lead to a slowdown in overall economic activity (Naser & Rashid, 2018). As the popularity of renewable energy sources like solar grows, there is a potential decline in the need for crude oil. This could result in a decrease in hydraulic fracturing and crude oil production. While there were initial obstacles and expenses linked to the implementation of solar panels on Earth, progress in technology and widespread manufacturing has rendered solar PV systems more within reach and cost-effective (Sorokin et al., 2023). Consequently, this study contributes to existing literature by examining the gradual decline in solar PV generation auction price in relation to solar PV generation quantity, investments in the solar PV sector, and the global WTI crude oil prices across seven EU countries, namely Greece, Hungary, Italy, Poland, Portugal, Romania, and Spain. To conduct this analysis, we employ a panel vector autoregression (VAR) model, utilizing annual data spanning from 2000 to 2021.

The uniqueness of this paper lies in presenting details about our methodology and research concentration especially the relationship

between the falling solar PV auction price and WTI crude oil price, along with offering policy recommendations and exploring the implications for the chosen countries. The structure of the rest of this study is as follows. The subsequent section offers the theoretical framework induces auctions and the literature review highlights specific articles with comparable methodologies, whereas Section 2 concentrates on the data and methodology. Section 3 delves into the result and discussion, and Section 4 presents the conclusions.

1 Theoretical background

Auctions are widely considered as an effective method for distributing subsidies related to renewable energy, providing valuable insights into the actual costs associated with renewable technologies (AURES, 2020). Connecting auction theory to the competitive market for renewable energy auctions, the price that satisfies the aggregate demand of winning buyers and covers the aggregate costs of the winning sellers is referred to as the market-clearing price. This clearing price ensures equilibrium in the energy market, where the aggregate quantity demanded equals the aggregate quantity supplied, a concept known in economics as market equilibrium (Morey, 2001).

Regarding the essence of auction theory, sellers aim to maximize their revenues, while buyers seek to acquire products at lower costs and thus the economic equilibrium appears. Auction theory is significant for both practical and theoretical reasons. Firstly, a substantial number of economic transactions are conducted through auctions. Secondly, auctions provide an excellent testing ground for economic theories due to their well-organized and straightforward economic environments. Finally, the auction process engages buyers and sellers in active and competitive interactions to determine the price (Klemperer, 1999). On this specific market, auctions have been instrumental in significantly reducing the installation costs of RE and have played a key role in the substantial decline in RE generation costs, experiencing an 85% reduction since 2010 (IRENA, 2021). This cost reduction is evident in the capital expenditures (CAPEX) for solar PV, where the investment cost per kW installed is notably lower (Diallo & Kitzing, 2020; Kost et al., 2021). The IEA (2019) emphasizes that engaging in competitive auctions expedites

the reduction of costs for certain renewable technologies, such as solar PV. Setting targets and employing competitive auctions has the potential to facilitate the swift transition of solar technologies within the electricity sector (IEA, 2021).

According to Steffen (2020), there is a discernible trend indicating that solar PV projects encounter a smaller weighted-average cost of capital (WACC). Rennkamp et al. (2017) contend that solar PV can produce electricity with significantly shorter construction lead times when compared to large coal or nuclear power plants. To promote regional appropriateness, the use of domestically produced machinery and local planning has been encouraged within the context of solar PV. This approach is identified as a potential avenue for bolstering local employment and labor involvement (Sweeney, 2015).

Thus, it is essential to persist in the development of renewable energy alternatives, particularly solar energy, to pave the way for a sustainable energy future. This approach aims to diminish greenhouse gas emissions and diminish dependence on hydrocarbon-based energy sources. The transition toward solar energy is expected to bring about substantial transformations in the energy market, and it is imperative to factor in these shifts in any energy-related model or analysis (Ratner et al., 2022).

1.1 Literature review

The price of WTI crude oil directly affects prices of gasoline, diesel, and other oil products, influencing consumer and business costs. Fluctuations in WTI prices also impact inflation, currency exchange rates, and political stability in oil-dependent regions. Therefore, analyzing WTI prices helps businesses, investors, and governments make informed decisions and strategies, especially in uncertain markets (Sorokin et al., 2023).

Samour and Pata (2022) explore how U.S. interest rates and oil prices affect renewable energy use in Turkey from 1985 to 2016. They find that U.S. interest rates impact Turkey's renewable energy adoption via income and local interest rates. Turkey's economic ties to the U.S. amplify this effect, while oil prices hinder renewable energy through income-related factors.

Long et al. (2023) get a notable connection between renewable energy and oil. While

elevated oil prices may stimulate investment in renewable energy, lower oil prices could lead consumers to prefer oil-based products. Additionally, minor fluctuations in global crude oil prices have the potential to induce substantial shifts in the investment patterns of Chinese renewable energy firms (Broadstock et al., 2012; Cao et al., 2020). Creating substantial investments and establishing robust support systems in renewable energy are essential components to drive increased generation of renewable energy (Sisodia et al., 2015a, 2015b). Mauleon and Hamoudi (2017) found that investments are important to reach economics of scales in RE deployment. So, any measure (like reduced installation costs) that incentivizes investment is desirable. Balashova and Serletis (2021) found in their research that oil price volatility, assessed through the GARCH-M(1,1) model, hinders total factor productivity (TFP) growth in both "old" and "new" EU countries. This, in turn, decelerates the rate of innovation and investment activity.

Lardic and Mignon (2006) and Rafiq et al. (2009) highlighted the substantial impact of oil prices (OP) on economic indices. This influence is diverse, especially when comparing oil-importing and oil-exporting countries. In the case of oil-importing nations, a rise in OP can lead to adverse effects on economic indicators. If these indicators decline, the ability to invest in infrastructure for renewable energy (RE) becomes constrained, hindering the allocation of necessary funds. On the contrary, an influx of funds into RE can expedite renewable energy generation, prompting consumers to shift towards options like solar PV. Consequently, the adoption of renewable energy is expected to rise, gradually replacing fossil fuels (Samour & Pata, 2022).

Ahmad (2017) and Dutta (2017) both support the idea of a substitution relationship between OP and renewable energy, suggesting that a rise in oil prices could result in an increased demand for renewable energy. Enhancing electricity production from renewable energy sources (RES) will diminish reliance on imported energy fuels like oil, promoting improved energy independence (Paska et al., 2009). Solar PV installations are highlighted as the most promising avenues for development in the upcoming decades (Paska et al., 2020).

The impact of regulatory frameworks on businesses and investments is crucial, with

both positive and negative implications (Saltari & Travaglini, 2011; Schmit & Conrad, 2011). The renewable energy sector is currently experiencing significant growth and dynamism, making it an attractive investment option for companies and individuals seeking substantial returns. A notable example is the solar industry in the EU-27, where supportive schemes and a reliable regulatory environment are pivotal factors in fostering increased investments (Siodia et al., 2016). In the context of private sector involvement in renewable energy investment in the Middle East, Aslani et al. (2012) highlight that friendly government policies and secure markets serve as driving forces for private firms venturing into this sector. The auction settlement has introduced a support policy that provides a stable environment for investing in solar photovoltaic (PV) systems, i.e., for the implementation of new renewable energy sources (Paska et al., 2020).

1.2 Theoretical model

To conduct the current study, the authors adopt the following theoretical framework to estimate the cost-effective solar energy in the seven open economies of the European Union.

$$\Delta AV_{SPV,i,t} = Const. + \alpha_1 \Delta \ln SPV_{GEN,i,t} + \alpha_2 \Delta SPV_{INV,i,t} + \alpha_3 \Delta P_{WTI,i,t} + \varepsilon_t \quad (1)$$

where: $AV_{SPV,i,t}$ – the global auction value for the solar photovoltaic energy generation; $SPV_{GEN,i,t}$ – the quantity of solar photovoltaic electricity generation in the selected countries; $SPV_{INV,i,t}$ – the public investment in solar photovoltaic; $P_{WTI,i,t}$ – the West Texas intermediate oil price.

Incorporating the West Texas intermediate oil price to reflect fossil fuel pricing and provide a more comprehensive depiction of the global energy market environment and dependence is essential, considering that countries can function as either net crude or refined commodity importers. Within the European Union (EU), all member countries are actively transitioning their economies toward a greener path. In an effort to reduce greenhouse gas emissions and address environmental concerns, these nations are increasingly adopting solar photovoltaic technology for electricity generation while reducing reliance on fossil fuel-based sources, particularly oil. This shift is in line with the ambitious net zero emission target by 2050.

Not even that shifting investment from fossil fuel (FF) to the solar PV projects is an important criterion for chasing the emission target by 2050.

To enhance the deployment of renewable energy (RE) and decrease reliance on fossil fuel-based electricity generation, countries are implementing the RE auction scheme. This is motivated by the global competitiveness of auction values compared to fuel-based electricity generation. For the purpose of the paper's theoretical model and quantitative analysis, specific EU countries (including Greece, Hungary, Italy, Poland, Portugal, Romania, and Spain) were chosen. These countries exhibit open economies, share close geographic similarities, and have been adopting the RE auction scheme in recent years as part of their efforts to achieve a net-zero target. Further, based on the net-zero targets, public investments are entering in this periphery. Based on our constructed theoretical model, we can anticipate that: (1) competitive auction values for solar PV will gradually increase solar PV generation ($\alpha_1 > 0$); (2) thereby more investments are coming into the solar PV market ($\alpha_2 > 0$); and (3) thereby positive effect on the alternative source of energy will support positively for stabilizing Brent crude oil pricing ($\alpha_3 > 0$).

2. Research methodology

2.1 Data

Since the emergence of renewable energy (RE), particularly solar photovoltaic (PV), there has been a noticeable increase in its adoption across selected countries starting in the 2000s. This surge in production has spurred a greater inclination towards consuming more renewable energy in these nations. In order to facilitate the robust deployment of RE at reasonable costs, countries began adopting auction schemes after 2012, with widespread implementation occurring predominantly from 2016 onward, although the global adoption of such schemes commenced in 2010. Linking with this pervasiveness public investment started to enter in this sector after 2010. The introduction and adoption of auction schemes for solar PV generation have led to a situation where the cost of energy generation from fossil fuels, particularly oil-based sources, is becoming competitive with auction prices. This study aims to assess how the decreasing auction values for solar PV impact solar PV generation and the global oil benchmark (i.e., WTI), examining whether the relationship is positive

or negative. Also, the study wishes to verify the fund flows from the government end in the selected countries.

A yearly time series data from 2000 to 2021 have been researched, focusing on this time frame due to the establishment and robustness of renewable energy (RE) practices. A sample group comprising seven open economies from rather (semi-) periphery of the European Union (Greece, Hungary, Italy, Poland, Portugal, Romania, and Spain) was chosen to validate the proposed theoretical model (Equation (1)). To ensure a uniform load factor for planned solar generation potential, all selected countries were categorized based on similar climate positions. Furthermore, these nations adopted renewable energy auctions as a strategic approach for the resilient deployment of renewable energy resources.

The data pertaining to the energy sectors were sourced from the bp Statistical Review of World Energy, while auction value and investment data were obtained from the IRENA database (Tab. 1). It should be noted that the robust development of renewable energy (RE) commenced in the 2000s and continued thereafter. However, not all the countries in the sample embraced RE during this period, and the auction scheme was not consistently followed from the 2000s onwards. Consequently, due to the absence of data for certain periods and countries, the panel data can be characterized as unbalanced, a feature assessed through the panel VAR model. Conversely, it is essential to highlight that there is no presence of unit-root in the data. Additionally, the standard deviation and mean of the data remain time-invariant. This temporal constancy in the standard

Tab. 1: Data sources

Name of the variable	Source
Auction price/value for solar photovoltaic generation ($AV_{SPV,i,t}$)	IRENA Database (July 2022)
Solar photovoltaic generation quantity ($SPV_{GEN,i,t}$)	Bp Statistical Review of World Energy (July 2021)
Investment in solar photovoltaic sector ($SPV_{INV,i,t}$)	IRENA Database (July 2022)
West Texas intermediate oil price ($P_{WTI,i,t}$)	Bp Statistical Review of World Energy (July 2021)

Source: own

Tab. 2: Descriptive statistics and unit-root tests

	$AV_{SPV,i,t}$	$\ln SPV_{GEN,i,t}$	$SPV_{INV,i,t}$	$P_{WTI,i,t}$
Mean	0.062	0.177	13.032	61.298
Median	0.045	0.007	0.000	61.923
Maximum	0.195	8.890	429.145	100.062
Minimum	0.000	-25.039	0.000	25.932
Std. dev.	0.070	2.544	61.126	23.849
Skewness	0.698	-5.877	5.279	0.183
Kurtosis	1.965	66.042	30.989	1.854
Jarque-Bera	19.258	26,217.740	5,705.118	9.219
Probability	0.000	0.000	0.000	0.009
Unit-root test: Levin, Lin & Chu t^*				
(P)	0.000	0.000	0.000	0.000
Observations	153	153	153	153

Source: own (in EViews 10)

deviation and mean validates the stability condition of the VAR model (Tab. 2).

2.2 Method

One can assert that econometricians employ various econometric models to examine the influence of one variable on others. A contemporary model used for this purpose is the panel vector autoregression model (VAR). Panel VAR models aim to illustrate the dynamic interconnections within the data by imposing a limited set of constraints. Impulse response analysis or policy counterfactuals can be easily constructed, incorporating relevant exogenous shocks. The panel VAR follows the structure of a VAR model, assuming that all variables are endogenous and interdependent. However, it includes a cross-sectional measurement in addition to the depiction (Canova & Ciccarelli, 2013). Besides, the panel VAR model proves beneficial in assessing spillovers arising from unique interdependencies among countries, markets, and sectors (Jouida, 2018). It also aids in identifying shocks within endogenous variables. This approach treats all variables as endogenous and interdependent, encompassing both dynamic and static perspectives. This consideration extends beyond a set of predetermined or exogenous variables, incorporating a cross-sectional dimension (Somosi et al., 2024). The dynamic interpretation of a set of N time series variables, denoted as $y_t = (y_{1t}, \dots, y_{Nt})'$, can be succinctly defined by the basic VAR model form Equation (2).

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \quad (2)$$

where: y_t – the model variables for the $(N \times 1)$ vector; F_t – the matrix which contains $(N \times N)$ autoregression coefficients; $\varepsilon_t = (u_{1t}, \dots, u_{Nt})'$ – the unobserved error term vector with $(N \times 1)$ Gaussian distribution where $\varepsilon_t \sim (0, E(u_t, u_t'))$ – a positive definite covariance matrix.

The determination of the optimal lag length in the model is accomplished through the utilization of criteria such as Schwarz (or Bayesian) information criteria (SC), Akaike information criteria (AIC), and Hannan-Quinn information criteria (HQ). These criteria are employed to assess the stability and asymptotic normality of the data. Subsequently, a test for the standardized condition is conducted to ascertain whether the modulus values are less than one. This condition indicates invertible explanations and the explanations of infinite-order

vector moving averages (Kiss et al., 2020; Lütkepohl, 2005).

When constructing Equation (2), various parameter boundaries can be considered. Short-term constraints may be disregarded to elucidate the distribution of shocks in Cholesky's formulation, while long-term restrictions can be explicated by the shocks in Blanchard-Quah's formulation. To achieve this, our initial step involves acquainting ourselves with the structural representation of the VAR form in a condensed manner (Equation (3)), incorporating a time lag (p), and featuring three variables with structural coefficients A and A^s .

$$y_t = A_1^s y_{t-1} + \dots + A_p^s y_{t-p} + Bu_t \quad (3)$$

$$\text{where: } \varepsilon_t = A^{-1} Bu_t \text{ and } S = A^{-1} B$$

We presume that specific coefficients hold a value of zero. The impact of u_{1t} is immediate on all other variables simultaneously, whereas u_{2t} influences only variables 1 and 2 concurrently. Similarly, u_{3t} exclusively affects the third variable in accordance with Cholesky's restriction (Equation (4)).

$$\varepsilon_t = Su_t = \begin{bmatrix} s_{11} & 0 & 0 \\ s_{21} & s_{22} & 0 \\ s_{31} & s_{32} & s_{33} \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} \quad (4)$$

In the approach presented in the extended restriction model by Blanchard and Quah (1989), the assessment of a shock's impact is limited to the row of the F -matrix corresponding to the position of the affected variable. The cumulative effect of the shock over time is presumed to be negligible, and ψ , representing the long-term multiplier ($F = \psi S$), is employed in the formulation (Equation (5)).

$$(1 - A_1 - \dots - A_p)^{-1} \varepsilon_t = \psi \varepsilon_t = F u_t \text{ and } F = \begin{bmatrix} f_{11} & 0 & 0 \\ f_{21} & f_{22} & 0 \\ f_{31} & f_{32} & f_{33} \end{bmatrix}, \text{ while } S = \begin{bmatrix} s_{11} & s_{12} & s_{13} \\ s_{21} & s_{22} & s_{23} \\ s_{31} & s_{32} & s_{33} \end{bmatrix} \quad (5)$$

The F -matrix delineates the long-term possessions, and in the EViews 10 econometric program, its formation is influenced by the loading sequence of variables into the VAR model. This assumes the presence of a shock impacting each variable, with

Tab. 3: Structure of the *F*-matrix containing the long-term effects

Variables	Shocks			
	<i>AV</i> _{SPV,<i>i,t</i>}	<i>SPV</i> _{GEN,<i>i,t</i>}	<i>SPV</i> _{INV,<i>i,t</i>}	<i>P</i> _{WTI,<i>i,t</i>}
<i>AV</i> _{SPV,<i>i,t</i>}	<i>f</i> ₁₁	0	0	0
<i>SPV</i> _{GEN,<i>i,t</i>}	<i>f</i> ₂₁	<i>f</i> ₂₂	0	0
<i>SPV</i> _{INV,<i>i,t</i>}	<i>f</i> ₃₁	<i>f</i> ₃₂	<i>f</i> ₃₃	0
<i>P</i> _{WTI,<i>i,t</i>}	<i>f</i> ₄₁	<i>f</i> ₄₂	<i>f</i> ₄₃	<i>f</i> ₄₄

Source: own (in EViews 10)

the final variable in the sequence affecting only itself. The development of the *F*-matrix (Tab. 3) aligns with the theoretical model presented in the paper.

To identify stable and enduring connections among the variables, this study employs the Johansen test for co-integration. If the test fails to establish such a relationship, it does not conclusively demonstrate the absence of one; rather, it simply implies that a relationship may not be present (Dinh, 2019). The analysis of impulse response plays a crucial role in econometric studies, particularly in the context of the VAR model. In this analysis, the functions are interpreted as the impact of a unit shock on a specific variable within a given model, where the shock originates from variable *i* to variable *j*, all else being equal. Moreover, variance decomposition, for a specified time horizon, refers to the breakdown of prediction error variance. This decomposition process delineates the short-term and long-term effects

of specific variables, representing the percentage of uncertainty in variable *i*th attributed to the *j*th shock after the *h* period (Dinh, 2020).

3. Results and discussion

The model utilized in this paper determined the lag length through the “lag order selection criteria,” wherein lags were constrained to 0–2 to fulfill the stability condition. The selection of the model was based on the AIC (Appendix, Tab. A1), indicating an optimal lag of 2 (with AIC at 19.55389, the lowest in the table). Consequently, the panel VAR exhibited no statistical errors at this juncture. Notably, the paper observed no inverse roots of the characteristic polynomial outside the unit circle, ensuring that all moduli were smaller than 1. This outcome further confirmed the stability condition of the VAR model (Tab. 4). The co-integration analysis (Appendix, Tab. A2) indicates the statistical significance of the independent variables at a 5% significance level. In the long run,

Tab. 4: Roots of characteristics polynomials

Root	Modulus
0.813638 – 0.269944i	0.857249
0.813638 + 0.269944i	0.857249
–0.033486 – 0.584658i	0.585616
–0.033486 + 0.584658i	0.585616
0.558431	0.558431
0.028578 – 0.173833i	0.176166
0.028578 + 0.173833i	0.176166
–0.138233	0.138233

Source: own (in EViews 10)

the independent variables exhibit a substantial impact on the dependent variable. This conclusion is drawn from the observation that all the values of the trace statistic and max-Eigen statistic surpass their respective critical values (Dinh, 2019).

Impulse responses (identifying cross-sectional dependence in a VAR model) prove challenging as the findings hinge on the impacts of individual variable shocks on auction value of solar PV, rather than centering on the model's coefficients, as is typical in most econometric approaches. Nevertheless, it is noteworthy that the residuals exhibit a notable degree of homogeneity (Appendix, Fig. A1) illustrate the impact of each variable's stimulus on the auction value of solar PV over time, along with 95% confidence intervals (± 2 standard errors) as depicted in Fig. 1. To begin, an examination of the dependent variable, namely the auction value at the initial period, was conducted to determine whether the trend was increasing or decreasing. The analysis revealed a positive trend. Subsequently, the

impulse responses of the remaining variables exhibited positive effects. This positivity suggests that the competitive auction value for solar PV accelerates the generation of solar PV in the selected EU countries. As the solar PV generation increases, these countries are likely to decrease their reliance on fossil-fuel-based sources for electricity generation. This reduction in dependence is influenced by the use of WTI oil price as a reference for spot price, future price, or the assessed price of oil, serving as a key global oil benchmark. Because the auction value is becoming the competitive of the Brent crude oil price. Further, the investment is found to be positive but not too significant which means that the investment is not sufficient yet for chasing the stipulated target within stipulated time span.

Finally, the analysis of variance decomposition is crucial, as it examines the percentage fluctuation in a time series attributable to the variables at the chosen time horizon and breaks down the forecast error variance for that specific period (Dinh, 2020).

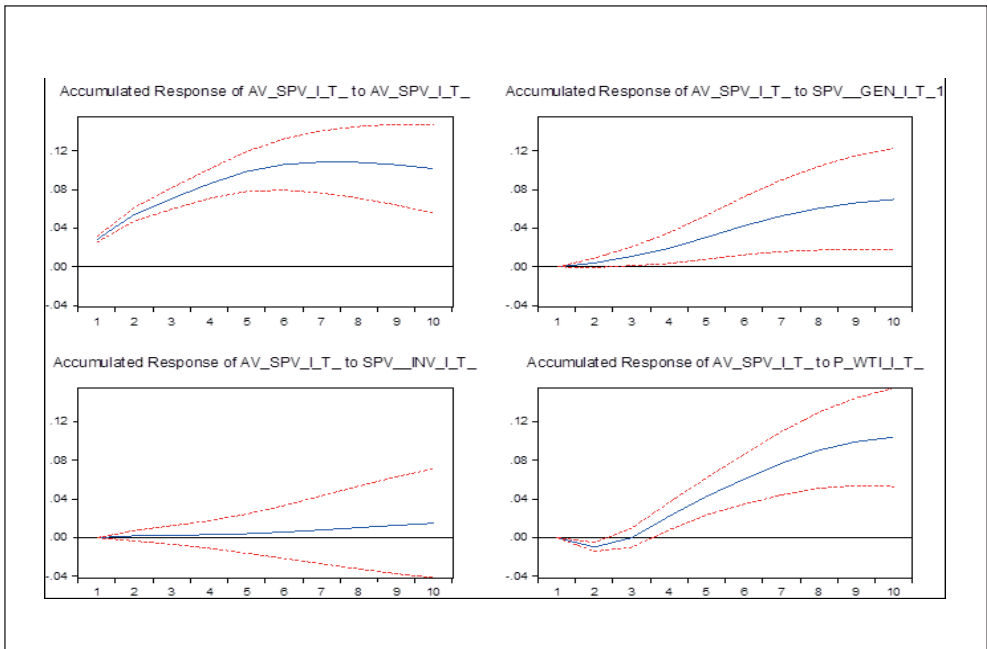


Fig. 1: Accumulated impulse response functions of auction value to model variables in long-run

Source: own (in EViews 10)

Tab. 5: Variance decomposition of $AV_{SPV,i,t}$ on VAR factors

Period	$AV_{SPV,i,t}$	$SPV_{GEN,i,t}$	$SPV_{INV,i,t}$	$P_{WTI,i,t}$
1	90.000	4.000	0.320	5.000
2	88.953	5.052	0.559	8.736
3	81.295	7.282	0.632	10.191
4	63.662	9.838	0.772	25.327
5	55.041	11.446	0.869	32.343
6	51.615	13.065	0.902	36.098
7	45.953	15.534	1.308	39.205
8	41.278	15.254	1.414	41.054
9	40.203	15.622	1.520	41.654
10	38.029	15.722	1.608	41.640

Source: own (in EViews 10)

Referring to Tab. 5, the variance decomposition of the auction value for solar PV indicates a significant contribution (~60%). Additionally, solar PV generation shows an above-marginal effect (~11%), while the WTI oil price demonstrates a relevant influence (~28%) and solar PV investment exhibits (~1%) marginal effect. These findings align with our primary assumption that competitive auction values for solar PV will gradually increase solar PV generation, thereby reducing dependence on oil-based electricity generation as an optimistic catalyst for stabilizing Brent crude oil prices.

Conclusions

To ensure a sustainable future and address global warming, as emphasized in the Paris Agreement (United Nations, 2015), it is imperative to focus on transitioning the energy mix to neutralized current and impending global environmental degradation. A comprehensive approach to the future of the energy sector necessitates the collaboration of leaders from major countries in formulating a framework that aligns with the evolving energy landscape. The implementation of an effective support scheme will serve as an additional catalyst for the smooth operation of the overall approach. Introducing an auction scheme in the solar PV market can contribute ensuring a desired quantity of energy at a lower cost, benefiting both buyers and sellers. This approach is poised to make the entire economy,

including the energy sector, more profitable. An exemplary demonstration of this profitability is the global auction value competing favorably with the WTI oil price.

The current investigation employs a panel VAR model to analyze seven expanding and open economies (i.e., Greece, Hungary, Italy, Poland, Portugal, Romania, and Spain). The solar PV auction value serves as the dependent variable in this model. Utilizing the panel VAR model, the dependent variable is used to discern the impulse responsiveness concerning the variables under consideration. According to our study's results, the countries in our sample seem to be actively addressing climate change and striving to meet environmental objectives in line with the European Green Deal and the Paris Agreement.

We found a gap in the existing literature during our research. Subsequently, we selected seven growing and open economies from the EU to participate in the auction scheme as new practitioners. These countries were deemed appropriate subjects for investigating the potential of solar PV generation, investment scenarios in the solar PV sector, and the influence of WTI oil prices. Analysis of data for 22 years (from 2000 to 2021) for the selected countries revealed that the VAR model satisfied stability conditions.

After conducting our research, it was determined that the solar PV auction value has a significant impact on the relevant WTI oil price. This suggests that the auction value

competes effectively with traditional oil-based power generation sources, such as gasoline, diesel fuel, and other oil products, which are directly influenced by the cost of WTI crude oil. Furthermore, our findings indicate that solar PV generation has a marginal effect, while the investment outcome has been noted to have an insignificant impact. Despite the increasing competitiveness of the auction value with WTI oil prices, insufficient public investment has hindered the ability of sample countries to expand their electricity generation from solar PV source. Additional endeavors are required to secure funding for emerging and developing economies, allowing them to expedite the implementation of clean energy. The recent COP28, led by the United Arab Emirates, signifies a significant advancement. It is imperative for nations to promptly translate these aspirations into reality by adopting tangible policies that facilitate a fair and impartial shift away from fossil fuels. This transition must be swift enough to uphold the Paris Agreement's objective of restricting global warming to 1.5°C.

In light of our research results, a pertinent inquiry emerges – how might the countries included in our sample confront the challenge of insufficient public investment? In addressing this query, it becomes apparent that governments of these countries could incentivize private investment, particularly through equity investment, fostering a mutually beneficial outcome for all stakeholders involved. Such a strategy not only aids in securing necessary funds but also cultivates a favorable perception within the community. Moreover, the EU itself can also dedicate funds to such projects as it did with the RRF.

Last but not the least, in the energy sector, the notion of "current or at this moment solution" is not pertinent; instead, it is closely associated with long-term strategizing. As a result, developed nations implement comprehensive energy plans over extended periods. Thus, maintaining coherent energy policies and ensuring effective management within this sector are imperative.

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Appendix

Tab. A1: VAR optimum lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1,649.499	NA	38,144.46	21.901	21.981	21.933
1	-1,504.829	279.758	6,939.62	20.196	20.596	20.359
2	-1,440.319	121.331*	3,651.701*	19.554*	20.273*	19.846*

Note: * indicates lag order selected by the criterion.

Source: own

Tab. A2: Johansen co-integration test

Unrestricted co-integration rank test (trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None*	0.359	180.346	47.856	0.000
At most 1*	0.274	113.709	29.797	0.000
At most 2*	0.239	65.713	15.495	0.000
At most 3	0.152	24.781	3.841	0.000
Unrestricted co-integration rank test (maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen statistic	0.05 critical value	Prob.**
None*	0.359	66.638	27.584	0.000
At most 1*	0.274	47.996	21.132	0.000
At most 2	0.239	40.932	14.265	0.000
At most 3	0.152	24.781	3.841	0.000

Note: Trace test indicates 4 cointegrating eqn(s) at the 0.05 level; max-Eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; ** MacKinnon-Haug-Michelis (1999) *p*-values.

Source: own

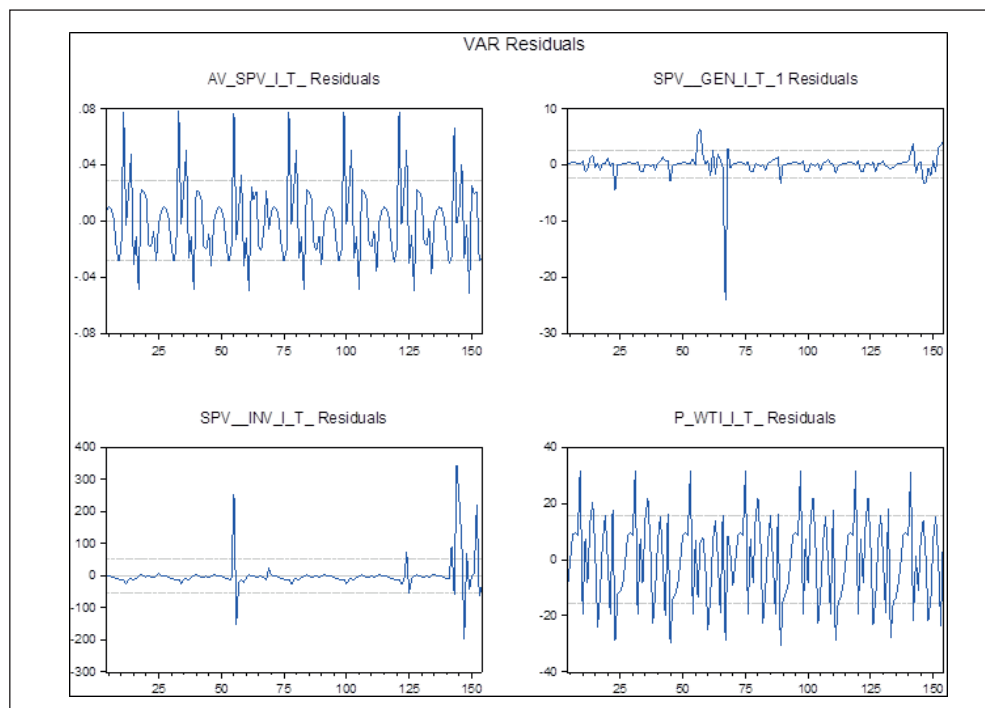


Fig. A1: VAR model residuals

Source: own

How and why does inner resignation (quiet quitting) impact service innovation behavior? A moderator role of ethical leadership

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Abstract: Tourism enterprises are labor-intensive, and the service innovation behavior of employees plays an important role in keeping these enterprises ahead of their competitors. Inner resignation (IR) is a relatively new concept in organizational life, and it is a situation that should be prevented due to its negative impact on the organization. In this study, the moderating role of ethical leadership (EL) in reducing the negative effect of inner resignation on service innovation behavior (SIB) was examined with a cross-cultural comparison for Turkish and German tourism employees. A total of 743 employees working in hotels in Turkey and Germany were surveyed using a questionnaire. The results of the research show that employees' inner resignation has a negative impact on their service innovation behavior. On the other hand, ethical leadership plays a moderating role in the effect of inner resignation on service innovating behavior. The moderator role of ethical leadership perceptions in this relationship was also examined separately for German and Turkish employees due to cultural differences. While the moderating role of ethical leadership in the effect of German employees' inner resignation on service innovating behavior was found to be statistically significant, this role was found to be insignificant for Turkish employees.

Keywords: Inner resignation, service innovation behavior, ethical leadership, hotel employees, cross-cultural management.

JEL Classification: M16, M14, Q3.

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Introduction

In modern organizations, leaders seek to maximize their employees' knowledge, skills, and talents. This exchange of ideas and creativity is realized through the adoption and appropriation

of the organization by the employees. This exchange of ideas depends on the organizational commitment of workers (Li & Cao, 2020). Today, a variety of individual and organizational factors have an impact on employees' willingness

to volunteer for the organization's benefit (Bingham et al., 2013). Sometimes for personal reasons and sometimes as a result of organizational practices and policies, an employee may lose the desire to use his or her knowledge, talents, and skills for the achievement of organizational goals (Acharya & Kesari, 2016). This situation, which is a manifestation of the employee's conscious withdrawal, may take the form of absenteeism, inner resignation from the job, or leaving the organization by breaching the employment contract. Resignation behavior is not always external (physical), but can be inner (psychological). In the case of inner resignation, the employees are not willing to contribute their knowledge, ideas, thoughts, skills and experiences for the benefit of the organization. They continue to labour for the organization and remain members. Nevertheless, their contribution is ineffective. These employees continue to perform their duties physically, but they have departed psychologically.

The literature refers to employees' psychological resignation as inner resignation. Although inner resignation is common in many organizations, managers do not give priority to the issue. The effects of inner resignation include decreased job performance, decreased desire to work, and inability to achieve company objectives. Inner resignation signifies that the employee no longer makes full use of his or her skills and abilities; in a sense, it reduces the human resources required to perform the job and causes a shortage of already restricted human resources (Nink, 2013; Richter, 1999). According to Gallup's study, half of the American workforce are quietly quitting their jobs (Constantz, 2022). This trend became pronounced in the tourism and hospitality sector following the end of COVID-19 shutdowns and the resumption of operations, with a significantly greater decline in employee productivity compared to other industries (Gordon & Sayed, 2022). Therefore, inner resignation not only leads to a decrease in productivity and an increase in costs, but it also poses a challenge for the application of time, quality, and innovation in business processes, which are crucial for modern organizations (Krystek et al., 1995).

Employees in the labor-intensive hospitality sector play a critical role as they are considered invaluable assets for companies, contributing to the competitive advantage of tourism businesses through their behaviors and skills

(Elshaer & Marzuuk, 2019; Yong Kim & Oh, 2004). Therefore, the inner resignation of employees poses a critical challenge for tourism companies, potentially having more adverse effects compared to product-producing companies (Dominique-Ferreira, 2023; Hamouche et al., 2023; Liu-Lastres et al., 2024; Wu & Wei, 2024). In businesses where products are simultaneously produced and consumed, such as tourism enterprises, employees' inner resignation can negatively impact customer satisfaction and service quality (Liu-Lastres et al., 2024). The hospitality industry is an example of an extremely fast-paced sector where managers and employees face significant pressure to be productive (Kalargyrou et al., 2023). Furthermore, in this industry, frontline employees may exhibit deviant workplace behaviors due to factors such as role ambiguity, job insecurity, low wages, and workload (Wu & Wei, 2024). When encountering uncertain and conflicting job situations, these employees are aware of and respond to negative role stress factors. Among these responses, there is a tendency to exhibit deviant behaviors in the workplace, such as doing less work or putting in less effort, in order to protect themselves and minimize potential harm from external stressors (Wu & Wei, 2024).

Service innovation behavior helps tourism employees to generate new ideas for service improvement and to accept new ideas from others (Abbas & Raja, 2015). Service innovation is an important behavioral outcome in numerous service contexts, including hotels, travel agencies, airlines, restaurants/cafes, hospitals, and retailers (Li & Hsu, 2016; Su, 2011). Indeed, service innovation in the hospitality industry seeks to improve customer experience, introduce new markets, and consistently increase profitability by restructuring the value creation process and providing added value to customers (Vargo & Lusch, 2004). Technological advancement is one of the key forces that can revolutionize hospitality and tourism services (Lee-MinWoo & Baker, 2017).

In the labor-intensive hospitality industry, employees are essential because it is believed that the greatest ideas for process innovation come from those who perform the work (Elshaer & Marzuuk, 2019). In the context of social learning (Bandura & McClelland, 1977) and social exchange theory, it is believed that employees respond positively when organizational leaders demonstrate ethical behaviors, decrease their

inner resignations, and increase service innovation behaviors. Literature review reveals that Bandura's (1969) social learning theory and Blau's (1968) social exchange theory are most frequently used to explain the effects of ethical leadership on employees. Employees of ethical leaders may perceive a social exchange relationship with their leaders due to the ethical treatment they perceive and the trust they experience. Consequently, the tendency to respond positively to the leader and the institution increases (Bahar, 2019). Within the framework of social exchange theory, leaders' ethical behaviors encourage employees to exhibit organizationally-beneficial behaviors.

The model of this study was determined on hotel employees in Germany and Turkey. The GLOBE international leadership study has shown that cultural context influences leadership concepts (House et al., 2004). Other cross-cultural studies have also shown that an individual's culture influences his or her perceptions of ethics and ethical leadership (Haque & Yamoah, 2021; Li et al., 2014; Resick et al., 2011; Sarwar, 2020). In addition to Hofstede's cultural dimensions, Turkey is collectivist, uncertainty-avoidant, high power distant, and feminine. Germany is a country characterized by its masculinity, high uncertainty avoidance, and inner control (Ozturk, 2020). Comparing the research variables in two different cultural contexts will provide a better understanding of the relationships between the variables and administrative differences in the cultural context. Individual cultural differences have been found in cross-cultural research to create differences in the perceptions, behaviors, and attitudes of employees within the organization (Francioli et al., 2018). Furthermore, social learning and social change theories suggest that ethical leadership serves as a moderator in assessing counterproductive employee work behaviors (e.g., burnout, deviant behaviors, low task performance, and inner resignation) (Mo & Shi, 2017). By establishing a link between ethical leadership and the relationship between inner resignation and service innovation behaviors, this study aims to discover "why" and "how" an organization's inner resignation affects individuals' service innovation behaviors. Although there is limited research examining the effects of inner resignation on tourism businesses (Giousmpasoglou et al., 2021; Hamouche et al., 2023; Liu-Lastres et al., 2024), no study has

been found that investigates these relationships in a cross-cultural context. In this context, it can be said that this research is important in terms of advancing the understanding of the dimensions of the concept. Employees are the most important resource in the tourism industry, and quitting their jobs can cause significant financial (e.g., loss of customers and increased costs) and moral (e.g., bad image, customer dissatisfaction) losses to companies. Therefore, tourism research on this topic will make significant contributions to theory and practice.

1. Theoretical background

1.1 Relationship between inner resignation and innovation in service behavior

The concept of inner resignation describes the psychological resignation of employees. In general, inner resignation refers to an unspoken, hidden process of resigning (Faller, 1993; Friedrich, 2010). In the literature, psychological contract theory is used to explain inner resignation (Parzefall & Coyle-Shapiro, 2011). According to psychological contract theory, when an employer and employee enter an employment relationship, both a formal written employment contract and an implicit psychological contract beyond the formal contractual employment relationship are formed (Richter, 1999). A psychological breach of contract is the employee's perception that the obligations of the contract have not been fulfilled (Robinson & Morrison, 2000). The process that follows a breach of psychological contract is determined by the principle of justice or the attempt at restoration of justice (Schmitz et al., 2002). Inner resignation is only one of many possible responses to this situation. As a result of inner resignation, the individual attempts to maintain equilibrium by minimizing his/her own efforts. He/she minimizes his/her contribution to the organization. He/she starts by contributing the minimum amount required by the formal contract, but not all of his/her performance. In this respect, inner resignation is the employee's response to the organization's breach of the psychological contract (Faller, 1991). Negative feelings about the workplace and perceived breach of the psychological contract can lead to anxiety, demoralization, job dissatisfaction, low organizational commitment, intentions to leave physically and psychologically, and poor job performance (Li et al., 2016). Consequently,

it is hypothesized that inner resignation could lead to similar organizational outcomes.

According to the literature, psychological breach reduces employee commitment, citizenship, loyalty and service innovation. Similarly, these concepts are negatively related to inner resignation (Raidt, 1989; Secer, 2009). Similarly, inner resignation is thought to be related to the actions of individuals during the production and implementation of new ideas (Scott & Bruce, 1994). Organizations are distracted from this important value by the inner resignation of employees who play an essential role in making tourism businesses more desirable through innovative services and practices. According to Krystek et al. (1995, p. 12): "Inner resignation not only leads to reduced productivity and increased absenteeism, but also poses a serious problem in terms of time, quality and innovation, all of which are crucial for organizations." In this context, the first research hypothesis is as follows:

H1: Inner resignation has a negative effect on service innovation behavior.

1.2 The role of ethical leadership as moderator in the relationship between inner resignation and service innovation

Ethical leadership can be defined as the demonstration of normatively appropriate behavior through personal actions and interpersonal relationships and the promotion of such behavior to followers through two-way communication, empowerment, and decision making (Brown et al., 2005). Brown et al. (2005) and Cho et al. (2018) describe ethical leaders as individuals who demonstrate honest, reliable, and fair behavior while attempting to influence their followers. Ethical leaders tend to create an environment that improves the attitudes and behaviors of their followers. However, ethical leadership also plays an important role in developing employee skills by creating a positive organizational climate.

One of the main factors associated with inner resignation, which is relatively new but has been shown by several studies to have a significant impact on the organization, is leadership behavior (Brinkmann & Stapf, 2005; Gabelaia & Bagociunaite, 2023; Krystek et al., 1995; Scheibner & Hapkemeyer, 2013). The main cause of inner resignation is poor leadership behavior. These behaviors include insufficient

information sharing between supervisors and employees (97%), arbitrary decisions (95%), and supervisors' unwillingness to share (93%) (Krystek et al., 1995; Scheibner & Hapkemeyer, 2013). A recent study found that the least effective managers have three to four times as many people who fall in the quiet quitting category compared to the most effective leaders (Zenger & Folkman, 2022). According to Brinkmann and Stapf (2005), the manager can expose the employee to inner resignation through behaviors such as less willingness to communicate, poor or faulty communication, interfering with the employee's work, providing incorrect information, and not supporting participation. However, leadership styles such as authoritarian leadership are based on leaders' distrust of employees and employees' distrust of leaders. This relationship of mutual distrust is the path that leads to inner resignation. In their study, leadership behaviors contributed the most to the explanation of inner resignation. On the other hand, Schmitz et al. (2002) discovered a relationship between inner resignation, an unsupportive leadership style, and a lack of collaborative leadership. According to Hohn (1989), inner resignation is primarily a result of serious errors in unethical leadership behavior. Ethical leadership, which is positively associated with employees' job satisfaction and psychological well-being, is believed to reduce inner resignation (Avey et al., 2012).

Consistent with the previous explanations, the presence of ethical leaders creates a positive atmosphere within an organization. This positive atmosphere may contribute to a decrease in employee inner resignation. However, although there is no study that examines these concepts together, there are studies that indicate that ethical leadership has a positive effect on service innovation behavior (Gurkan & Akay, 2021). Leadership and service innovation (Karadal & Ozsungur, 2017) are associated with employee creativity (Javed et al., 2018) and innovative business behaviors (Haque & Yamoah, 2021). It is believed that these leaders, who consider the rights of their employees and demonstrate acceptable behaviors, will increase service innovation and decrease inner resignation. In this regard, it is believed that ethical leadership will play a moderating role in the relationship between inner resignation and service innovation behavior. The second hypothesis is as follows:

H2: Ethical leadership plays a moderating role in the relationship between inner resignation and service innovation behavior.

1.3 Cross-cultural study context

In order to foster greater service innovation behavior within an organization, it is critical to trace the origins of ideas. This study aims to show that inner resignation undermines service innovation. As a factor that shapes individuals' thoughts, emotions, and actions, culture is believed to influence both inner resignation and service innovation behavior. The concept of inner resignation emerged in the German management literature in the early 1980s and has been further explored in subsequent works (Derschka, 1988; Faller, 1993; Höhn, 1989; Jochmann, 1989; Krenz, 1998; Krystek, 1995; Löhnert, 1990; Nuber, 1987; Raidt, 1987; Raidt, 1989; Richter, 1999; Sieland, 1991; Volk, 1986). This study focuses on the comparison of German and Turkish employees due to the origin of the concept, its manifestation in different cultural dimensions (Hofstede, 2001), and the ease of data collection. Despite the lack of cross-cultural studies on inner resignation and service innovation behavior, this study aims to fill this gap by examining differences in the relationship between these variables in Turkey and Germany. Known cultural differences between Turkey and Germany, especially in individualism/collectivism, authority distance, and uncertainty avoidance (Hofstede, 2001), are expected to influence the relationship between inner resignation and service innovation behavior. Therefore, the research hypotheses are as follows:

H1a: Turkish employees' inner resignation negatively affects service innovation behavior.

H1b: German employees' inner resignation negatively affects service innovation behavior.

Cultural differences between nations can affect business life (Hofstede, 2005). Researchers who used this cultural framework to examine the impact of cultural differences between two nations on organizational life found that the culture to which employees belong influences their perceptions of organizational life (Francioli et al., 2018). Studies suggest that ethics and ethical leadership may be perceived differently in different cultures (Engelen & Brettel, 2011; House et al., 2004; Li et al., 2014; Resick et al., 2011; Sarwar, 2020). For example, Dincer (2021) showed differences between German and Turkish leaders in terms of behavior toward followers, methods used, and innovation leadership. In addition to Resick et al. (2011), it was found that the basic behavioral traits of the ethical leader (integrity, character, morality, and accountability) are universally recognized and that there may be cross-cultural convergence in the concept of ethical leadership. This part of the research aims to determine how perceptions of ethical leadership influence inner resignation and service innovation in two different societies. The research also aims to provide a comparative analysis of whether ethical leadership perceptions play a moderating role in the relationship between German and Turkish employees' inner resignation and their service innovation behaviors. The research hypotheses based on this information are as follows:

H2a: Ethical leadership plays a moderating role in the relationship between inner resignation and service innovating behavior among Turkish employees.

H2b: Ethical leadership plays a moderating role in the relationship between inner

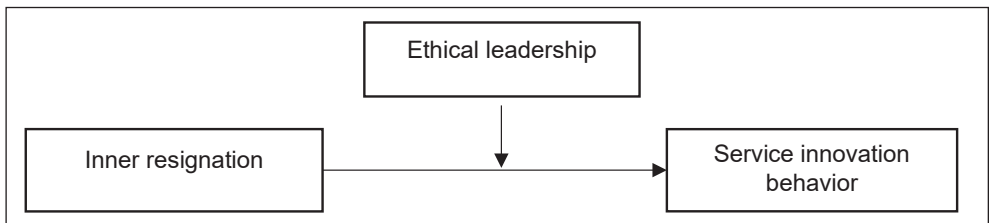


Fig. 1: Research model

Source: own

resignation and service innovation behavior among German employees.

The research model that has been created for this purpose is described in Fig. 1.

2. Research methodology

2.1 Population and sample

In this cross-cultural comparative study, data was collected by distributing highly structured questionnaires to employees of three-, four-, and five-star hotels in Turkey and Germany. The convenience sampling method was used to collect the questionnaires. In convenience sampling, which is a non-probability sampling method, the researcher selects and includes the most appropriate individuals for the study (Gurbuz & Sahin, 2006). During the data collection process, which took place in early 2022, questionnaires were sent to a total of 1,167 employees. 645 of them were Turkish and 522 were German. 795 questionnaires were returned. Forty-two questionnaires were deemed unsuitable for analysis and excluded from the study after review. Therefore, the responses of 453 Turkish and 300 German employees were considered. In total, there are 753 samples. The demographic characteristics of the participants show that 60.2% are Turkish and 39.8% are German-born. 31% of the participants are between the ages of 25 and 34. 42% have a Bachelor's degree, 55.2% are male, and 40.9% have between 1 and 5 years of experience.

2.2 Data collection tool

The study used the 5-item inner resignation scale developed by Jehle and Schmitz (2007). The scale includes statements such as „I lost interest in institutional discussions over time” and „I used to give more to my work.” To measure service innovation behavior, the 7-item scale developed by Williams and Anderson (1991) was used. The scale includes statements such as „I fulfill the duties expected of me” and „I do not neglect the parts of my job that I have to do.” To measure the ethical behavior of managers, the ethical leadership scale developed by Brown et al. (2005) was used. The scale has 10 items such as: “Managers in this hotel make fair and balanced decisions” and “Managers in this hotel are reliable people.” All scales are 5-point Likert type and scoring ranges from 1 = I strongly disagree to 5 = I strongly agree.

3. Results

3.1 Findings on the scales

Prior to statistical analysis, all variables were analyzed in terms of univariate and multivariate normal distribution. In the normal distribution statistics, the coefficients of kurtosis and skewness for the service innovation behavior ranged from 0.082 to 0.012, for the inner resignation from 0.508 to 0.060, and for the perception of ethical leadership from 0.455 to 0.131 (Bayram, 2010). The distribution is normal if the values of skewness (asymmetry) and kurtosis are in the range of 2. This means that all scales are normal distributed. During the modeling phase of the study, the maximum likelihood method was used. The significance level was set at 0.05.

Validity of scale factor structures:

First-level confirmatory factor analysis

To verify the structures of the scales used in the research, exploratory and confirmatory factor analyses were conducted. The Kaiser-Meyer-Olkin (KMO) value and Bartlett's sphericity test results indicate that the data set is suitable for factor analysis ($KMO_{IR} = 0.770$, $\chi^2 = 798.420$, $df = 10$, and $P = 0.0001$; $KMO_{SIB} = 0.854$, $\chi^2 = 2,198.291$, $df = 21$, and $P = 0.0001$; $KMO_{EL} = 0.950$, $\chi^2 = 5,275.381$, $df = 45$, and $P = 0.0001$, respectively).

A single factor with an Eigenvalue < 1 was identified according to the results of the exploratory factor analysis (EFA) performed on the scale of inner resignation, the independent variable of the study. The factor loadings of the items that make up the structure of the single factor ranged from 0.78 to 0.54. This single factor accounts for 49.13% of the total variance. In SEM, a first-level analysis of a single factor was conducted. Confirmatory factor analysis (CFA) resulted in the modeling of five expressions in a single dimension. The analysis showed that the structure of the scale of inner resignation was statistically significant ($\chi^2 = 29.59$, $df = 10$, $p = 0.00$). $RMSEA = 0.081$, $GFI = 0.95$, $CFI = 0.96$, $AGFI = 0.95$, $NFI = 0.96$, $IFI = 0.96$, and $TLI = 0.93$ were determined as the fit index values. These fit index values are an indication of the acceptability of the single factor model. The alpha reliability of the scale was determined to be 0.73.

As a result of the EFA for ethical leadership, which is the moderator variable of the research, a single factor with an Eigenvalue of 1

Tab. 1: Structural model goodness of fit values

Scale/ indexes	χ^2	df	p	χ^2/df	CFI	GFI	AGFI	NFI	IFI	TLI	RMSEA
IR	29.959	10	0.00	4.231	0.96	0.95	0.95	0.96	0.96	0.93	0.081
EL	212.774	43	0.00	4.948	0.96	0.91	0.91	0.96	0.96	0.95	0.080
SIB	59.236	14	0.00	4.231	0.97	0.97	0.93	0.97	0.97	0.95	0.092

Note: *IR* – inner resignation; *EL* – ethical leadership; *SIB* – service innovation behavior.

Source: own

was determined. Although the factor loadings of the scale items varied between 0.85 and 0.60, the dimension explained 63.34% of the total variance. Using structural equation modeling (SEM), a single-factor first-level confirmatory factor analysis was used to determine the correlation between the structural properties of the ethical leadership scale and its items. The analysis revealed that the single-factor structure of the 10 items comprising the ethical leadership perception scale ($\chi^2 = 212.774$, $df = 42$, $p = 0.00$) was significant ($\chi^2 = 212.774$, $df = 42$, $p = 0.00$). $RMSEA = 0.080$, $GFI = 0.91$, $CFI = 0.96$, $AGFI = 0.91$, $NFI = 0.96$, $IFI = 0.96$, and $TLI = 0.95$ were obtained as values for the goodness of fit index. These goodness of fit index values indicate that the single factor model is acceptable. The alpha reliability value of the scale was found to be 0.93.

The EFA for the service innovation behavior scale, which is the dependent variable of the research, revealed a single factor with an Eigenvalue of 1. Since the factor load of one scale item was less than 0.50, this item was eliminated from the analysis and the analysis was repeated. As a result of the analysis, the factor loads of the items ranged from 0.85 to 0.60. The dimension accounted for 56.99% of the total variance. As a result of the first level confirmatory factor analysis performed to determine the correlation between the service innovation behavior scale, whose structural characteristics were determined, and its items, the minimum chi-square value ($\chi^2 = 59.236$, $df = 14$, $p = 0.00$) was significant. $RMSEA = 0.092$, $GFI = 0.97$, $CFI = 0.97$, $AGFI = 0.93$, $NFI = 0.97$, $IFI = 0.97$, and $TLI = 0.95$ were obtained as the values of the goodness of fit index. These goodness of fit index values indicate that the single factor model is acceptable. The alpha reliability value

of the scale was found to be 0.94. A summary of the results of the confirmatory factor analysis is presented in Tab. 1.

3.2 Results of correlation analysis

The mean, standard deviation, and correlations between the data obtained on ethical leadership, service innovation behavior, and inner resignation, which are the research variables, were analyzed for all samples and countries. The results are presented in Tab. 2.

The coefficients of all employee variables for inner resignation, ethical leadership, and service innovation are statistically significant ($p < 0.01$) when examining Tab. 2. Inner resignation is significantly negatively correlated with service innovation ($r = -0.579$, $p < 0.01$) and ethical leadership ($r = -0.580$, $p < 0.01$). In addition, there is a correlation between ethical leadership and service innovation behavior ($r = 0.742$, $p < 0.01$). The study considers the correlations between inner resignation, service innovation behavior and ethical leadership, discussed on a country basis, essential. Accordingly, a strong positive correlation ($r = 0.737$, $p < 0.01$) was found between ethical leadership and service innovation behavior of Turkish employees, while inner resignation had a negative relationship with both service innovation behavior ($r = -0.569$, $p < 0.01$) and ethical leadership ($r = -0.552$, $p < 0.01$). On the other hand, a strong positive correlation ($r = 0.751$, $p < 0.01$) was found between ethical leadership and service innovation behavior, while a negative and significant correlation was found between inner resignation and service innovation behavior ($r = -0.587$, $p < 0.01$). There is also a negative and significant correlation between the inner resignation of the German employees and their perception of ethical leadership ($r_{\text{German}} = -0.587$, $p < 0.01$).

Tab. 2:

Correlation between ethical leadership, service innovation behavior and inner resignation

	Variables	Mean	SD	IR	EL	SIB
Both countries (n = 753)	IR	3.03	0.83	1.000		
	EL	3.29	0.91	-0.580*	1.000	
	SIB	3.17	0.92	-0.579*	0.742*	1.000
Turkey (n = 453)	IR	2.94	0.83	1.000		
	EL	3.32	0.90	-0.552*	1.000	
	SIB	3.22	0.94	-0.569*	0.737*	1.000
Germany (n = 300)	IR	3.16	0.81	1.000		
	EL	3.24	0.91	-0.623	1.000	
	SIB	3.09	0.88	-0.587	0.751	1.000

Note: IR – inner resignation; EL – ethical leadership; SIB – service innovation behavior; * indicates significance level of 0.01.

Source: own

3.3 Testing the hypotheses

The purpose of the study was the examination of the moderating effect of ethical leadership on the relationship between inner resignation and service innovation behavior. In order to determine whether this effect differs at the cultural

level, two main hypotheses and sub-hypotheses related to these hypotheses were developed. The Amos program was used to test the developed hypotheses. Accordingly, the analyses carried out under the first research hypothesis are presented in Fig. 2.

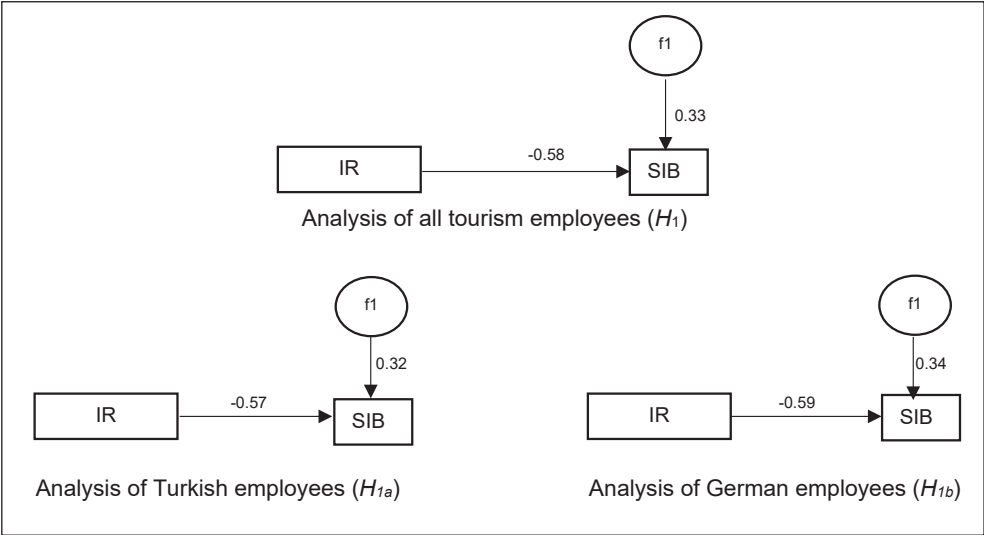


Fig. 2:

Analysis of hypotheses H1, H1a, H1b

Source: own

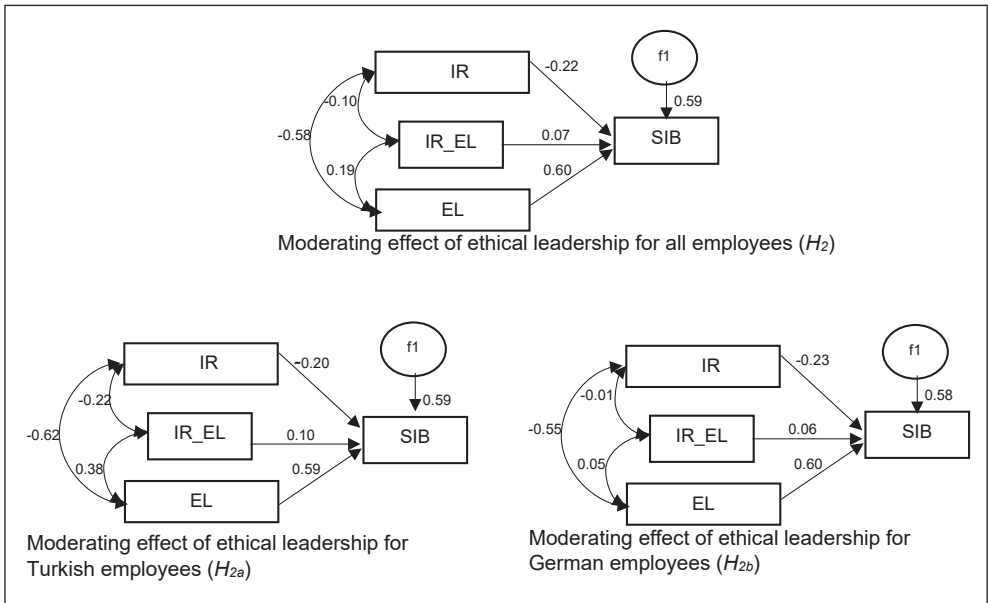


Fig. 3: Moderator impact of ethical leadership (H2, H2a, H2b)

Source: own

It is determined whether the level of inner resignation of all employees in Fig. 2, Turkish employees, and German employees has a different impact on service innovation behavior. The results indicate that there is a negative relationship between inner resignation and service innovation behavior ($\beta = -0.553$; $R^2 = 0.335$; $p < 0.01$), for Turkish employees ($\beta = -0.534$; $R^2 = 0.324$; $p < 0.01$) and for German employees ($\beta = -0.530$; $R^2 = 0.345$; $p < 0.01$). Below are the analyses conducted to determine whether ethical leadership acts as a moderator in the relationship between inner resignation and service innovating behavior *H1 (H1a and H1b)*.

Fig. 3 shows the results of an analysis conducted to determine the role of ethical leadership in influencing inner resignation on service innovating behavior. The moderator impact model in which all employees are considered together and only German employees are considered separately is found to be statistically significant (all participants' $p = 0.005$; German $p = 0.017$). However, the results of the analysis indicate that the moderator impact model with consideration of only Turkish employees is not significant ($p = 0.051$). The results are presented in Tab. 3.

Tab. 3 shows that the predicted variables included in the regression analysis (inner resignation and ethical leadership) account for 58.8% ($R^2 = 0.588$) of the change in service innovation behaviour for all participants, 58.4% ($R^2 = 0.584$) for Turkish employees, and 59.5% ($R^2 = 0.595$) for German employees. However, Tab. 3 shows that this change is significant only when all the participants and the German employees are considered together ($p < 0.05$). Therefore, it can be concluded that the effect of ethical leadership on the relationship between inner resignation and service innovation behaviour among Turkish employees is not significant ($p = 0.051$). The analysis indicates that the perception of ethical leadership is a moderator of the relationship between inner resignation and service innovation behaviour among German employees. The moderator effect indicates under what circumstances and in what way the effect of the independent variable will be increased or decreased (Bayram, 2010). The slope test is used to determine in which situations (low/high) the obtained significant moderator effect varies. The corresponding results are presented graphically.

Tab. 3: Findings of the moderator impact analysis (H2, H2a, H2b)

	Relationship	β	SE	CR	R^2	p	Result
Turkish-German	$SIB \leftarrow Z-IR$	-0.553	0.027	-19.451	0.335	***	H1 confirmed
Turkish	$SIB \leftarrow Z-IR$	-0.534	0.046	-14.708	0.324	***	H1a confirmed
German	$SIB \leftarrow Z-IR$	-0.530	0.042	-12.556	0.345	***	H1b confirmed
Turkish-German	$SIB \leftarrow IR$	-0.206	0.026	-7.796	0.588	***	H2 confirmed
	$SIB \leftarrow IR_EL (XY)$					0.005	
	$SIB \leftarrow EL$					***	
Turkish	$SIB \leftarrow IR$	-0.220	0.034	-6.430	0.584	***	H2a rejected
	$SIB \leftarrow IR_EL (XY)$	0.058	0.030	1.946		0.051	
	$SIB \leftarrow EL$	0.571	0.034	16.599		***	
German	$SIB \leftarrow IR$	-0.179	0.042	-4.218	0.595	***	H2b confirmed
	$SIB \leftarrow IR_EL (XY)$	0.081	0.034	2.394		0.017	
	$SIB \leftarrow EL$	0.519	0.044	11.898		***	

Note: IR – inner resignation; EL – ethical leadership; SIB – service innovation behavior; *** indicates significance level of 0.001.

Source: own

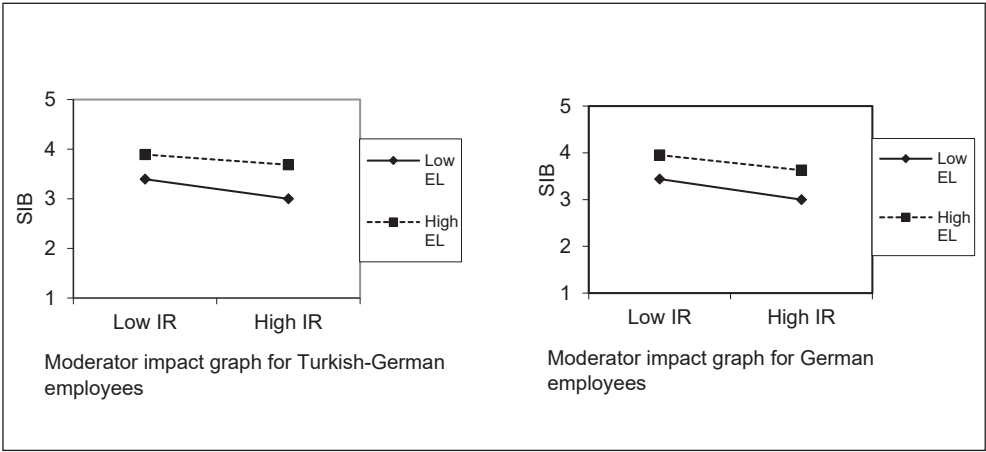


Fig. 4: Graphs of moderator impact

Source: own

The interaction effect of inner resignation and ethical leadership variables on service innovation behavior is significant for all participants and German employees, as shown

in Fig. 4. The interaction effect of inner resignation and ethical leadership variables on service innovation behavior is significant for all participants and German employees, as shown

Tab. 4: Situational change of moderator impact

Variables			Impact	<i>t</i>	<i>P</i>
Turkish-German	EL	Low	-0.206	-6.514	0.000
		High	-0.145	-2.647	0.008
German		Low	-0.179	-4.003	0.000
		High	-0.140	-2.265	0.009

Source: own

in Fig. 4. According to Tab. 4, in the analysis of Turkish-German employees together, the negative impact of inner resignation on service innovation behavior is -0.206 when there are low ethical leadership practices in the organization, while this impact decreases to -0.145 in the presence of high ethical leadership practices. In the case of German employees, if there are low ethical leadership practices in the organization, the negative impact of inner resignation on service innovation behavior is -0.179, while this value decreases to -0.140 in high ethical leadership practices.

Conclusions and discussion

The purpose of this study is the determination of the role of ethical leadership as a moderator between inner resignation and service innovation behavior. The research conducted on Turkish and German tourism employees was evaluated within the framework of the models and hypotheses.

According to the research result, the inner resignation explains 33.5% of the change in service innovation behavior for all employees, 32.4% for Turkish employees, and 34.5% for German employees, as determined by the research. Therefore, the main research hypotheses *H1* (*H1a* and *H1b*) were supported. There are no published studies that examine the relationship between inner resignation and service-innovating behavior. However, the results of previous studies (Afsar & Badir, 2015; Kim & Lee, 2013; Krystek et al., 1995) that examined the effect of positive relationships between individuals and organizations on organizational innovation in the service sector are comparable to the results of the current study.

As a result of the second hypothesis of this study, it was found that ethical leadership moderates the relationship between inner resignation and service innovation behavior.

When the Turkish-German employees are evaluated as a whole, the effect of inner resignation on service innovation behavior is -0.206 when ethical leadership is low and -0.145 when ethical leadership is high. Therefore, research hypothesis *H2* is accepted. Having an ethical leader can help reduce the negative effects of inner resignation. At this point, the presence of a leader who incorporates the principles of justice and equity into organizational policies and practices can increase service innovation behavior by minimizing the negative effects of inner resignation. This effect can be reduced by the presence of a leader in the organization. The leader's ethical stance, behavior, and discourse can serve as a model. On the other hand, the combination of high levels of inner resignation and low perceptions of ethical leadership has a negative effect on service innovation behavior.

However, the results of the analysis indicate that only German employees have a significant moderator effect when the hypothesis is evaluated on a country basis. For German employees in organizations with a low level of ethical leadership practices, the effect of inner resignation on service innovation behavior is 0.179, while for organizations with a high level of ethical leadership practices, it is 0.140. Therefore, research hypotheses *H2* to *H2b* were accepted, but *H2a* was rejected. While the presence of ethical leader reduces the negative effect of inner resignation on German employees' service innovation behavior, it has no effect on Turkish employees' behavior.

This result can be explained by the fact that Turkish and German employees may perceive leadership differently for various reasons, including cultural norms and expectations. For example, many organizations in Turkey still rely on hierarchical, top-down leadership models (Hofstede, 2005; House et al., 2004), where

authority is often seen as absolute and unquestionable. In contrast, German companies tend to be more democratic and participative in nature, where employees are encouraged to question authority and to voice their opinions. In addition, German companies often promote ethical leadership practices, such as diversity and sustainability. These may not be as prevalent in Turkish organizations. There may be different levels of trust in the workplace, which can influence how employees perceive their leaders.

Practical and managerial implications.

This study underscores several critical implications for management and practice. Foremost, it emphasizes the pivotal roles of inner resignation and ethical leadership in shaping service innovation behavior. Particularly, high levels of inner resignation among employees in the tourism sector are found to diminish the likelihood of generating and implementing original ideas. Despite being relatively underexplored in organizational behavior literature, inner resignation is prevalent among employees (Jehle & Schmitz, 2007; Richter, 1999; Schmitz et al., 2002; Ustun & Tatli, 2020).

Consistent with previous findings, inadequate leadership attitudes and behaviors emerge as primary triggers of inner resignation (Gabelaia & Bagociunaite, 2023; Krystek et al., 1995; Scheibner & Hapkemeyer, 2013; Zenger & Folkman, 2022). Thus, it becomes imperative for leaders and managers to cultivate an ethical culture across the organization (Scheibner & Hapkemeyer, 2013). To this end, implementing training programs aimed at enhancing leaders' ethical leadership skills proves beneficial. Such programs can target conflict resolution, communication, and decision-making to establish a culture of ethical leadership within the organization. Ethical leadership positively correlates with job satisfaction and psychological well-being among employees (Avey et al., 2012), leading to reduced levels of inner resignation. Moreover, it fosters work motivation, commitment, and organizational performance (Kim & Brymer, 2011), while also influencing service innovation behavior in the tourism sector (Erdem, 2021; Ozsungur, 2020).

The labor-intensive nature of the tourism industry amplifies the adverse impacts of inner resignation, potentially affecting service quality, customer satisfaction, and operational efficiency. However, inner resignation is not irreversible,

and proactive measures are recommended. Organizations should prioritize the development and promotion of ethical leadership practices through leadership development programs focused on fostering ethical leadership skills. Such initiatives equip leaders with the competencies to effectively lead diverse teams, tackle complex challenges, and foster relationships grounded in justice, equality, and trust.

Additionally, inner resignation, which can manifest across all organizational levels, presents challenges in identification due to its subtle symptoms. Collaborative efforts between managers and the human resources department are crucial in discerning the underlying causes of inner resignation (Ustun & Tatli, 2020). Creating a positive work environment that prioritizes employee well-being and encourages employee voice is essential. This involves establishing mechanisms for feedback, suggestions, and idea-sharing, alongside cultivating supportive work environments that value and empower employees to contribute to service innovation. Addressing cultural differences among employees, especially in multinational organizations, is paramount. Managers should be cognizant of cultural norms and expectations, adapting leadership approaches accordingly to foster inclusive and effective organizational practices.

Furthermore, proactive measures to reduce inner resignation entail selecting suitable employees, assigning tasks according to abilities, implementing fair performance evaluation systems, and ensuring equitable wage systems (Hartner-Tiefenthaler, 2021). Rewards for performance should be both fair and proportionate, serving as effective motivators. Adopting models like the effort-reward imbalance (ERI) can aid in mitigating the incidence of inner resignation.

Recognizing and understanding cultural differences among employees, particularly in multinational contexts, is crucial for effective management. Managers need to be sensitive to cultural norms and expectations that may influence employee perceptions of leadership and organizational practices, adapting their approaches accordingly. This cultural awareness fosters inclusivity and enhances organizational effectiveness.

In conclusion, addressing inner resignation and promoting ethical leadership are essential for fostering service innovation behavior in the tourism industry. By implementing proactive measures and cultivating supportive work

environments, organizations can mitigate the negative impacts of inner resignation and unlock the full potential of their employees to drive innovation and success.

Study limitations and future research suggestions. There are limitations to this study. First, the selection of the sample was on the basis of practical considerations. Only employees who gave permission to complete the questionnaire were included in the study. In future studies, the sample can be selected using different methods. Second, the cross-sectional nature of this study should be mentioned. Although the hypotheses developed in this study revealed the relationships between inner resignation, service innovating behavior, and perceived ethical leadership, one of the future research proposals calls for a longitudinal study. Again, it may help to validate the findings by replicating this study in different industries, time periods, and with different variables. Finally, the studies have been carried out with German and Turkish employees in the hotel industry. It will be possible to introduce a multicultural structure in future studies by examining different countries.

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Key factors influencing the implementation of virtual reality in employee training

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Abstract: Virtual reality (VR) is rapidly becoming more popular and accessible. With the growing popularity of its use in the corporate sphere, there are already a number of publications that focus on adapting this modern technology to employee training. Unfortunately, they only focus on certain areas and lack a comprehensive view. This study focused on this research gap and is one of the first (and in the Czech Republic, the very first) studies investigating the key factors influencing the implementation of VR in employee training. The Delphi method was implemented using a total of 22 deliberately selected experts according to pre-selected criteria to ensure sufficient and relevant data. The Delphi method was conducted in 3 rounds, and 59 factors were obtained, which were divided into positive and negative, at the same time, in both these areas, the factors were categorized into 5 dimensions, which were determined based on the modified Khan's framework. In the analysis of the third round, Kendall's coefficient of concordance was calculated for each group. This study represents a significant contribution to the research on virtual reality as a tool for employee training. Moreover, the findings of the study are beneficial for companies, managers and human resources managers in terms of successfully implementing virtual reality into employee training.

Keywords: Delphi method, employee training, modern technologies, enterprises, Khan's framework, Industry 4.0.

JEL Classification: M21, O33, M20.

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Introduction

In today's rapidly evolving business environment, organizations are constantly striving to develop critical employee capabilities to gain a competitive edge (Khandelwal & Upadhyay, 2021). Thus, employee training enhancing the knowledge and skills of employees, which align with organisational strategies and technological advancements, is becoming increasingly important for the longevity and sustainability

of the organization (Mazurchenko et al., 2022). In the changing context of business and the deeper involvement of technology and digitalization in organizations, virtual reality (VR) technologies represent a significant opportunity for employee training (Kulkarni et al., 2022). VR technologies possess great potential as modern and relevant tools for employee training and their application in training and education settings is promising (Joshi et al., 2021).

Virtual reality-based training offers immersive and realistic learning environments and allows employees to learn and practice their skills and gain knowledge in a controlled and safe environment (Stefan et al., 2023). Moreover, VR-based training enables employees to gain a level of skills that were previously difficult to acquire using traditional training methods (Khandelwal & Upadhyay, 2021).

With the growing application of virtual reality in employee training, the research on this topic has increased tremendously (Ding & Li, 2022). Most existing VR research examined the effects of VR technology for training purposes both in general (Toyoda et al., 2021) or specifically with regard to single sub-factors that influence the effectiveness and adaptation of virtual reality training. For example, Joshi et al. (2021) studied the effectiveness and efficacy of VR modules, Howard and Gutworth (2020) investigated the attributes of VR training programs that lead to its success, Stefan et al. (2023) examined in their study factors such as study objectives, study designs and evaluation measures, and Toyoda et al. (2021) studied the motivation of employees to adopt VR-based training.

Unfortunately, although the creation of a VR environment for training purposes involves a complex process that is affected by many factors, there has been limited empirical work which has simultaneously investigated factors that positively or negatively affect this process (Toyoda et al., 2021). Identifying these factors is crucial to ensure successful VR implementation in employee training (Joshi et al., 2021). Furthermore, understanding both positive and negative factors help organizations to effectively adopt VR technologies for learning or training purposes.

Thus, the purpose of this research is to investigate factors affecting the implementation of virtual reality for employee training. More specifically, the study aims to identify and integrate positive and negative factors affecting VR implementation in employee training within the organizational context.

1. Theoretical background

1.1 Employee training

Human capital is recognized as a highly valuable and sought-after asset that, if properly utilized, can drive the growth of a company's market value and appears to be much more

important in the long term than the ownership and use of tangible resources and financial capital (Somogyi, 2020). Employee competencies, knowledge, and skills are becoming key factors determining the competitive advantage in global markets (Hammond & Churchill, 2018). Organizations consider human resources as a second source of profit and bring human resource development to a strategic level, with training and development becoming an important condition for corporate development (Halbouni et al., 2016). Moreover, training is one of the main objectives of human resource management – increasing individual and organizational productivity achieved through it (Ozkaser, 2019).

Employee training in organizations is considered an employer tool for building employee competencies and developing their potential (Demerouti & Peeters, 2018). It is a systematic process of changing work behavior and the level of competence (knowledge, skills, and abilities). It includes employee motivation, which helps to reduce the gap between the employee's subjective qualification (ability to act and demonstrate competence to achieve the organization's goals) and objective qualification (the highest level of education attained and the demands placed on the employee) (Hanaysha, 2016) and increase productivity (Kijek et al., 2020).

In the dynamic context of corporate training, traditional methods are often insufficient to engage employees and ensure the sustainable development of their skills (Dachner et al., 2021). However, integrating virtual reality into employee training programs has provided an innovative solution (De Lorenzis, 2023). Thanks to Industry 4.0 and its digitalization, educational content is becoming more accessible to employees and new opportunities are opening up for them. In particular, digital skills are increasingly mentioned in the context of the growing need for skilled workers in the labor market (Saniuk et al., 2023). Also, the current generation of millennials, known as digital workers, have internet-connected devices, and web applications and services are constantly engrossing them in their daily lives (Varadaraj & Al Wadi, 2021).

1.2 Virtual reality

Technologies such as virtual reality are booming as they are becoming ever more accessible

to users and can be presented on a variety of platforms, from smartphones to sophisticated vision devices, for a more immersive VR experience that allows users to experience a computer-generated environment as if it was real. It is a simulated environment created by a computer and perceived through a headset or other fully immersive device (Lara-Alvarez et al., 2023).

The main characteristics that distinguish VR applications from other technologies are immersion, interaction and imagination (Burdea & Coiffet, 2003). Immersion is defined as the sense of presence that participants feel when interacting with a virtual environment (Grasini & Laumann, 2020). Interaction as another important characteristic can enrich the user experience (Mikropoulos & Natsis, 2011). Last but not least, VR is also considered a good tool to stimulate the user's ability to generate creative ideas or visualize non-existing things (Burdea & Coiffet, 2003). Virtual reality devices have historically focused on visual stimulation, but newer wearable VR headset technologies (VR goggles) are making significant efforts to integrate audio and feedback (via headphones). A wide range of tools are available on the market that can deliver immersive virtual reality experiences. Among the most popular are virtual reality goggles (Al Mansoori et al., 2023). From an economic standpoint, VR holds significant potential across various sectors. The global VR market is projected to grow substantially, driven by increasing demand in entertainment, education, healthcare, and real estate (Raji et al., 2024). In the labor market, VR is transforming job training and professional development, creating realistic simulations for training employees in a risk-free environment, improving skills and productivity while reducing costs (Jaunzems et al., 2020). The rise of VR is also creating new job opportunities in software development, content creation, and hardware manufacturing (Krauß et al., 2021). As VR technology advances, it is likely to spur innovation, drive competition, and lead to improved products and services, further boosting the economy (Javaid et al., 2024).

Virtual reality is rapidly emerging as an interactive environment of the future with various educational benefits (Fussell & Truong, 2021). Virtual reality is reshaping employee training, providing a dynamic and immersive learning experience. According to Parong and Mayer

(2018), VR training enhances knowledge retention by engaging multiple senses, fostering a deeper understanding of concepts. This multi-sensory approach contributes to more effective training compared to traditional methods (Parong & Mayer, 2018).

Virtual reality has been found to be more effective in training employees in several other areas – specifically conceptual knowledge (understanding of principles) and spatial knowledge (Baceviciute et al., 2022). VR also yields higher levels of perceived learning (Baceviciute et al., 2022; Makransky & Klingenberg, 2022). VR technology allows employees to learn in a comfortable personal space and provides a safe environment with minimal exposure to dangerous situations (e.g., explosions, and natural disasters (Conges et al., 2020)). For example, employees can use VR at home to learn how to use equipment and follow safety procedures. In some industries, VR training can also provide privacy for trainees. This is especially important when the learner may be uncomfortable with their behavior due to the presence of an observer during the learning process itself. However, there are situations where the presence of the trainer is necessary because the trainer must give timely feedback on the trainee's performance and alert the trainee to problems (Xie et al. 2021). Grabowski and Jankowski (2015) saw in their study that using virtual reality can reduce training costs by eliminating the need for a trainer, training room or long trips to off-site training. Philip et al. (2023) also mentioned the importance of management's interest in using virtual reality for training.

When we talk about the advantages of virtual reality, we also need to consider the disadvantages. A study of Souchet et al. (2023) confirms that some people experience unpleasant symptoms when using virtual reality. These symptoms are commonly described by the umbrella term cyber-sickness (Ramaseri Chandra et al., 2022). Many symptoms associated with cyber-sickness are reported in the scientific literature, including: nausea, headache, stomach discomfort, and numbness (Baceviciute et al., 2022). However, it can also cause slowed reaction times and an overall decrease in cognitive performance (Mittelstaedt et al., 2019). Cost and accessibility have been another barrier to the wider adoption of virtual reality (Bohil et al., 2011). At the same time, the time-consuming nature of scenario and animation development

is mentioned as a drawback in several publications (e.g., Eiris et al., 2020). Others include dependence on technology (Kardefelt-Winther, 2017), data security (Feng et al., 2021), content intensity (Diemer et al., 2015), and limited personal contact (Schroeder, 2018).

Some studies agree that VR is an effective and suitable tool for employee training, while others highlight its disadvantages and present different perspectives. Research supporting the use of VR often emphasizes its ability to increase engagement and interactivity, which can lead to better skill acquisition (Li & Xu, 2020). On the other hand, some studies point out the drawbacks of VR, such as cognitive overload, technical difficulties, and high implementation costs (Makransky et al., 2019). Other research offers mixed results; some studies support VR as an effective tool for enhancing learning, while others indicate that its benefits are not always clear and depend on specific contexts and instructional design (Jensen & Konradsen, 2018; Luo & Wang, 2020). Furthermore, studies by Smith and Wang (2019) and Brown and Green (2020) present varying outcomes on the effectiveness of VR, demonstrating that the efficacy and suitability of VR for employee training can be strongly influenced by factors such as implementation methods, context of use, instructional design, and individual user needs. This inconsistency in research suggests that while VR has the potential to be a powerful tool, its implementation must be carefully planned and tailored to specific educational conditions and goals. Therefore, there was a need to conduct research to bring this into alignment and create a list of all the factors that affect whether or not virtual reality is used for employee training.

The following research questions were developed from the literature review:

RQ1: What are key factors that positively influence the implementation of virtual reality in employee training?

RQ2: What are key factors that negatively influence the implementation of virtual reality in employee training?

2. Research methodology

To identify key factors that influence the implementation of VR in employee training, the Delphi method was adopted. The Delphi method is an appropriate research design to use when a problem or phenomenon lacks a clear

understanding or consensus (Adler & Ziglio, 1996; Sourani & Sohail, 2015). The classic Delphi method has four key features: anonymity, repeatability, supervised feedback and statistical summary (Giannarou & Zervas, 2014). A five-point Likert scale can be used to assess the consistency of expert opinions (Greatorex & Dexter, 2000). In the first round, experts are asked to answer the question by listing factors or by filling in a questionnaire. Experts are then invited to a second round of evaluation, during which they can refer back to the first-round analysis. A similar process of analysis, evaluation and selection then takes place in the third round (Skulmoski et al., 2007). At least two rounds of questionnaires are repeated to obtain expert opinion. In most studies, two or three rounds of repeated Delphi discussions are sufficient to reach consensus (Belton et al., 2019).

The data for this research were collected between August 2023 and November 2023. This study was based on a 3-round Delphi method. In the first round, experts were asked to consider which factors might influence whether or not virtual reality is implemented in employee training. This influence could be either positive or negative. The objective of the first round was to get as many factors as possible. After collecting the answers, an analysis was done and a list of all the factors written down by the experts was made. These factors were then divided according to the modified e-learning framework from Khan (2007) into five groups as follows: management, employees, infrastructure and institutional support, virtual reality (VR) processing and others.

In the second round, the experts were sent a list with these factors in groups separately for factors that positively influence the implementation of virtual reality in employee training (34 factors) and separately for factors that negatively influence the implementation of virtual reality in employee training (25 factors). The experts were provided with a 5-point Likert scale and asked to select the extent to which these factors influence the implementation of VR in employee training. In other words, they were supposed to indicate the level of importance of these factors. After data collection and analysis of the second round, the factors were ranked in order of importance in each group and separately for positive and negative.

In the third round, these results were sent to the experts to consider whether they agreed

with the ranking or would change it. The objective of this round was to reach a consensus on a list of factors and their ranking from most important to least important. Once consensus was reached, a factor was considered a key implementation factor if it scored an average of 4 or more points

in expert ratings and 51% or more of the expert ratings scored 4 or more points. Only 4 experts out of 22 had reservations about the final ranking. However, this did not affect the result after statistical analysis. The process of the Delphi method in this study is shown in Fig. 1.

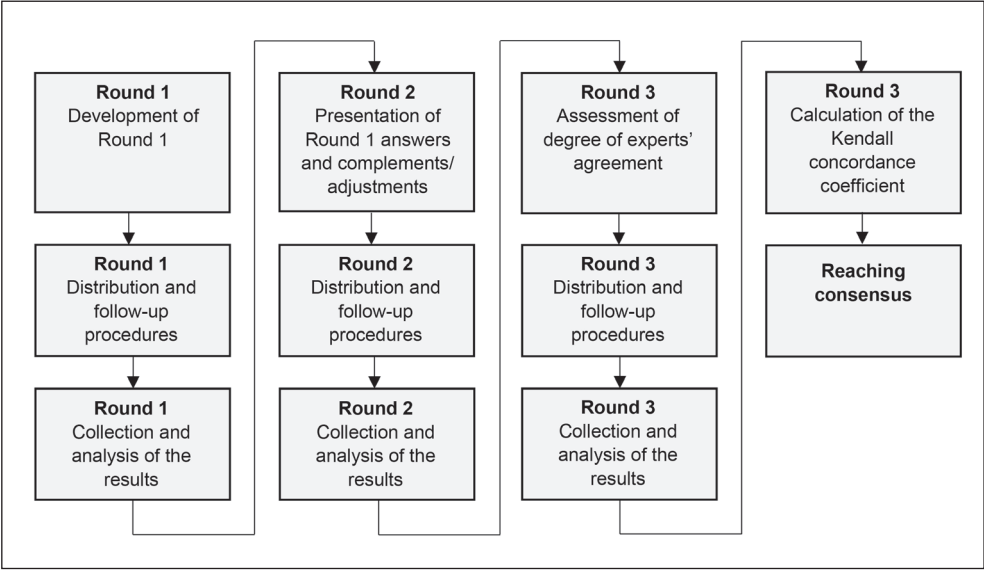


Fig. 1: The Delphi process

Source: own

2.1 Participants

When using the Delphi method, the selection of appropriate experts is of great importance (Okoli & Pawlowski, 2004). If the experts are homogeneous, 10–15 people are enough to form a representative group (Delbeq et al., 1975). Suitable experts are those who have knowledge and experience, have the willingness and time to participate in the project, and have good communication skills (Adler & Ziglio, 1996). Therefore, the experts were chosen purposefully.

The purpose of the group was to include people representing a diverse and rich range of experiences who could give their views on virtual reality in employee training. To get the desired wide range of ideas and concepts from this group, it was important that participants could not only speak clearly about their own experiences, but also represent the views

of their peers. 28 experts agreed to participate in the survey. The following selection criteria were considered for the nomination of experts (the expert had to meet 2 out of 3 criteria): (i) the research participant has practical experience of completing and/or creating virtual reality in workforce training; (ii) the research participant has practical experience of implementing and delivering virtual reality training in a small or medium-sized enterprise; (iii) the research participant is considered an expert in the field of corporate training (at least 5 years of experience).

3. Results and discussion

3.1 Results

In the first round, 28 experts were contacted, of which 24 participated in the survey. The responses to the first round of questions provided a large amount of material for

analysis. The procedure for analyzing the answers to the open-ended questions was reading and re-reading the answers received and then establishing preliminary dimensions into which the answers could be classified. These dimensions were based on Khan's (2007) e-learning framework. The framework was modified to fit the use of virtual reality in employee training. The original pedagogical dimension, as well as the interface design dimension, were merged into single dimension VR processing in the modified framework. The original technology dimension, the resource support dimension and the institutional dimension were merged into one dimension called infrastructure and institutional support. The evaluation and ethical dimensions were merged under the dimension other. The original management dimension was split into two new dimensions, management and employees. Therefore, the original framework was modified into five dimensions: management, employees, infrastructure and institutional support, VR processing and others. These dimensions were the same for both positive factors and negative factors. Subsequently, the authors reviewed the formulated dimensions and answers to ensure that the answers were correctly classified, and possibly adjusted the formulated categories, e.g., by merging similar categories.

After the analysis, the first round of the survey yielded 59 factors, of which 34 were positive and 25 negative. Factors were categorized into

5 groups according to the modified Khan framework, added a 5-point scale to each factor, and sent back to the experts to assess the degree of influence of the factor on implementation. The objective of this round was to determine the level of importance for each factor, ranking them from most important to least important. In the second round, 22 experts participated, two experts were unable to respond due to workload. However, this did not affect the overall balanced composition of the panel.

The same number of experts (22), participated in the third round. After the analysis of the second round, when the mean was calculated and the factors were ranked in order of importance from most to least important in each group, a questionnaire was sent to the experts to ask if they agreed with this ranking and if not, to number the factors differently and comment on the reason if necessary. In other words, the experts had the opportunity to reconsider the scores they had provided in the second round. Of the 22 experts, 4 experts changed the rankings, the rest remained unchanged.

The results of the third round of the survey are shown in Tabs. 1–2, with the factors already ranked from most to least important in each group separately. Tabs. 1–2 show the mean for each factor, followed by the sum of order and final overall rank.

Tab. 1 shows the results of the third round for the factors that positively influence

Tab. 1: Factors that positively influence the implementation of virtual reality in employee training – Part 1

	Mean	Sum of order	Overall rank
Management			
Management support for the use of technology in employee training	4.91	26	1
The company management's interest in the development and training of employees	4.36	42	2
Incorporating virtual reality into the company's education system	4.27	68	3
Appropriate promotion of virtual reality in the enterprise	4.18	85	4
Multidisciplinary implementation team	3.64	110	5
Management's motivation towards employees to use VR in training	3.09	131	6
Employees			
IT skills needed	4.64	22	1

Tab. 1: Factors that positively influence the implementation of virtual reality in employee training – Part 2

	Mean	Sum of order	Overall rank
Positive attitude of employees towards the use of VR in training	4.05	46	2
Previous experience of virtual reality	3.95	72	3
Employees' own motivation for training	3.91	84	4
Employee's willingness to change	3.86	106	5
Infrastructure and institutional support			
Opportunity to train during working hours	4.86	35	1
Ease of use of hardware (VR glasses)	4.59	49	2
The complexity of the educational system integrated into VR, including the sequence and repetition of individual educational modules	4.14	69	3
Existence of a system that can manage all content and manage/monitor long-term usage	3.91	86	4
High-quality hardware equipment in the company (VR glasses, tablet for remote control including data SIM/wi-fi)	3.91	99	5
Linkage of data within intra-company education, feedback	3.73	124	6
A designated space for virtual reality training	3.64	155	7
Automatic data recording	3.50	175	8
VR processing			
High-quality software processing (e.g., sharp image, sound)	4.36	22	1
Quality educational content (correct, relevant and sufficient information)	4.32	45	2
Ease of use and intuitiveness	4.23	71	3
Procedural correctness of educational modules	3.95	91	4
The degree of approximation of the virtual environment to the real environment	3.86	106	5
High degree of immersion and interactivity of the environment	3.82	127	6
Others			
Sufficient funds for the implementation of virtual reality in employee training	4.91	22	1
Reducing the time required for training	3.95	44	2
The possibility to implement training in a safe, controlled environment	3.95	66	3
Lower training costs (e.g., absence of lecturers, rental of training rooms)	3.64	88	4
The attractiveness of virtual reality	3.50	111	5
Above-standard elements in training	3.23	133	6
Unified conditions for trained persons	3.14	155	7
The need to repeatedly educate a larger number of workers	3.00	173	8
Language flexibility	2.23	198	9

Source: own

the implementation of virtual reality in employee training.

As can be observed from Tab. 1, almost all factors scored greater than 3 (excluding language flexibility). Tab. 2 shows the results for the factors that negatively affect the implementation of virtual reality in corporate training.

Kendall's coefficient W was computed to determine the level of agreement among the experts on the Delphi panel. The coefficient was calculated for each group of factors according to the following formula (Chráska, 2016):

$$W = \frac{\sum X^2 \cdot \frac{(\sum X)^2}{n}}{\frac{1}{12} k^2 \cdot (n^3 - n)} \quad (1)$$

where: W – Kendall's coefficient of concordance; X – sum of the order; k – number of experts; n – the number of factors.

The results of the Kendall's concordance coefficient calculation are shown in Tab. 3 and Tab. 4 for each group separately.

Kendall's concordance coefficient ranges between 0 and 1, with 1 being complete

Tab. 2:

Factors that negatively influence the implementation of virtual reality in employee training – Part 1

	Mean	Sum of order	Overall rank
Management			
Reluctance of leaders responsible for training to deal with the implementation of virtual reality in employee training	4.59	24	1
Insufficient or inappropriate promotion of virtual reality	4.27	50	2
Negative management attitude towards virtual reality in training	4.14	61	3
Lack of motivation of managers for the development and training of employees	4.05	85	4
Poor communication between the process/analytics team and the group of developers and programmers	3.91	111	5
Incorrectly set expectations and definition of problems/solutions by management	3.68	131	6
Employees			
Insufficient preparation of employees for new technologies in training, lower digital skills, insufficient IT skills	4.68	22	1
Insufficient motivation of employees for training using VR	3.91	44	2
Reluctance to use new technology	3.77	66	3
Fear of nausea when using virtual reality	3.45	88	4
Lack of prior experience with virtual reality	1.82	110	5
Infrastructure and institutional support			
Unavailability of technology in the workplace	4.91	25	1
Creation of only sub-units and lack of linkage to business processes	4.36	52	2
Insufficient or missing management system for managing educational modules	4.32	69	3
Complexity of hardware elements and inappropriate usage settings for employees	3.95	82	4
Obsolescence of hardware (VR glasses), the need to frequently purchase newer versions	3.68	102	5

Tab. 2: Factors that negatively influence the implementation of virtual reality in employee training – Part 2

	Mean	Sum of order	Overall rank
VR processing			
Cyber sickness (e.g., nausea, headache) in some individuals	4.50	23	1
The complexity of the VR environment and individual control elements	3.77	43	2
Low-quality software processing (low number of FPS (frames per second) and therefore choppy application)	3.77	66	3
Improper creation of VR content (failure to comply with basic principles and expected outputs)	3.55	88	4
Others			
Lack of funds	4.91	22	1
The need to create many unique training scenarios for businesses that have diverse work activities	4.32	45	2
Inability to process fine motor skills in virtual reality	3.68	67	3
Sensitivity of company data, protection of personal data	3.55	87	4
Missing face-to-face interaction, limited personal contact between employees	2.14	109	5

Source: own

Tab. 3: Kendall's concordance coefficient for positive factors

Group name	Kendall's concordance coefficient
Management	0.942
Employees	0.888
Infrastructure and institutional support	0.846
VR processing	0.900
Others	0.991

Source: own

Tab. 4: Kendall's concordance coefficient for negative factors

Group name	Kendall's concordance coefficient
Management	0.936
Employees	1.000
Infrastructure and institutional support	0.710
VR processing	0.983
Others	0.965

Source: own

concordance. After the analysis of the third round, all the groups came out closer to 1, and thus, it can be said that the experts almost agreed on the order of the factors that emerged from the second round analysis.

As mentioned above, the authors consider a factor to be key if it has a mean of 4 or higher

and at least 51% of the ratings score 4 or more points. According to this measure, 13 key factors emerged that can positively influence the implementation of VR in employee training.

Eleven key negative factors came out from Tab. 2. Based on the analysis, 10 key positive and 10 key negative factors that influence

Tab. 5: Ten key final factors

Factors positively influencing the implementation of virtual reality in employee training (n = 34)	Factors negatively influencing the implementation of virtual reality in employee training (n = 25)
Management support for the use of technology in employee training	Unavailability of technology in the workplace
Sufficient funds for the implementation of virtual reality in employee training	Lack of funds
Opportunity to train during working hours	Insufficient preparation of employees for new technologies in training, lower digital skills, insufficient IT skills
IT skills needed	Reluctance of leaders responsible for training to deal with the implementation of virtual reality in employee training
Ease of use of hardware (VR glasses)	Cyber sickness (e.g., nausea, headache) in some individuals
The company management's interest in the development and training of employees	Creation of only sub-units and lack of linkage to business processes
High-quality software processing (e.g., sharp image, sound)	Insufficient or missing management system for managing educational modules
Quality educational content (correct, relevant and sufficient information)	The need to create many unique training scenarios for businesses that have diverse work activities
Incorporating virtual reality into the company's education system	Insufficient or inappropriate promotion of virtual reality
Ease of use and intuitiveness	Negative management attitude towards virtual reality in training

Source: own

the implementation of VR in employee training are shown in Tab. 5. These factors were selected based on the mean and also ratings score.

The most positive factors come from the management (3) and VR processing group (3). For the negative factors, the highest number of items is again for management (3), followed by infrastructure and institutional support (3).

3.2 Discussion

This study obtained the consensus through three rounds of expert surveys, and 59 factors were ranked based on the importance mean value (including 24 key factors). The experts were almost unanimous in reassessing the ranking of the factors in each group. For factors that can positively influence the implementation of virtual reality in employee training, the coefficient ranged from 0.84 to 0.99. The lowest agreement

was for the dimension infrastructure and institutional support. On the other hand, the highest agreement was in the other dimension.

The coefficient for the factors that can negatively affect the implementation of virtual reality in corporate training ranged from 0.71 to 1. The lowest coefficient is the same as for the positive factors in the infrastructure and institutional support category. However, the highest coefficient is for the employees dimension, where all experts were in complete agreement, and therefore, the coefficient has a value of 1.

The first research question asked: What are key factors that positively influence the implementation of virtual reality in employee training? Management support for the use of technology in employee training and sufficient funds for the implementation of virtual reality in employee training were identified as the most important factors that can positively influence the implementation of VR in training, with the same mean value of 4.91. Factors related to management and personnel, or soft factors, are rarely mentioned in peer-reviewed publications, but their importance has been confirmed in studies, e.g., Philip et al. (2019) or Gupta and Bhaskar (2022). On the other hand, finance (for the acquisition of software and hardware or in the context of cost savings) is mentioned very often (e.g., Grabowski & Jankowski, 2015; Xie et al., 2021). Other key factors identified were: opportunity to train during working hours, IT skills needed, ease of use of hardware (VR glasses), the company management's interest in the development and training of employees, high-quality software processing (e.g., sharp image, sound), quality educational content (correct, relevant and sufficient information), incorporating virtual reality into the company's education system, ease of use and intuitiveness, appropriate promotion of virtual reality in the company, positive attitude of employees towards the use of VR in training and comprehensiveness of the training system integrated into VR, including the sequence and repetition of individual training modules.

The second research question asked: What are key factors that negatively influence the implementation of virtual reality in employee training? Two factors came out with the same value of 4.91: unavailability of technology in the workplace and lack of funds. The importance of the factor "unavailability of technology" is confirmed, e.g., by Wyk and Villiers (2009).

Finance, in general, is a very frequently mentioned factor (disadvantage, advantage) in academic studies, in a negative sense (e.g., high software and hardware acquisition costs) and has been mentioned in studies such as Le et al. (2015) and Bohil et al. (2011). Thus, hard factors come first for negative factors, but soft factors are also in the key 10, and this study proves how important they are. Other key factors identified were insufficient preparation of employees for new technologies in training, lower digital skills, insufficient IT skills, reluctance of leaders responsible for training to deal with the implementation of virtual reality in employee training, cyber sickness (e.g., nausea, headache) in some individuals (the importance of this factor is often mentioned, e.g., Souchet et al., 2023). Additional issues include the creation of only sub-units and lack of linkage to business processes, insufficient or missing management system for managing educational modules, the need to create many unique training scenarios for businesses that have diverse work activities, insufficient or inappropriate promotion of virtual reality, negative management attitude towards virtual reality in training and lack of motivation of managers for staff development and training.

Conclusions

Using the Delphi method, this study established a consensus on factors that either positively or negatively influence the implementation of virtual reality as a training tool for employee training. 22 experts from different areas identified 59 factors. 34 of them were positive and 25 negative. The factors were further divided into 5 groups according to Khan's modified framework. In these groups, the experts determined the importance of each factor according to the Lickert scale. Both research questions were answered.

This study represents a significant step forward in research on virtual reality as a tool for employee training. This is one of the first studies to identify factors that may influence the implementation of VR in employee training and the first such study in the Czech Republic. By obtaining data from the existing literature and finding a research gap, key factors were obtained from experts in the field and were ranked in order of importance. The study has important implications for companies, CEOs, HR managers and for virtual reality providers.

Limitations of the study. It should be noted that the current study has some limitations. Firstly, the number of experts who participated in the study was limited, so further research is needed to find out whether these views are representative enough of the wide range of employee training using virtual reality. Another limitation is geographical, as all the experts were from the Czech Republic. Therefore, it cannot be said that these factors will be the same for other countries.

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Opportunities and challenges for managers within the East-European agriculture sector: Case study on Romania

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Abstract: Agriculture has always been essential to the development of human society, providing the food necessary for human survival. For the Romanian economy, agriculture is a very important sector in terms of the number of enterprises involved and the agricultural area used, but also because of the workforce employed in the sector. However, Romanian agriculture is a vulnerable sector, which has had to face several unfavourable events in recent years. The COVID-19 pandemic, the energy crisis, the conflict in Ukraine, and the lack of agricultural inputs have brought many risks for Romanian farmers in 2023, such as higher food prices and more expensive electricity for consumers. This paper aims to identify the perceptions of the managers regarding the outcomes of the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the future potential of agriculture in Romania and to determine their perceptions about the impact of other issues with which agricultural companies had to deal with in recent years (climate change, draught, inflation, governmental measures). Other goals of the paper were to find out the managers' plans and prospects to potentially introduce or use new technologies and digitization within their own companies and uncover their assessments regarding the sector's future within the European and international context. To identify these perspectives, qualitative research was carried out through in-depth interviews with respondents holding leadership positions within 16 Romanian agricultural companies. The data was analyzed in order to identify similarities and discrepancies within their statements and find corroborative ideas that could help improve the sector. The results of the paper showed how the COVID-19 pandemic and the unstable geo-political context along with other issues increased production costs, but favored digitization and technology. In the past years, because different events changed the European and Romanian economy, a lot of academic research has revolved around the areas of health, energy and technology. Therefore, the study brings elements of originality because of the theme and the approach, which provide valuable insights not only for Romania but for other countries in the region as well.

Keywords: Energy crisis, geo-political instability, COVID-19 pandemic, agricultural production, food security, climate change, draught, inflation.

JEL Classification: Q10, Q18, M11, M12, F18.

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Introduction

The years between 2019 and 2024 have been agitated with a pandemic and geo-political conflicts having significant social and economic impacts (Dinca et al., 2023). There could be much to discuss about this decade's unpredictable events, their aftermath, and the measures taken to deal with them, e.g., the outcomes of the COVID-19 pandemic for health and other complementary sectors or the discontinuations with the supply chain, and rising prices for energy and food caused by Russia's invasion of Ukraine (European 2030 Resolution Foundation, 2023).

Following the outbreak of the COVID-19 pandemic, world governments have taken different measures aiming at impeding or even ending the spread of the virus. The main measures include: national lockdowns along with social distancing, closing educational institutions by implementing home school programs, the introduction of travel alerts customs restrictions for people originating from certain countries deeply affected by the pandemic, increasing imports and production of medical equipment (e.g., ventilators, masks) and the number of employees in the medical field, increasing the number of police and army interventions, restrictions for public transportation, and offering and receiving international support, whether medical or financial. However, even though these measures taken by world governments had their benefits for public health, they have proven to show their disadvantages, both socially and economically (Haug et al., 2020). In order to recalibrate the economies of countries, world governments have introduced a series of fiscal measures to recover the status of different economic domains (Vămănescu et al., 2023). Thus, refundable and non-refundable loans were introduced in various countries for the sectors severely affected by the pandemic, such as tourism or transport, which received financial support from governments.

Succeeding the COVID-19 pandemic and the conflict between Russia and Ukraine, increased inflation on food, agricultural products,

energy and manufacturing goods can be identified worldwide and the inflation rate remains a significant indicator showing the general state of the economy (Buheji, 2022). In the period following the COVID-19 pandemic and the conflict in Ukraine, Romania experienced a period similar to the stagflation of 1974–1982 due to very high energy prices (Wang, 2023). It is important to emphasize that the increase in inflation causes an increase in global poverty, which in turn causes social inequality, a high unemployment rate and overall financial instability, because the purchasing power of the population decreases dramatically.

The agricultural sector has been impacted globally, both by the measures taken by governments against the COVID-19 pandemic, by the conflict in Ukraine, by the overall economic decline, but also by environmental factors such as climate change or global warming. An important factor for reshaping and boosting agriculture could be the implementation of digital technologies in this sector.

Since agriculture is a vital industry for the world economy and for the above-mentioned food industry, it has a major impact on economic growth, employment and the development of rural communities. However, the Romanian agriculture is characterized by low productivity compared to its potential and the measures that could be taken in order to surpass those difficulties have not been researched enough in the last years.

Therefore, within this research gap, the purpose of this article is to determine the impact of the multiple recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the agriculture in Romania. The main research question of the paper is: What vulnerabilities have recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) brought to the agriculture in Romania and what measures could be taken and implemented in order to strengthen it? The aim was to identify the impact on production processes, on exports, sales but also on the overall economic activity of Romanian

agricultural companies. Through the qualitative research in which managers from agricultural firms in Romania were interviewed, there were identified the threats and opportunities triggered by the current economic context (of the region as well), but also if Romania is prepared for a future that will be shaped by sustainability.

1. Theoretical background

The last few years have been tense due to pandemic and political-military conflicts affecting social and economic systems. Extensive high-priority policies have been carried out as counteraction of these unforeseen events.

The COVID-19 pandemic triggered a socio-economic crisis along with a health one and its consequences are challenging and wide-ranging on a global level (Jambor et al., 2020). In order for the pandemic to be controlled worldwide, travel restriction measures were introduced, which decreased productivity in companies as well as trade in goods and services (Zhang & Ma, 2020). National governments in many countries have taken various measures to control this health crisis, which made the process of import and export of food very difficult (Gherasimescu et al., 2023). Among many sectors, such as tourism or transportation (especially by plane), the food and agriculture sectors were deeply affected by the lockdown measures (Hamid & Mir, 2021). Many countries temporarily suspended exports with the aim of protecting food stocks in local markets, generating global food insecurity (Aker, 2020). However, concomitantly, governments and central banks had to think about measures to recover the economy. Therefore, the COVID-19 pandemic changed the way businesses were run worldwide (Badan & Petre, 2020). Numerous global companies have had to reanalyze their risks, priorities, and strategies for the future (Nakat & Bou-Mitri, 2021). As positive aspects of the health crisis, among the most important which can be mentioned are the fact that numerous imports were replaced by domestic products and the creation and growth of more online companies (Dinu et al., 2021; Jiang et al., 2020).

Another impactful event starting in the 2020s was Russia's invasion of Ukraine and it has generated severe repercussions in the international energy markets, including price instability, stocks' deficit, problems in the defense and economic incertitude. It is estimated that

higher energy costs are going to lead to rising prices of goods and services (Yin et al., 2023). One implicitly positive input of increasing fossil fuel prices is they offer a strong motivation to speed up the transition towards sustainable alternatives (Reglobal, 2022).

The side effects of COVID-19, combined with those triggered by the conflict in Ukraine, could have strong repercussions for individuals, business sectors, and countries, including geopolitical tension, increased costs, energy sector impasse, and a slowdown in global economic growth (Xing et al. 2023). The conflict in Ukraine has brought many challenges to the agricultural sector in 2023, and imports of cheap cereals and oilseeds from Ukraine have had a negative impact on the incomes of Romanian farmers, who have faced low prices, unfair market competition and increasing difficulties in financing agricultural activity (Istudor et al., 2021).

For the EU, the constant changes within the energy sector have represented a priority in the last five years and extensive action measures have been implemented at the EU level and by EU member states in this sense. The agricultural sector, which stands as an essential one for EU rural areas, uses large amounts of energy, and therefore it is deeply affected by the high energy prices (European Economic and Social Committee, 2023).

Climate change also negatively affects biodiversity by threatening the expansion of animal species. Human health is also affected, as deaths are recorded in 2023 due to the extreme climate in several regions of the globe. In addition, drastic modifications of climate may cause human health conditions, such as asthma, cardiovascular diseases, malaria, dengue, respiratory allergies, malnutrition, or heart attacks. Tourism is threatened by climate change and global warming, because certain areas of the world become impossible to visit during the summer holidays due to extremely high temperatures. The winter ski season is also affected by the fact that the amount of snow has decreased compared to previous decades.

To support the planet in the fight against climate change, short- and long-term actions are necessary. Short-term measures consist of education among farmers, forest protection, sustainable tourism development and energy efficiency (Micu et al., 2022). On the other hand, long-term measures against climate change include smart agriculture, biodiversity and

ecosystem conservation, reducing deforestation and using green energy (Raihan, 2023).

In Romania, the climate is characterized by changes of the seasons, by mild winters and increased air temperature, and by the desertification of the areas where wheat, oats and sunflowers, are cultivated, but also by extreme phenomena, such as gusts, storms and blizzards. In the last 40 years, the temperature of Romania increased by +2°C (Popescu et al., 2023). Simultaneously, in terms of informing Romanian farmers about the reduction of carbon emissions and pollution, there are too few initiatives. With the country's accession to the European Union (in 2007), farmers followed trainings and preparations on this subject, but still, the interest regarding this subject remains reduced.

It is worth noting that the pandemic represented a great accelerator of different modern technologies. Examples are Google, Facebook, TikTok, WhatsApp or Instagram platforms. These tools are free and can increase the popularity of businesses, that being the reason for them attracting a large number of users (Uşaklıoğlu, 2020).

By digitalization, other technological concepts are also comprised, such as robots, smartphones, artificial intelligence (AI), 3-D printers, 5G industry and other innovative ways of doing business (Amankwah-Amoah et al., 2021).

In 2022, the Digital economy and society index (DESI) ranked Romania as 27th out of 27 in the European Union (Fig. 1), in terms of human capital in digitization, connectivity, integration of digital technology and digital public services (Popa & Turek Rahoveanu, 2021). This position is due to the government's lack of interest in this branch, the lack of planning of the digitization process at a national level, and the reduced efficiency of institutions in this direction. In order to accelerate these processes, in 2020, the Authority for the Digitization of Romania (ADR) was established in Romania, being subordinate to the government.

For Romania, the digitalization of companies would benefit the country's economy by contributing approximately EUR 42 billion to the GDP until 2025. The COVID-19 pandemic highlighted Romania's lack of digital education and the fact that the population lacks the skills to use technology in various administrative sectors, such as educational, medical or social (Panait & Rădoi, 2022).

The 5G industry represents the future of the digital economy, which will spur global development by creating new job opportunities. The 5G era aims to connect people, machines, to facilitate the medical, agricultural, educational, transport system, and to facilitate access to education and culture. The agricultural sector can be supported by the 5G industry, through the development of sensors

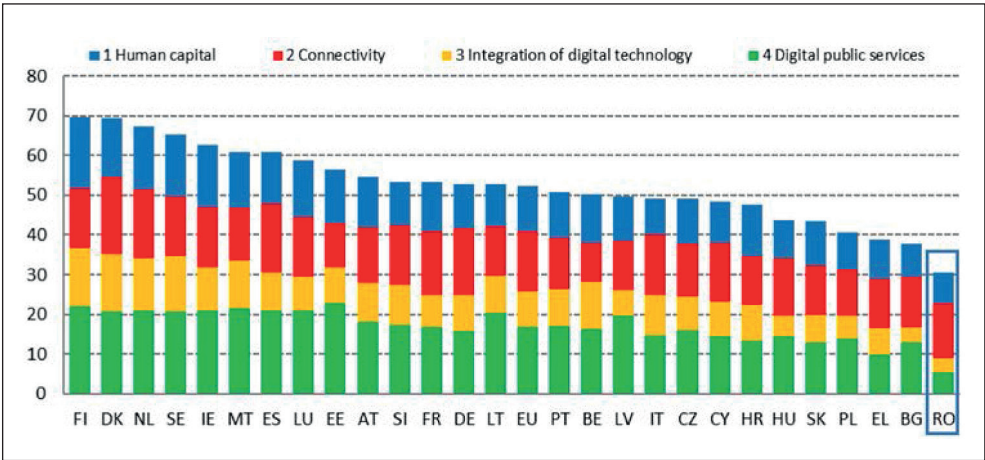


Fig. 1: Digital economy and society index (DESI) 2022 ranking

Source: <https://digital-strategy.ec.europa.eu/en/policies/desi-romania>

in farms (identification of humidity, topography, animal health), the development of the irrigation system, soil and harvest monitoring, but also through the use of agricultural drones (Ionescu et al., 2021).

2. Research methodology

In order to better understand the economic activity and the potential challenges within Romanian agricultural companies, the way they were impacted by exogenous shocks (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) and their perspectives for the future, a qualitative study was conducted using in-depth interviews. In-depth interviews are frequently applied when conducting research of an exploratory nature and, in particular, when the researchers want detailed information about the respondents' opinions and wish to explore new issues in depth. Interviews are often used to provide context to other (secondary) data, offering a more complete picture of a specific topic or subject (Andrei et al., 2021; Gârdan et al., 2018). The goal of the research was to explore the various facets of the agricultural sector, such as the production process and costs, delivery, imports, exports, sales, but also the advantages of new technologies and digitalization. Specific objectives are to:

- Identify the opinions of the managers regarding the repercussions of the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the future potential of agriculture in Romania;
- Determine the perceptions of the managers on the impact of other issues with which agricultural companies had to deal with in recent years (climate change, draught, inflation, governmental measures);
- Find out the plans and the prospects of the managers to potentially introduce or use new technologies and digitization within their own companies;
- Uncover the opinions of the managers regarding the future of the sector within the European and international context.

The qualitative research method allows relevant information to be obtained through interviews, with the in-depth interview technique being applied. The use of this technique is appropriate in relation to the study's goal and the researchers' target to find out in a clear and explicit manner the opinions and perceptions of agriculture business owners or directors.

In most cases, qualitative research includes an unstructured, exploratory methodology based on small samples, able to offer much more detailed information than what is available through other data collection methods, such as surveys (specific for quantitative research) (Epuran et al., 2018).

The in-depth interview allows a qualitative understanding of the causes and motivations underlying the phenomena studied and the social reality of their organizations (Gârdan et al., 2018).

In the context of this study, a partially structured interview guide was chosen, with pre-established discussion topics in a particular framework. Even if there is already a pre-established arrangement of questions, the researchers had the freedom to insert supplementary questions. Also, for this study, which is exploratory in nature, the use of a semi-structured interview guide is justified, as the greatest possible flexibility is needed to allow the most diverse information to be obtained (Pîrvu et al., 2024).

The sample was chosen from the pertinent statistical population consisting of Romanian entrepreneurs in the agricultural sector. The sampling design used was purposive sampling, also known in the literature as judgmental or subjective sampling; purposive sampling is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of the population to participate in their surveys (Campbell et al., 2020). The selection was established through a selection questionnaire encompassing filter questions on-topic with the goals of the study. Sixteen managers were selected to participate in the interviews on a voluntary basis and interview guides were then applied to each of them. Given that qualitative research aims to explore local perceptions and subjective logic, the sample is not statistically representative, but the applicability of the results acquired through the specific structure for the situation encountered in the analysed field is ensured. Even though qualitative research is usually characterized by small sample sizes, which is also the case for this research, we ensured the sixteen participants had the appropriate backgrounds, experience and company position in order to support the depth of case-oriented analysis that is fundamental to this mode of research.

Tab. 1: Structure of the sample of respondents

Criteria of structuring the sample	Grouping the respondents depending on each criteria			
Education level and competence area	Bachelor studies in Economics (6 people)	Bachelor studies in Agronomics (4 people)	Master studies in Economics (5 persons)	Doctoral studies in Economics (1 person)
Age	30–39 years old (3 people)	40–49 years old (6 people)	50–59 years old (5 people)	60–69 years old (2 people)
Position within the company	Production manager (4 people)	Research manager (1 person)	Purchasing manager (1 person)	General manager (10 people)
Management experience in agriculture	10–15 years (4 people)	15–20 years (5 people)	20–25 years (6 people)	Over 25 years (1 person)

Source: own

The respondents came from the following agricultural sub-sectors: antimicrobial substances production, meat and egg preparations, techniques and machinery for the meat industry, poultry meat production, dairy production, cereal production, and horticulture solutions.

In order to ensure the highest possible validity of the research results, the authors followed the recommended norms of data collection based on a solid interaction between researchers and interview participants. Participants at the study were chosen if they fulfilled an imperative condition, specifically high decision-making capacity within the firm and access to basic information on the strategic orientation of the firm in question. Thus, out of the 16 people finally interviewed, the distribution of the respondents' functions was as follows: 10 general managers, 4 production managers, 1 research manager and 1 purchasing manager.

Regarding the management experience within the agricultural sector of the sample interviewed, it can be stated that: 4 respondents had between 10 and 15 years, 5 respondents between 15 and 20 years, 6 respondents between 20 and 25 years management experience and 1 respondent with over 25 years management experience (Tab. 1).

Interviews were conducted at the companies' offices or via Zoom call, depending on the availability and schedule of the respondents. The questions of the interviews focused on the impact of the COVID-19 pandemic,

the energy crisis and the conflict in Ukraine on production processes and costs, sales, delivery time, exports, imports, the workforce, but also on technology, social networks and digitization. The discussions were recorded and then transcribed, and the information was processed using the content analysis technique. The interview guide included open questions, but each question needed a mark on a 5-point Likert scale first (from strongly disagree to strongly agree) and afterward a more detailed answer into why the respondents agree or disagree with that respective statement.

The interview guide had the following structure: the first question explored how recent events (the COVID-19 pandemic, the energy crisis, and the conflict in Ukraine) have impacted the future potential of agriculture in Romania, highlighting various challenges. The second question concerned managers' perceptions regarding the impact of other issues with which agricultural companies had to deal with in recent years (climate change, draught, governmental measures and politics) on the future potential of agriculture in Romania. The third question dealt with the managers' perceptions about the plans and the prospects of the managers to potentially introduce or use new technologies and digitization within their own companies, while the fourth and last question referred to the opinions of the managers regarding the future of the sector within the European and international context.

3. Results and discussion

After transcription and centralization, the interviews were analyzed under three aspects (Cătoi, 2002): (i) vertical analysis, through the individual approach of each interview, respectively the opinions of each manager, in which the attention paid by them to the issues contained in the sub-themes of the in-depth interview was highlighted; (ii) horizontal analysis, by summarising the approach to each theme analysed by all 16 managers; and (iii) counting the answers for the questions with a 5-point Likert scale, which is related with the horizontal analysis.

The first subject of discussion addressed in the semi-structured interview guide concerned managers' perceptions regarding the consequences of the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the future potential of agriculture in Romania, and it represents Q1 of our research. In order to answer the first research objective, seven sub-questions were introduced in the interview guide, numbered from Q1.1 to Q1.7.

In what way have the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) impacted the future potential of agriculture in Romania, causing the following issues?

Q1.1 – Delayed the production process within the company?

Q1.2 – Increased the factory costs?

Q1.3 – Delayed in the order delivery process?

Q1.4 – Affected the sale of agricultural products?

Q1.5 – Hampered or stopped agricultural product exports?

Q1.6 – Affected the imports of agricultural raw materials (e.g., pesticides, insecticides, herbicides, fertilizers, seeds, fertilizers, fuel)?

Q1.7 – Brought challenges for the company's workforce? (cutting jobs, reducing salaries, renouncing to bonuses).

For Q1.1, regarding potential delays in the production process, the companies that participated in the study, 10 out of 16 respondents disagreed or strongly disagreed. Therefore, more than 60% of the agricultural companies subjected to the study confirmed that the production process followed its natural course in spite of the recent challenges.

Regarding the effects on the cost of the (agricultural) goods manufactured in their companies (Q1.2), 12 of the total 16 respondents

answered "agree" or "strongly agree." Therefore, more than half of the agricultural companies included in the research answered that the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) affected the factory costs.

Concerning the repercussions on the delivery process (Q1.3), delays respectively, 11 of the total 16 respondents answered "strongly disagree" or "disagree." It can be concluded that more than half of the agricultural companies participating in the study stated that the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) did not affect the delivery process.

Regarding the impact of recent events on the firm's sales (Q1.4), the answers were very mixed (8 of the respondents agreeing or strongly agreeing, while 5 disagreed or strongly disagreed).

When we analyze the answers for Q1.5, dealing with hampering or stopping product exports because of recent events (the COVID-19 pandemic, the energy crisis, and the conflict in Ukraine), the answers were again quite mixed. Seven of the respondents answered "strongly disagree" and "disagree," while eight answered "agree" and "strongly agree." The answers to this particular question are in line with the previous questions because the companies which experienced problems with sales were the ones who identified problems with exports as well.

When it comes to Q1.6 referring the impact of recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the imports of agricultural raw materials (e.g., pesticides, insecticides, herbicides, fertilizers, seeds, fertilizers, fuel), the answers were divided. Four answered "strongly disagree" and "disagree." Four answered "indifferent" while eight answered "agree" and "strongly agree."

Regarding the impact of recent events on the labor force within the companies studied, 12 respondents mentioned "strongly disagree." All the answers in a detailed manner are presented in Tab. 2, where the subjects of Q1.1 to Q1.7 are specified within the first column and numbered from 1 to 7.

Following the content analysis, 15 respondents mentioned that some measures that could help them in a major way are improving the way subsidies are granted to small farms, stimulating farmers' associations and

Tab. 2: Breakdown of the opinions of the managers – how recent events impacted the agricultural companies in Romania

Activity affected	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Median of grouped data
1. Delaying the production process	8	2	4	2	0	5
2. Increasing the factory costs	1	2	1	8	4	2
3. Delaying the order delivery process	4	7	3	1	1	3
4. Sale of agricultural products	1	4	3	6	2	3
5. Hampering or stopping agricultural product exports	4	3	1	6	2	3
6. Affecting the imports of agricultural raw materials	3	1	4	3	5	3
7. Bringing challenges for the company's workforce	12	2	1	1	0	5

Source: own

increasing the degree of capitalisation of farms by facilitating farmers' access to credit through agricultural credit guarantee mechanisms. Thirteen respondents specified that stimulating the use of irrigation systems and their modernization and facilitating access to relevant European and national funds could be two supplementary measures that could support them in developing their activities. All these respondents referred to the year 2023 when Romania, together with five other Eastern European countries, asked the European Union for specific compensation instruments for farmers affected by cheap imports from Ukraine, receiving less than they needed.

Eleven participants said that the lack of professional training of farmers is visible and they wish for more modern vocational and technical agricultural education, which could increase the involvement of young people in agriculture by implementing schemes to support them (or facilitating access to relevant European funds) through appropriate advisory and training services. One respondent mentioned that: "Even though there are loans for financing the agricultural sector, overall, they are difficult to access and do not cover farmers' or producers' needs." Ten respondents agreed that young farmers are considered to be a potential force for Romanian agriculture and that the new

generation shows more interest in the environment than the old generation of farmers; however, one of the biggest obstacles faced by young farmers in Romania is the difficulty of renting or buying land and agricultural equipment.

The second subject of discussion (Q2) addressed in the semi-structured interview guide concerned managers' perceptions regarding the impact of other issues with which agricultural companies had to deal with in recent years (climate change, draught, governmental measures and politics) on the future potential of agriculture in Romania. In order to answer the second research objective, one main question was introduced in the interview guide.

In what way have other problems (climate change, draught, governmental measures and politics) caused bigger or smaller problems for your company in recent years? Were any of the issues mentioned in the first question encountered because of one of these causes?

It is worth mentioning that 12 out of 16 respondents stated that farmers are among those most affected by climate change and environmental degradation because food production depends on soil fertility, water quality, weather conditions and the presence of pollinators. For these reasons, farmers need to play an active role in protecting natural resources and moving towards more sustainable and

environmentally friendly agriculture. Eleven respondents mentioned the need for the European Union to continue to support them financially in adopting these recovery measures.

Ten respondents also mentioned tax evasion in the agricultural sector as a burden affecting them in the last decade and they mentioned licensing grain warehouses, optimizing taxation in the agricultural sector and regulatory measures to reduce tax evasion as potential methods to support their business progress.

The third subject of discussion (which represents Q3 of our research) addressed in the semi-structured interview guide dealt with the managers' perceptions about the plans and the prospects of the managers to potentially introduce or use new technologies and digitization within their own companies. In order to answer the third research objective, three sub-questions were introduced in the interview guide (highlighted as Q3.1, Q3.2 and Q3.3).

The first question from this section was Q3.1. In the last 3 years, have you introduced technologies in your agricultural production activity? The biggest proportion of the respondents (7 out of 16), chose to mention "indifferent" (or "neutral"), with only 6 of them agreeing or strongly agreeing. One of the respondents who agreed mentioned that he started using an ERP system in 2018, and it helped him very much to manage the production chain, from crop planning to the sale of finished products. "It not only improved operational efficiency, but also helped me reduce costs and increase profitability," he said.

When it came to promoting the activities of the company on social networks (e.g., Facebook, Instagram, LinkedIn, Twitter), which embedded the content of question Q3.2

in order to make it more visible and open to the general public (especially the younger one) 10 out of the 16 companies disagreed and strongly disagreed.

For question Q3.3 regarding the desire to reinforce the digitization of their activity in the future, no company answered "strongly disagree" and "disagree," 3 answered "indifferent," 5 answered "agree" and 9 answered "strongly agree." Therefore, most of the agricultural companies answered that they aim to digitize their activity in the future in order to develop. However, all of them mentioned that no big improvement has been made so far. All the answers in a detailed manner are presented in Tab. 3.

Fourteen out of sixteen respondents specified that both in Romania and throughout the EU, agriculture is facing a double demographic challenge: on the one hand, the ageing of the agricultural population, and on the other, fewer and fewer young people living in rural areas. This aspect makes the implementation of new technologies within the firms much harder, which was reflected in the answers to Q3.1.

More than half of them (10 respondents) concurred that the Romanian agricultural sector is facing a low level of digitization and modernization compared to other EU member states and that investments in modernization and restructuring of factories and farms along with the whole sector are needed to make agriculture competitive.

Seven respondents pointed out that they are already investing step by step in R&D and are interested in continuing to focus on seeds and genetic traits, chemical and biological solutions for crop protection, soil management, plant health, pest control and digital agriculture inspired by the fact that all these measures are already

Tab. 3: Breakdown of the opinions of the managers – the plans and prospects to potentially introduce or use new technologies and digitization within their companies

Activity developed or to be developed	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Introducing new technologies in the agricultural production activity	2	1	7	4	2
Promoting activity of the company, on social networks (e.g., Facebook, LinkedIn, Twitter)	7	3	3	2	1
Digitizing the activities of the company	0	0	2	5	9

Source: own

implemented on a higher level in other European countries (Eurofresh Distribution, 2023).

Even though many of the respondents admitted that communication could help distribute information from the company to its public, thus building a positive image and a long-term transparent relationship, 10 out of the total of 16 respondents said that they are not focused on promoting the activities of the firm on social media. Although they agree that the integration of the company in Facebook/LinkedIn groups dedicated to local and specialized agriculture communities could have the potential to make the business more competitive, it is not necessarily a priority to improve in the future.

Among the technologies mentioned by the respondents in order to ensure a more sustainable rural development are vertical and horizontal integration of farm activities and the formation of rural clusters, promoting farms that focus on reduced environmental impact and sustainable energy generation, promoting modern farm management models to increase value added in agriculture, through crop rotation or diversification methodologies but also through IT or robotics applications, promoting innovation through collaboration between universities, public and private entities, confirming also the results obtained by Popescu et al. (2023). However, almost all respondents agreed that new, advanced technologies are not something they foresee happening in their business in the near future.

The fourth subject of discussion addressed in the semi-structured interview guide referred to the opinions of the managers regarding the future of the sector within the European and international context. In order to answer the fourth research objective, one open question was introduced in the interview guide (without a previous Likert scale): "Q4. What are your thoughts about the future of the agriculture sector within the European and international context?"

Fifteen out of the sixteen respondents mentioned that they believe Romania needs a long-term strategy that ensures the strategic autonomy of agriculture, putting farmers at its center. Other topics mentioned by more than 10 respondents were: ensuring a link between food production in all its aspects (quantity, quality, diversity, accessibility, health safety), good management of natural resources (soil fertility, water quality, biodiversity), and the level of farmers' incomes who are expected

to deliver the goals from above (which are not easy).

At the same time, 10 respondents emphasized the fact that Romania's strategic positioning on the Black Sea represents a key position for Romanian agriculture, because exports can be easily transported through Constanta Port and the necessity to position Constanta Port among the main European ports, alongside Antwerp, Hamburg or Rotterdam, was mentioned. In the conditions in which Constanta would develop more as a strategic and commercial hub, grain exports, would increase more rapidly, accelerating the development of Romanian commercial exchanges. These respondents referred to a positive point of Ukrainian grain transit to international markets through Romania, namely that the Port of Constanta has become the most important alternative export route for Ukraine after the Russian invasion in 2022. They noted that Ukrainian grain has generated record activity in the Port of Constanta and this should be further supported by upgrading the rail and road infrastructure in and around the Port of Constanta using European funds.

Eleven participants who took part in the interview, emphasized the importance of belonging to the European Union, to the common market that offers Romania the necessary openness to establish commercial relations with member countries for exports and imports. For example, Romania's main economic partners are Germany, Italy, Bulgaria and Hungary. These respondents mentioned the positive aspects of Romania being involved in various agriculture programs and schemes managed by the EU, one of the respondents stating that: "They should be reinforced in the following years bringing in more specialists and experts in EU funds contracting."

Five participants in the study mentioned that a possible future accession of Romania to the Organization for Economic Cooperation and Development (OECD) would place the country among the main economic actors at the global level, which could give the chance for new commercial partnerships to be established, developing Romania's commercial exchanges at an international level. In the same context, 2 participants developed their opinions on the topic regarding a future European Union – Mercosur Agreement, an agreement that would also open the doors of Romanian trade to new international markets, not yet penetrated

by Romanian agriculture stakeholders. This agreement would offer trade opportunities to Romania, mainly with Brazil, which is Romania's main economic partner in Latin America.

Conclusions

The recent events, most importantly the COVID-19 pandemic and the conflict in Ukraine have left their mark on inflation in food, agricultural products, energy and manufacturing products worldwide. The agricultural sector has also been impacted globally, both by the measures taken by governments against the pandemic, the war in Ukraine, the overall economic decline, and climate change. Even though Romania owns its strengths within the agricultural sector, having the 6th largest utilized agricultural area among EU countries and being among the world's top 10 exporters of wheat and maize, the country's agriculture encountered serious difficulties following these events. The pandemic, as well as other economic problems, highlighted the low level of digitization and implementation of advanced technologies in Romania, especially in agriculture. Romania's agriculture is insufficiently mechanized, affected by fragmentation of land ownership, lack of capital and irrigation systems, and lack of professional education of agricultural workers (Grădinaru et al., 2024).

Qualitative research was carried out on the basis of specific methodology in the form of in-depth interviews with respondents holding leadership positions within 16 Romanian agricultural companies. The aim of the research was to explore the state of the various facets of the Romanian agricultural sector such as the production process and costs, delivery, imports, exports, and sales, but also the advantages of new technologies and digitalization. Specific objectives were to: (i) identify the opinions of the managers regarding the consequences of the recent events on the future potential of agriculture in Romania; (ii) determine the perceptions of the managers on the impact of other issues with which agricultural companies had to deal in recent years; (iii) find out the plans and the prospects of the managers to potentially introduce or use new technologies and digitization within their own companies; and (iv) to uncover the opinions of the managers regarding the future of the sector within the European and international context.

The first subject of discussion addressed in the semi-structured interview guide concerned

managers' perceptions regarding the consequences of the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) on the future potential of agriculture in Romania. Regarding potential delays in the production process, more than 60% of the agricultural companies subjected to the study confirmed that the production process followed its natural course in spite of the recent challenges. Regarding the effects on the cost of the (agricultural) goods manufactured in their companies, more than half of the agricultural companies included in the research answered that the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) affected the factory costs. Concerning the repercussions on the delivery process, more than half of the agricultural companies participating in the study stated that the recent events (the COVID-19 pandemic, the energy crisis, the conflict in Ukraine) did not affect the delivery process. Regarding sales, half of the respondents said they were affected, ticking "agree," while 9 of them said their exports were also affected.

The second subject of discussion addressed in the semi-structured interview guide concerned the managers' perceptions regarding the impact of other issues with which agricultural companies had to deal with in recent years (climate change, draught, governmental measures and politics) on the future potential of agriculture in Romania. It is worth mentioning that 12 out of 16 respondents stated that farmers are among those most affected by climate change and environmental degradation because food production depends on soil fertility, water quality, weather conditions and the presence of pollinators.

The third subject of discussion addressed in the semi-structured interview guide dealt with the managers' perceptions about the plans and the prospects of the managers to potentially introduce or use new technologies and digitization within their own companies. Most of the people participating in the interview (7 respondents) were neutral regarding the introduction of new technologies in the production activity in agriculture (4 respondents ticked "agree" and only 2 "strongly agree," regarding the introduction of technology). Most of the participants (10 respondents) declared that they do not use promotion sources on social networks, such as Facebook, LinkedIn, TikTok. When asked about the future

digitization of the company's activity, many managers (9 respondents) ticked "strongly agree." Fourteen out of sixteen respondents specified that both in Romania and throughout the EU, agriculture is facing a double demographic challenge: on the one hand, the ageing of the agricultural population, and on the other, fewer and fewer young people living in rural areas. More than half of them (10 respondents) concurred that the Romanian agricultural sector is facing a low level of digitization and modernization compared to other EU member states and that investments in modernization and restructuring of factories and farms within the whole sector are needed to make Romanian agriculture more competitive.

The fourth subject of discussion addressed in the semi-structured interview guide referred to the opinions of the managers regarding the future of the sector within the European and international context. Fifteen out of the sixteen respondents mentioned that they believe Romania needs a long-term strategy that ensures the strategic autonomy of agriculture, putting farmers at its center. Other topics mentioned by more than 10 respondents were ensuring a link between food production in all its aspects (quantity, quality, diversity, accessibility, health safety), good management of natural resources (soil fertility, water quality, biodiversity), and the level of farmers' incomes who are expected to deliver the objectives from above (which are not easy).

At the same time, 11 farmers emphasized the fact that Romania's strategic positioning on the Black Sea represents a key position for Romanian agriculture, because of the export potential of Constanta Port.

The limitation of this paper is represented by the limited number of respondents constituting the sample; therefore, the future perspectives of this research consist in expanding the sample of people (to approximately 70 farmers from Romania) in order to carry out quantitative research and in order to get even more detailed picture of the effects of recent events, the COVID-19 pandemic and the conflict in Ukraine, on Romanian agriculture.

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Can executive incentives improve corporate ESG performance? Evidence from Chinese listed companies

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Abstract: This paper examined the driving factors of ESG performance in Chinese listed companies from the perspective of executive motivation and found that: (1) monetary compensation incentives and equity incentives exert a sizeable impact on enhancing corporate ESG performance, and the robustness test results remain unchanged; (2) corporate strategic change and green technology innovation play a mediating role in executive motivation and corporate ESG; (3) the promotion effect of executive monetary compensation incentives on ESG performance is more significant in state-owned enterprises and heavily polluting entities, while the impact of executives' equity incentives on ESG performance is suppressed in state-owned enterprises; and (4) the economic effect test shows that good ESG performance has a positive economic influence of reducing a firms' litigation risk and idiosyncratic risk. This paper provides empirical evidence for Chinese listed companies to improve ESG performance.

Keywords: Monetary compensation incentives, equity incentives, ESG, corporate strategic change, green technological innovation.

JEL Classification: O42, G35, O32.

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Introduction

In the 21st century, with the growing prominence of social problems such as energy crisis, resource scarcity, and environmental pollution,

the concept of sustainable development has received greater attention from all walks of life. In 2004, the United Nations Global Compact introduced the concept of ESG for the first

time in its report “Who cares wins,” which refers to environmental, social, and governance factors. The report points out that in the face of increasingly fierce market competition in the context of globalization, only by effectively responding to ESG-related issues will enterprises have the opportunity to stand out from the competition. Since then, various types of ESG evaluation systems and ESG investment products have entered the market, with a large number of investors taking ESG as a key reference indicator of firm performance (Nazir et al., 2022).

As the influence of the ESG concept gradually expanded, there has been a gradual realization among enterprises of the paramount importance of ESG. Hence, companies are now increasingly incorporating ESG into their strategic planning and management practices, and ESG has also emerged as a research hotspot for academic circles (Gazman, 2023; Qureshi et al., 2021). Studies document that corporate ESG information disclosure and enhanced ESG practices can improve corporate competitiveness and sustainability and optimize long-term corporate value in the following three ways. First, corporate ESG information disclosure can play a positive role in urging companies to take the initiative to assume social responsibility and improve their own environmental performance. Consequently, this enables the firms to gain a positive reputation and competitive advantage, thus generating higher corporate value (Qureshi et al., 2020). Second, superior ESG performance of firms can reduce the cost of corporate financing, alleviate corporate financing constraints, and enable firms to gain higher value in the capital markets (Li & Zheng, 2022). Finally, ESG practices of firms can reduce risks such as corporate financial risks, default risks, and share price crash risks (Wang & Huang, 2022).

In 2018, as China's A-shares were included in MSCI, FTSE Russell, and other relevant indices, the relevant concepts of the ESG evaluation system gradually began to have a substantial impact on the information disclosure, corporate governance, corporate strategy, and resource allocation activities of China's listed companies. According to the Report on ESG development of listed companies in China, as of December 2022, 31.07% of A-share companies have disclosed ESG-related information, totaling 1,462 companies, with the disclosure ratio

of CSI 300 index companies reaching 92%. However, there is still a problem of insufficient investments for ESG undertakings in China. ESG endeavors by enterprises entail substantial corporate operating resources, requiring increased investment in environmental protection, carbon emissions reduction, building green industrial chains, taking more social responsibility, and even making changes in corporate strategies. It has been observed that when firms increase the inputs of strong externalities such as environmental and social responsibility, they will directly or indirectly escalate the overall cost of the firm. This will have a negative effect on the business and reduce economic efficiency, thus weakening the overall competitiveness of the firms (Li & Zheng, 2022).

This paper makes the following key research contributions in the extant literature on ESG. First, it extends the literature on the drivers of corporate ESG performance by incorporating the internal aspects of ESG performance, such as executive incentives. The literature on ESG drivers encompasses the role of external factors such as urban digital economy development, local government debt, and greening tax system, internal drivers such as enterprise digital transformation and corporate R&D investment on corporate ESG performance (Wang et al., 2022). However, we expand this line of research by empirically examining the key internal drivers of corporate ESG performance from an executive incentive standpoint. Hence, our study offers a fresh perspective on how firms can optimize ESG performance through internal drivers. Second, we reveal the underlying mechanism of the role of executive incentives in promoting corporate ESG performance.

By examining the channels of corporate strategic change and green technological innovation, this paper aims to uncover the “black box” of the causal relationship between executive incentives and ESG performance, which has certain practical significance. Third, our study enriches the research on the economic effects of corporate ESG performance. The existing literature on the economic consequences of corporate ESG performance examines the impact of a firms' ESG performance on operational and financial activities such as production and operation, audit costs, the cost of capital such as financing constraints, debt, and equity financing costs, enterprise performance such

as enterprise value and financial performance, and corporate risks such as credit risk and stock price crash risk (Li & Zheng, 2022). However, to offer a novel perspective, we examine the economic effects of executive incentives on ESG performance in terms of reducing litigation risk and idiosyncratic risk to provide targeted suggestions for the promotion of green and sustainable corporate development.

1. Theoretical analysis and research hypothesis

Existing research has made a full discussion on the drivers of corporate ESG performance. Starting from the external drivers, it is found that the market environment and macro policies have a significant impact on corporate ESG performance; cities and enterprises are the main carriers of resource elements, which play an important role in realising green development, and the development of digital economy in cities and responsible bank lending positively affect corporate ESG performance (Zhu & Wei, 2023). Meanwhile, corporate ESG performance largely depends on the efficiency of related policy formulation and implementation, and government subsidies and the greening of the tax system all contribute to corporate ESG performance (Chen et al., 2023).

Starting from internal drivers, it is found that enterprise digital transformation can internalise ESG externalities, improve enterprise internal information transparency and decision-making efficiency, and thus enhance enterprise ESG performance (Wang et al., 2022); enterprise R&D activities will encourage enterprises to independently innovate product upgrades, improve enterprise productivity, and optimise management performance in terms of enterprise ESG, in addition, corporate ESG performance is also affected by the nature of corporate equity and its own strategy (Wang et al., 2022).

Research on the internal drivers of corporate ESG performance is still relatively scarce, especially corporate executives, who, as strategic decision-makers, determine whether or not a company implements an ESG development strategy and are an important part of the internal drivers of corporate ESG practices. With the World Economic Forum making it clear in 2019 that ESG metrics need to be incorporated into leadership incentive programmes, the impact of executive incentives on corporate ESG performance is self-evident. Therefore,

companies need to establish an incentive system that can motivate executives to practice ESG concepts and ESG practices. Effective design of incentive and constraint mechanisms can achieve synergy of interests between shareholders and executives and reduce agency costs (Grossman & Hart, 1983), which can motivate them to take risks and mitigate risk-averse behaviours of executives in innovation investment (Zhou et al., 2018). Common executive incentives in practice are monetary compensation incentives and equity incentives.

1.1 Executive monetary compensation incentives and corporate ESG performance

There is no unanimous conclusion about the impact effect of monetary compensation incentives, and studies have confirmed that corporate executives have a risk-averse tendency, and that monetary compensation incentives can increase the level of risk-taking by executives, and increase the investment in risky long-term investments such as corporate innovation and research and development (Weng & Ma, 2022). At the same time, the setting of monetary compensation incentives for executives will weaken the tendency of executives to adopt environmentally polluting behaviours in order to maintain business performance and improve the quality of CSR disclosure (Jia et al., 2016). However, some scholars conclude that monetary compensation incentives have no or little incentive effect, and that executives are more willing to keep their compensation and maintain the status quo based on the principle of loss aversion (Dong et al., 2020).

On the one hand, giving executives a high level of remuneration protects their basic returns when innovation fails, easing their risk-averse tendencies and having a compensatory effect. According to risk management theory, because executives use their own management knowledge and skills as human capital, which is a kind of specialised investment, when external environmental shocks increase the risk of a company or industry, as long as the corresponding risk premium does not rise at the same time, executives with a risk-averse tendency may avoid the risk in two ways. One is to eliminate the risk directly by resigning; the other is to adopt short-term strategies to maintain stable financial performance and increase job security, even at the cost of giving

up risky but NPV-positive investments (Zhang et al., 2013). If executives fail to take action to avoid risks that result in damage to firm or executive performance and reputation, they will have a difficult time finding jobs in the managerial market in the future, which makes executives wary of formulating risky and long-cycle strategies such as ESG strategies. Monetary compensation incentives, on the other hand, can compensate executives for the losses they may suffer from executing riskier decisions, alleviating their worries (Akbar et al., 2021; Weng & Ma, 2022).

On the other hand, monetary compensation incentives can inhibit the opportunistic behaviour of executives, reduce the agency problem, and have an incentive effect. According to the principal-agent theory, because of the separation of enterprise ownership and operation rights, there is information asymmetry between owners and managers, the owner's goal of pursuing enterprise value maximisation and the manager's goal of pursuing self-interest maximisation are inconsistent, and the conflict between the two is difficult to be avoided (Guo et al., 2018). Owners are more concerned about the long-term stable development of the enterprise, while managers are keen to get the salary to achieve the accumulation of their own wealth, preferring low-risk, fast-return short-term investment activities. Monetary compensation incentives alleviate the conflict between the two sides to a certain extent. The increase in compensation can stimulate the work motivation of executives, and in order to maintain their high compensation level, executives will put more energy into focusing on company management activities, reducing opportunistic behaviour and agency problems (Yin et al., 2021). In addition, a reasonable compensation incentive system should reflect the company's strategic objectives, and higher compensation often implies stricter conditions for reaching them, which will require managers to take into account environmental performance, social responsibility commitment and many other aspects in the process of operation to achieve the long-term value of the enterprise to be maximised. There are even many companies that include ESG indicators in the assessment of short-term and long-term incentives for executives, respectively, and executive compensation is directly linked to corporate ESG performance. Therefore, despite the fact

that increasing corporate ESG inputs will cause current costs and risks to rise, executives with suppressed risk aversion tendencies will actively engage in ESG practices in order to achieve performance appraisal targets and obtain higher compensation levels. In summary, monetary compensation incentives make executives choose ESG development strategies that are riskier and more costly in the short term but beneficial to the firm in the long term through the compensation and incentive effects.

Based on the above discussion, we propose the following competing hypotheses:

H1a: Qualifying other conditions, there is a positive relationship between executive's monetary compensation incentives and corporate ESG performance.

H1b: Qualifying other conditions, there is a negative relationship between executive's monetary compensation incentives and corporate ESG performance.

1.2 Executive equity incentives and corporate ESG performance

Equity incentives make the interests and goals of executives and shareholders converge, and alleviate corporate agency problems. As a long-term incentive mechanism, equity incentives combine the pursuit of maximising the personal interests of the company's employees with the demand of the company's shareholders for maximising long-term interests by assigning executives the right to acquire the residual value in the operation of the enterprise (Lv et al., 2009), realising the self-motivation of the managers, increasing their concern for the future performance of the enterprise, strengthening the executives' motivation to work and their enthusiasm to create value, and enhancing their sense of responsibility and participation in corporate governance. When executives' shareholding is low or when they do not hold shares in the company, executives may seek personal benefits for themselves through short-term opportunistic behaviours that are detrimental to the company. Even if executives understand that carrying out ESG practices can benefit the firm in the long run and thus increase firm value, because the increase in firm value is not related to their own remuneration, executives are happier to maintain the status quo than the cost of their own human capital and the risks they may have to bear in carrying out ESG practices.

Equity incentives can transform executives from agents to owners, and executives and the company will both prosper and suffer. When executives formulate corporate strategies, they are no longer limited to fulfilling expected performance targets, but are committed to improving the environmental performance of the company from the perspective of ownership, assuming more social responsibility, maintaining a good reputation and image of the company, and making the company sustainable in the long term, thus enhancing the ESG performance of the company (Zheng et al., 2023). As a result, executives and shareholders' interests become more convergent, prompting them to incorporate corporate sustainability into their decision-making scope, and promoting top-down changes in organisational members' perceptions, so as to implement ESG development strategies that are conducive to the long-term development of the enterprise, and to enhance the ESG performance of the enterprise.

Therefore, this paper proposes the following hypothesis:

H2: Qualifying other conditions, there is a positive relationship between executive's equity incentives and corporate ESG performance.

2. Research design

2.1 Data source

In this study, all A-share listed companies from 2013–2022 are selected as the research sample. The ESG data are based on the rating results provided by the China Securities ESG Evaluation System, which is obtained from the Wind database. All remaining data was obtained from CSMAR and CNRDS databases. Financial, ST/*ST and firms with less than three years of listing were excluded from the sample. To eliminate the influence of extreme values on the results, continuous variables were scaled down at the upper and lower 1% levels. Stata 17.0 software was used for data processing.

2.2 Variable descriptions

Explained variables. Corporate ESG performance (ESG). We refer to the study of Wang et al. (2022) and adopt the ESG scores published by the China Securities ESG evaluation system as the explanatory variable. The ratings of "AAA, AA, A, BBB, BB, B, CCC, CC, C" are assigned from 9 to 1.

Explanatory variables. The explanatory variables of this paper are executive incentives,

which are divided into executive monetary compensation incentives (Top_3) and executive equity incentives ($Comp$). Monetary compensation is the most direct form of executive incentive, which directly reflects the recognition and incentive strength of the company's contribution to the executive. The top three senior executives usually include the core management, such as the CEO and CFO, who occupy a key position in the company's decision-making and operation and have an important impact on the company's performance. Therefore, the top three executives with more representative executive compensation are selected. Referring to the studies of Weng and Ma (2022), monetary compensation incentive (Top_3) is measured by using the natural logarithm of the total compensation of the top three senior executives of listed companies. The proportion of company shares held by executives directly reflects the degree of alignment between their interests and those of the company. A higher shareholding ratio indicates a stronger correlation between executives' benefits and the company's performance. Given that equity incentives are not widely implemented in Chinese listed companies and are primarily granted to key executives, we chose to measure the total shareholding ratio of all executives in listed companies. This approach ensures data availability and eliminates the impact of company size. Therefore, the equity incentive ($Comp$) is measured by using the number of shares held by senior executives of listed companies as a proportion of the total number of shares in the enterprise.

Control variables. To better measure the actual impact of executive incentives on corporate ESG performance, we account for the impact of following control variables: corporate size ($Size$), debt level (Lev), growth capacity ($Growth$), profitability (RoA), operational capacity ($Operat$), equity concentration ($Shrhold$), sole director ratio ($LnDrcRat$), board size ($Lnboard$), and age at IPO (Age). In addition, a year dummy variable ($Year$) and an industry dummy variable ($Industry$) are also included. The main variables in this paper are defined in Tab. 1.

2.3 Model construction

Since the explanatory variable ESG is a discrete ordered variable, this study employs the Ologit multiple ordered regression model based on the cumulative distributed Logit

Tab. 1: Definition of main variables

Variable type	Variable name	Variable symbols	Variable description
Explained variables	ESG score	<i>ESG</i>	Corporate ESG performance
Explanatory variables	Executive monetary compensation incentives	<i>Top₃</i>	Ln(total compensation of top three executives)
	Executive equity incentives	<i>Comp</i>	Cumulative number of shares held by executives/total number of shares
Control variables	Enterprise size	<i>Size</i>	Ln(total assets)
	Growth capacity	<i>Growth</i>	(operating income current period amount – operating income previous period amount)/ (operating income previous period amount)
	Profitability	<i>Roa</i>	Net profit/total assets
	Operating capability	<i>Operat</i>	Sales revenue/total assets
	Shareholding concentration	<i>Shrhold</i>	Shareholding ratio of the largest shareholder
	Proportion of sole directors	<i>LnDrcRat</i>	Number of independent directors/number of directors
	Board size	<i>Lnboard</i>	Ln(number of board of directors)
	Business age	<i>Age</i>	Ln(current year – year the company went public + 1)

Source: own

technique to test hypothesis *H1* and hypothesis *H2*, as follows.

$$ESG = \beta_0 + \beta_1 Exincentives + \sum Controls + \sum Year + \sum Individual + \varepsilon \tag{1}$$

where: *ESG* – the explanatory variable for corporate ESG performance; *Exincentives* – the explanatory variable for executive incentives, divided into monetary compensation incentives (*Top₃*) and equity incentives (*Comp*); and *Controls* represents the set of control variables.

3. Empirical results and analysis

3.1 Descriptive statistics

Tab. 2 shows the descriptive statistics of the main variables in this study. The mean value of ESG performance of enterprises is 4.077 and the standard deviation is 1.133, with the minimum value of 1.000 and the maximum value of 8.000, indicating that there are

differences in ESG performance among different enterprises. However, the average rating is between B and BB, and the overall level still needs to be improved. The standard of the core explanatory variable executive monetary compensation incentive (*Top₃*) is 0.083, indicating that the gap between the executive compensation of the sample companies is small and the distribution is reasonable. The standard deviation of executive equity incentive (*Comp*) is 7.213, and there are about 27% of firms with zero shareholding, indicating that the level of equity incentive varies widely among different companies. The equity incentive policy has not yet been implemented or the level of equity incentive is very low in a considerable number of companies in China.

3.2 Baseline regression results

The regression results are shown in Tab. 3. The results in column (1) show that the regression coefficient of executive monetary compensation incentives (*Top₃*) is significantly positive

Tab. 2: Descriptive statistics of variables

Variable	Observations	Mean	Std. dev.	Min	Max
<i>ESG</i>	29,988	4.077	1.133	1.000	8.000
<i>Top₃</i>	30,809	0.076	0.083	0.001	0.476
<i>Comp</i>	29,801	0.070	0.136	0.000	0.594
<i>Size</i>	30,864	22.279	1.322	19.724	26.352
<i>Growth</i>	30,864	0.433	0.209	0.061	0.955
<i>Roa</i>	30,808	0.384	1.049	-0.790	7.491
<i>Operat</i>	30,864	0.030	0.075	-0.360	0.201
<i>Shrhold</i>	30,861	0.594	0.407	0.054	2.463
<i>LnDrcRat</i>	30,864	33.426	14.751	8.260	73.560
<i>Lnboard</i>	30,862	0.378	0.054	0.333	0.571
<i>Age</i>	30,864	2.251	0.206	1.792	2.944

Source: own

Tab. 3: Executive incentives and corporate ESG performance – Part 1

	(1)	(2)	(3)
	<i>ESG</i>	<i>ESG</i>	<i>ESG</i>
<i>Top₃</i>	0.432**		0.390**
	(2.400)		(2.130)
<i>Comp</i>		0.400***	0.404***
		(4.620)	(4.660)
<i>Size</i>	0.497***	0.477***	0.494***
	(36.870)	(41.860)	(35.560)
<i>Growth</i>	-0.058***	-0.055***	-0.054***
	(-4.890)	(-4.470)	(-4.440)
<i>Roa</i>	5.437***	5.479***	5.438***
	(29.250)	(29.080)	(28.720)
<i>Operat</i>	-0.012	-0.010	-0.014
	(-0.380)	(-0.310)	(-0.440)
<i>Shrhold</i>	0.004***	0.004***	0.004***
	(5.360)	(4.830)	(4.970)
<i>LnDrcRat</i>	3.297***	3.192***	3.153***
	(13.890)	(13.250)	(13.060)
<i>Lnboard</i>	0.426***	0.441***	0.422***
	(6.750)	(6.900)	(6.570)

Tab. 3: Executive incentives and corporate ESG performance – Part 2

	(1)	(2)	(3)
	ESG	ESG	ESG
Age	-0.417***	-0.396***	-0.393***
	(-25.230)	(-22.210)	(-21.990)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
N	29,897	28,934	28,891
Wald Chi ²	5,948.500	5,661.080	5,668.770
Pseudo – R ²	0.072	0.071	0.071

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; Z statistics are given in parentheses.

Source: own

at the 1% significance level, which indicates that the executive compensation incentives play both a motivating and compensatory role. They alleviate executives' concerns, encouraging them to dedicate more effort to the company's management activities. This, in turn, motivates executives to adopt ESG development strategies that benefit the company in the long term. Column (2) shows that the regression coefficient of executive equity incentives (*Comp*) is significantly positive at a 1% significance level, which indicates that the equity incentives align the personal interests of company employees with those of the company, enhancing executives' sense of responsibility and engagement in corporate governance. This, in turn, positively impacts the corporate ESG performance. Column (3) shows the regression results after including both compensation incentive in model (1). The regression coefficients of both *Top₃* and *Comp* are significantly positive at the 1% level of significance, indicating that executive monetary compensation incentives and equity incentives do not negatively affect each other. This suggests that it is feasible for a company to implement both types of incentives simultaneously.

3.3 Robustness check

In order to increase the reliability of the findings of this paper, the following robustness tests are conducted.

The measure of the executive monetary compensation incentive indicator is replaced

with the natural logarithm of total senior management compensation (*Top₁*), and the measure of the executive equity incentive indicator is replaced with the ratio of the number of shares held by senior management to the total number of shares in the firm (*Comp₁*). The regression results are shown in columns (1–2) of Tab. 4. The correlation coefficient of *Top₁* and *Comp₁* are both significantly positive, which verifies the core hypothesis of this paper is robust.

Considering the lagged effect of executive incentives on corporate ESG performance, in order to avoid the possible endogeneity problem on the findings of this paper, the lagged one-period regressions of executive monetary compensation incentives (*L.Top₃*) and executive equity incentives (*L.Comp*) are used. The regression results are shown in Tab. 4. The positive relationship between executive monetary compensation incentives and corporate ESG performance remains significant.

The empirical testing process in this paper may suffer from endogeneity due to mutual causality. On the one hand, firms' incentives to executives affect firms' ESG performance, on the other hand, firms with better ESG performance are more inclined to improve incentives to senior executives. Therefore, this paper draws on the studies of Li et al. (2020) to select the mean value of executive monetary compensation incentives (*mTop₃*) and the mean value of executive equity incentives (*mComp*) in their industries and provinces as instrumental variables for the 2SLS test, respectively. In this

Tab. 4:

Executive incentives and corporate ESG performance – results of substitution variables and lagged one-period tests

	(1)	(2)	(3)	(4)
	ESG	ESG	ESG	ESG
<i>Top₁</i>	0.169*** (8.540)			
<i>Comp₁</i>		0.020*** (10.720)		
<i>L.Top₃</i>			0.676*** (3.540)	
<i>L.Comp</i>				0.277*** (3.030)
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>N</i>	29,879	28,934	26,403	25,531
<i>Wald Chi²</i>	6,045.970	5,763.520	5,282.650	4,949.310
<i>Pseudo – R²</i>	0.073	0.072	0.072	0.070

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; Z statistics are given in parentheses.

Source: own

paper, these two indicators are selected as instrumental variables because, first, they satisfy the requirement of correlation. The external macroeconomic environment and internal management characteristics of listed enterprises in the same industry and province are somewhat similar, thus the level of executive incentives of one enterprise is correlated with the average level of executive incentives in the same industry and province. Second, satisfying the exogeneity requirement, the averages within the same industry and province do not affect the ESG performance of individual firms.

Tab. 5 presents the regression results using two-stage least squares with instrumental variables. The first-stage results in columns (1) and (3) show that the regression coefficients for the instrumental variables *mTop₃* and *mComp* are both significantly positive, and the Kleibergen-Paap rk LM statistics both reject the original hypothesis, and the Kleibergen-Paap rk Wald F-statistics are all greater than the critical value of the Stock-Yogo weak instrumental variable identification F-test at the 10% significance level, which means the selected instrumental variables are all valid.

The results of the second stage in columns (2) and (4) show that the regression coefficients of the *mTop₃* and the *mComp* are both significantly positive, indicating that executive incentives can still significantly improve corporate ESG performance after eliminating the reciprocal causality problem. Thus, the core findings of this paper remain robust.

3.4 Mechanism of action

Corporate ESG performance is influenced by executives' strategic choices because executives have a decisive influence on the strategic decisions of the firm. If executives' strategic choices are more aggressive, then firms are more likely to engage in aggressive ESG practices. For example, executives may choose to invest more resources in product development to develop environmentally friendly products or reduce pollution emissions from production processes, among other measures. It has been seen that managers largely influence firms' strategic direction of an enterprise. Moreover, implementing incentives for executives makes them motivated to put in more effort to drive strategic change (Olaoye, 2024).

Tab. 5: Executive incentives and corporate ESG performance – instrumental variables

	(1)	(2)	(3)	(4)
	<i>Top₃</i>	<i>ESG</i>	<i>Comp</i>	<i>ESG</i>
<i>mTop₃</i>	0.501***			
	(39.350)			
<i>Top₃</i>		1.115***		
		(3.640)		
<i>mComp</i>			0.780***	
			(55.600)	
<i>Comp</i>				0.489***
				(3.580)
Kleibergen – Paap rk (LM)	1,102.739***		1,882.058***	
Kleibergen – Paap rk (Wald F)	1,548.677		3,091.637	
	(16.380)		(16.380)	
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>N</i>	29,897	29,897	28,934	28,934
<i>F/Wald Chi²</i>	216.010	7,143.130	152.790	6,791.180
<i>Adjusted R²</i>	0.533	0.194	0.351	0.193

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; *T* statistics are given in parentheses.

Source: own

In addition, executives may enhance ESG performance by adopting employee welfare initiatives and promoting community benefit activities to improve corporate performance in social responsibility. However, strategic change is a high-risk game that requires companies to make decisions that involve huge risks, such as increasing investment in product development, upgrading industrial chains, and adjusting market targets, which means that executives who make and execute strategic decisions undertake substantial risks. This includes describing specific risk dimensions in terms of key elements affecting corporate strategy such as strategic decision-making, strategic execution and strategic resources (Ross, 2014).

Based on Bentley et al. (2013) research on corporate strategic change, we calculate the following six indicators: R&D expenditure as a percentage of sales revenue, the ratio

of employees to sales revenue, the historical growth rate of sales revenue, sales and administrative expenses as a percentage of sales revenue, employee turnover, and the proportion of net fixed assets to total assets. The specific calculation process is as follows. First, compute the moving averages for these six indicators. Then, rank the indicators by year and industry, dividing them into five groups based on their rank in ascending order. The smallest group receives 0 points, the next smallest receives 1 point, and so on, with the fifth group receiving 4 points. For the proportion of net fixed assets to total assets, the scoring is reversed, with the smallest group receiving 4 points and the largest group receiving 0 points. Finally, the six indicators of each sample enterprise are added together, and the sum of the indicators is the enterprise strategy variable. The range of values is between 0 and 24, with larger

values representing more aggressive corporate strategy and smaller values representing more conservative corporate strategy. The results are shown in columns (3–4) of Tab. 6. The regression coefficients of executive monetary compensation incentive (Top_3) and executive equity incentive ($Comp$) are both significantly positive, indicating that executive incentive enhances the strategic aggressiveness of executives to promote innovation and change and ESG practices.

Drawing on the study by Li and Shen (2020), the patent search system of the State Intellectual Property Office of China and the China Research Data Service Platform were used to obtain the green patents obtained by listed companies, and the sum of the number

of green inventions and green utility models obtained independently and jointly by the sample companies was obtained, and the total number of green patents obtained by the sample companies was used as the corporate green technological Innovation (GP). The results are shown in columns (3–4) of Tab. 6. The regression coefficients of executive monetary compensation incentive (Top_3) and executive equity incentive ($Comp$) are both significantly positive, indicating that executive incentives encourage companies to increase investment in green technology innovation, promoting healthy and sustainable development. This, in turn, further optimizes the enterprise's ESG management performance and enhances corporate ESG performance.

Tab. 6:

Executive incentives and corporate ESG performance – a mechanistic test of corporate strategic change and green technological innovation

	(1)	(2)	(3)	(4)
	<i>Strategy</i>	<i>Strategy</i>	<i>GP</i>	<i>GP</i>
<i>Top₃</i>	1.908***		0.685***	
	(4.260)		(9.100)	
<i>Comp</i>		2.641***		0.114***
		(11.980)		(2.770)
<i>Controls</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>Industry</i>	Yes	Yes	Yes	Yes
<i>N</i>	22,969	22,168	30,579	29,593
<i>Adj – R²</i>	0.248	0.252	0.385	0.382

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; Z statistics are given in parentheses.

Source: own

3.5 Further analysis

Due to the special property rights nature and governance structure of SOEs, the effect of executive incentives on corporate ESG performance may differ somewhat under different ownership nature. On the one hand, the soft budget constraint problem and multi-level principal-agent relationship are created by the characteristics of state ownership. The soft budget constraint weakens the executive compensation-performance sensitivity, and the multi-level principal-agent relationship leads to the owner deficiency problem, which makes executives

more sensitive to political promotion incentives, thus weakening the promotion effect of executive compensation and equity incentives on corporate ESG performance. On the other hand, the advantages of state-owned capital in policy, capital, and technology confer higher compensation incentives to executives, further increasing their level of risk-taking and strengthening their willingness to invest in strategic ventures. Thus, the relationship between compensation incentives and corporate ESG performance presents different characteristics among firms with different ownership properties.

To examine the role and influence of different ownership natures in the relationship between executive incentives and corporate ESG performance, this paper introduces state holding as a moderating variable in the regression model, with state holding taking the value of 1 and non-state holding otherwise taking the value of 0. Based on model (1), the interaction term $Soe \times Top_3$ of executive monetary compensation incentive and enterprise ESG score and the interaction term $Soe \times Comp$ of executive equity incentive and enterprise ESG score are introduced. The regression results are shown in columns (1–2) of Tab. 7.

The regression coefficients of the interaction term $Soe \times Top_3$ and $Comp \times Top_3$ in columns (1–2) are both significantly positive, indicating that state-owned holding plays a negative moderating role in the process in which executive compensation and equity incentive affect ESG performance of enterprises. This may be because, compared to private enterprises, SOEs are often controlled or influenced by the government. As a result, the incentive mechanisms for executives in SOEs are more influenced by political considerations than market-oriented economic factors. The government imposes stricter regulations on the implementation of equity incentives in state-owned enterprises. Consequently, executives may prioritize achieving government-set economic goals while neglecting ESG factors. Additionally, executives in SOEs typically prioritize higher political status and stable career prospects over performance-based incentive mechanisms driven by market competition.

Corporate pollution level. In the context of green and low-carbon development, heavy-polluting enterprises are expected to receive higher disclosure in terms of environmental protection and social responsibility due to their high energy consumption and pollution and their motivation to improve their ESG performance is stronger. On one hand, environmental regulations are more stringent for heavily polluting enterprises, and the implementation of carbon trading policy makes the cost of environmental regulations for heavily polluting enterprises far greater than the benefit of rough development. On the other hand, compared with non-heavily polluting enterprises, the public is more sensitive to the environmental performance of heavily polluting enterprises. Hence, heavily polluting enterprises need to maintain their

legal status through ESG disclosure. Under the Porter hypothesis of the “push-back” effect, shareholders as principals will be more active in motivating executives to carry out green innovation activities. Therefore, we expect that executive’s motivation will have a stronger effect on ESG performance in the heavily polluting enterprises.

The regression results are shown in columns (3–4) of Tab. 7. While the regression coefficient of the interaction term $Hp \times Top_3$ is significantly positive, the regression coefficient of the interaction term $Hp \times Comp$ in column (4) is insignificant. We consider the reason for these results to be that the ESG practices of heavily polluting enterprises require long-term investment and governance far exceeding that of non-heavy polluting enterprises, with higher associated risks. Unlike monetary compensation incentives, which directly increase executives’ risk-taking levels, the synergistic benefits of equity incentives do not provide immediate motivational effects for executives in the short term. On the contrary, these incentives may trigger self-protective behaviors in executives, leading them to adopt more conservative strategies, thereby inhibiting the positive impact of equity incentives on the company’s ESG performance.

Superior corporate ESG performance can effectively reduce a firm’s litigation risk and idiosyncratic risks. First, through positive ESG performance, companies can improve their reputation and enhance the trust of consumers and investors, thus reducing their exposure to litigation. Moreover, companies with superior ESG performance usually have better governance structures. An effective governance structure can prevent misconduct and corruption within the company, thus reducing the company’s risk of facing litigation. Finally, Reber et al. (2022) document that ESG disclosure helps to reduce information asymmetry between firms and investors after going public, build strong reputation, and make firms face less idiosyncratic risks. At the same time, firms with superior ESG performance are more likely to take measures to improve energy efficiency and through the use of renewable energy alternatives. Such firms will also pay more attention to employee’s welfare, social responsibility, optimize corporate governance, and reduce the likelihood of excessive risk for the firm.

Tab. 7:

Executive incentives and corporate ESG performance – a mechanistic test of corporate strategic change and green technological innovation

	(1)	(2)	(3)	(4)
	ESG	ESG	ESG	ESG
Top₃	0.617*** (3.120)		0.133 (0.670)	
Comp		0.650*** (7.060)		0.387*** (3.890)
Soe	0.442*** (11.920)	0.401*** (12.870)		
Hp			-0.218** (-2.410)	-0.127 (-1.440)
Soe × Top₃	-1.500*** (-4.610)			
Soe × Comp		-1.924*** (-5.740)		
Hp × Top₃			1.002*** (3.140)	
Hp × Comp				-0.044 (-0.250)
Controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	28,654	27,728	29,592	28,636
Wald Chi²	5,765.920	5,499.280	5,861.570	5,576.060
Pseudo – R²	0.072	0.071	0.072	0.070

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; Z statistics are given in parentheses.

Source: own

Therefore, effective executive incentives can enhance corporate ESG performance and further influence corporate litigation risk and corporate idiosyncratic risk. Drawing from the work of Hu et al. (2019), litigation risk (*Litiamount*) is measured by dividing the firm's last year's litigation amount by its total assets. Corporate idiosyncratic risk (*Idiosyncratic_{risk}*) is measured by using individual stocks' standard deviation of weekly excess returns, following Zhao et al. (2020) and others. The specific test results are

shown in column (1) and column (2) of Tab. 8. The regression coefficients of ESG with *Litiamount* and *Idiosyncratic_{risk}* are both significantly negative, which implies that the economic effect of executive incentives on corporate ESG performance can improve corporate governance, enhance overall risk management capabilities, and boost sustainable development. This, in turn, enhances the company's reputation, reduces the likelihood of litigation, and effectively prevents the occurrence of special risks.

Tab. 8: ESG performance and enterprise risk – litigation risk and idiosyncratic risks

	(1)	(2)
	<i>Litiamount</i>	<i>Idiosyncratic_{risk}</i>
ESG	–0.013***	–0.001***
	(–17.600)	(–19.290)
Controls	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
N	29,945	29,934
F	0.115	0.464
Adjusted R²	10.114	336.672

Note: ***, **, * represent significance at the level of 1, 5, and 10%, respectively; T statistics are given in parentheses.

Source: own

Conclusions

With the implementation of green and low-carbon development strategy in China, actively practicing ESG policies has become the consensus of enterprises. We empirically examine the effects and mechanisms of executive incentives on corporate ESG performance by using Chinese A-share listed enterprises from 2013–2022 as the research sample. Empirical testing shows that, first, monetary compensation incentives generate both incentive and compensatory effects, while equity incentives align the interests of executives and shareholders. Both types of incentives significantly enhance the corporate ESG performance without negatively affecting each other, and the robustness of these results remains consistent. Furthermore, corporate strategic change and green technology innovation act as mediators between executive incentives and corporate ESG performance. Implementing incentives for executives increases their strategic aggressiveness, prompting them to initiate strategic changes. At the same time, it leads executives to focus more on green technology innovations that are beneficial for the company in the long run, maintaining its sustainable development. Lastly, due to the higher level of salary constraints in state-owned enterprises, the effectiveness of implementing executive incentives in these firms is relatively low. In heavily polluting enterprises, where ESG governance costs are higher, there is a stronger inclination to enhance

the more direct effects of executive monetary compensation incentives. In terms of economic outcomes, excellent ESG performance can improve corporate governance, boost the company's reputation, and consequently reduce litigation risk and idiosyncratic risk.

Based on the findings and conclusions of this study, the following countermeasures are proposed: the government should improve the ESG information disclosure system and guidelines, formulate relevant laws, regulations and policies to regulate the content and requirements of ESG information disclosure. Furthermore, relevant policymakers should establish a regulatory mechanism for information disclosure to supervise the disclosure behavior of Chinese companies and penalize violations to increase the publicity on ESG performance.

We investigate the effects and the influence mechanism of executive incentives on ESG performance, as well as the heterogeneity and ESG effect under different scenarios. However, there are still some shortcomings which could be addressed by future studies. With the development of ESG concept, more and more companies now link executive incentives with ESG performance. Currently, firms disclose limited information on executive incentives linked to ESG performance. Future studies can explore the reasons behind this and identify ways to encourage more comprehensive reporting. Investigating the association between executive incentives and ESG performance

across Western and Chinese firms would be an interesting avenue for further research.

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Do women get into less debt? Gendered local political performance in the EU

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Abstract: Gender differences in local financial management are, according to empirical grounds, a reality that predetermines differences in the fiscal performance of municipalities led by women and men. The position of women leaders in public administration and their influence on sources of income, the nature of expenses, and the level of indebtedness have been a popular research issue in recent years, but it includes an almost unexplored gender dimension that needs deeper analysis. For this reason, the main aim of the paper is to examine the relationship between women's representation in local politics (mayor and councilors) and local indebtedness, emphasizing the assumption about observed better fiscal discipline in municipalities led by female local authorities. The econometric estimations based on the panel data approach are conducted on the sample of twenty-seven European Union countries in the period 2011–2021 using the share of female mayors and female local councilors as explanatory variables. Further, we test the effects of the moment of the EU accession and the degree of fiscal decentralization to offer deeper insights into the problem. Results support the assumption of an inverse relationship between female mayors and local indebtedness, while female local councilors do not cause any statistically significant impact on local indebtedness. Other results show that the number of women in local politics and the degree of fiscal decentralization are important to consider when examining this relationship.

Keywords: Female mayor, female councilors, European Union, indebtedness, local governments.

JEL Classification: J16, H70, H74.

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Introduction

Across all the countries of the European Union (EU), the debts of local governments arise due to the need for political authorities to respond to the basic needs and demands of their residents related to public goods and public services. Indebtedness of local governments

is one of the basic indicators expressing the performance of the local financial management, for which the state level is not directly responsible, but usually monitors and limits it (Maličká, 2017).

The local indebtedness of the EU countries and its reasons are discussed by many

authors (Basílio & Borralho, 2022; Bröthaler et al., 2015; Cornille et al., 2022; Frouté, 2021; Galiński, 2023a; Lentner, 2014; Simionescu & Cifuentes-Faura, 2023; Zabler, 2021). When considering local indebtedness determinants, only minor attention is dedicated to the factor of gender perspective, even though it is proven that women and men have different attitudes toward political decision-making (Baiman, 1990; Cabaleiro-Casal & Buch-Gómez, 2018; Gómez-Miranda et al., 2022; Kim & Shim, 2003; Krogstrup & Wälti, 2011; McGregor, 1960; Rodríguez et al., 2018; Weikart et al., 2006). The limited empirical evidence in local indebtedness indicates that women in decision-making tend to be risk averse. This may lead to better fiscal discipline in a locality, thus lower local indebtedness (Balaguer-Coll & Ivanova-Toneva, 2021; Cabaleiro & Buch, 2024; Cuadrado-Ballesteros et al., 2022, 2023; Hernández-Nicolás et al., 2018; Suzuki & Avellaneda, 2017). Hence, the gender-based literature works with the assumption about the inverse relationship between women's representation in local politics and local indebtedness in favor of higher women's representation in politics. Besides, the European Institute for Gender Equality (EIGE) promotes gender-sensitive governments regarding gender equality as a fundamental value in the EU and points to a wide space of improvements possible to perform in many EU countries (e.g., Hungary, Slovakia) (EIGE, 2024a).

Within the EU, the gender-based research on local indebtedness is a domain of a couple of countries, e.g., Spain (Balaguer-Coll & Ivanova-Toneva, 2021; Cabaleiro-Casal & Buch-Gómez, 2020; Cabaleiro & Buch, 2024; Cuadrado-Ballesteros et al., 2022, 2023; Gómez-Miranda et al., 2022) and Portugal (Brusca et al., 2015). Similar studies conducted on a sample of municipalities of other EU countries or at the level of the EU are rather unavailable. The lack of systematic research on gender stereotypes when considering the local fiscal performance in terms of local indebtedness and assumptions about different attitudes towards gendered decision-making have motivated us to conduct the research that contributes to the topic in question. Moreover, gender stereotypes in political decision-making have typically been analyzed at the national level or within individual countries and there is a noticeable gap in the literature when it comes to examining this relationship at the local government level across multiple countries.

The paper examines the relationship between women's representation in local politics and local indebtedness using the panel data approach. The analysis is conducted on a sample of twenty-seven EU member countries for the period from 2011 to 2021. When testing the assumption about the inverse relationship between women's representation in politics and levels of indebtedness, we employ the indicators expressing the share of women in the post of mayors and councilors of local governments. In the sub-analyses conducted to offer more insights into the problem, we refer to the EU's heterogeneity. We take into account a level of women's representation in local politics, inspired by Cuadrado-Ballesteros et al. (2022) and Cuadrado-Ballesteros et al. (2023), discussing how many women are enough, and we divide the sample of EU countries into countries with lower and higher levels of women's representation in local politics than EU's average. Next, referring to the observed heterogeneous nature of the EU when considering the EU member countries (Cabaleiro & Buch, 2024; Horváthová et al., 2012; Maličká et al., 2017), we provide further analysis of the sub-samples of EU countries. We consider the moment of the EU accession that points to the different economic circumstances within the EU, and the degree of fiscal decentralization, which points to the different extensions of the local public sector in the EU countries. In this case, new EU members are young democracies that overcame a transition in recent decades. The degree of fiscal decentralization refers to fiscal autonomy granted to local governments and varies across EU countries.

This paper expands the field of scientific studies focusing on the influence of women representatives in local politics on local indebtedness. This paper offers a novel perspective on this relationship, considering the EU's area, which is one entity but heterogeneous inside. This study not only contributes to the existing body of gender-based literature but also provides valuable insights into the fiscal implications of gender diversity at the local level across the EU.

The paper is organized in the following structure. After the Introduction, the Theoretical background summarizes related theories, provides a literature review of results of similar research, and presents research questions and hypotheses. The section on Research

methodology deals with employed methods and selected data entering the estimated models. The section on Results presents the main findings achieved in the context of empirical foundations. The Discussion section discusses the research findings and offers policy recommendations. The paper ends with the Conclusions, which present limitations, problematic areas of research, and future research.

1. Theoretical background

Worldwide, ongoing research on public debt is thus one of the focal points of the public finance literature (Alesina & Perotti, 1995; Ambrose et al., 2015; Cifuentes-Faura & Simionescu, 2023; Elgar, 2002; Roubini & Sachs, 1989). Worldwide, local indebtedness is one of the focal points of the literature on local public finance, e.g., New Zealand (Ehalaiye et al., 2017), China (Mingyao et al., 2022), USA (Davidson et al., 2021), Brasilia (Soares & Gonçalves, 2022). Local indebtedness focusing on EU countries is examined in, e.g., Flanders (Ashworth et al., 2005), Hungary (Kovács & Stion, 2013; Lentner, 2014), Austria (Bröthaler et al., 2015), Slovakia (Maličká, 2017), Germany (Micheli, 2020; Zabler, 2021), France (FROUTÉ, 2021), Portugal (Basílio & Borralho, 2022), Spain (Simionescu & Cifuentes-Faura, 2023), Belgium (Cornille et al. 2022), Poland (Galiński, 2023a), and the EU (Galiński, 2023b).

The debt incurred by local governments is a complex issue with numerous advantages and disadvantages. Proper use of borrowing can support economic development, but it must be approached cautiously to avoid excessive debt burdens and financial challenges in the future (Ehalaiye et al., 2017). Borrowing allows the costs of long-term projects to be spread across both current and future taxpayers, preventing an excessive burden on current budgets. In emergencies, such as natural disasters or unexpected expenses, loans can also provide the necessary funds for rapid response and recovery, and also, loans can help support economic development and community growth by creating jobs and improving the quality of life for residents. Of course, going into debt also has disadvantages, including a high debt burden, limiting financial flexibility, and increasing the risk of default. Loans come with interest costs, which can significantly increase overall expenditures over time (Bröthaler et al., 2015; Maličká, 2017).

Referring to the assumptions of the concept of the common pool problem (Blom-Hansen, 2010; Fritz & Feld, 2020), increased public budget deficits and debts might originate from the political vulnerability of governments (Ashworth et al., 2005; Roubini & Sachs, 1989). Several factors influence governments' vulnerability, including local governments with local debts. Among them are also gender-based reasons affecting local governments' fiscal performance, such as social stereotypes about preferences in decision-making (Cabaleiro-Casal & Buch-Gómez, 2018; Gómez-Miranda et al., 2022; Holman, 2017; Kim & Shim, 2003; Krogstrup & Wälti, 2011; Rodríguez et al., 2018; Weikart et al., 2006).

1.1 Gender stereotypes in political decision-making

Several theories cover and explain gender stereotypes in political decision-making. They work with assumptions introduced by papers on different leadership and management styles and the factors that determine them. McGregor (1960) discusses Theory X and Theory Y about managers' behavior and promotes a shift toward a collaborative leadership style looking beyond self-interests. The Agency Theory, discussed by Baiman (1990), works with a factor of different attitudes of managers toward risk-taking. Tackling gender differences when considering common good and risk-aversion, papers on biological and psychological characteristics of women and men provide us with a clear insight into this problem (e.g., Archer, 2019). Common interest and risk aversion are characteristic of women (Archer, 2019; Borghans et al., 2009; Byrnes et al., 1999). Implications of such a characteristic of women when being leaders in local politics are that women tend to be people-oriented and emphasize the common good. It influences their political decisions in the field of public spending. Besides, as mentioned by Gómez-Miranda et al. (2022), voters might in the term of elections reward engaged local politicians interested in the community, manage public resources efficiently, and avoid financial risk. As observed, e.g., by Kim and Shim (2003), Rodríguez et al. (2018), Cabaleiro-Casal and Buch-Gómez (2018), and Gómez-Miranda et al. (2022), these theories are supported by the empirical evidence. The main theoretical concept of this paper is built up on the crucial role of the attitudes toward common

interest and the risk-aversion of women that prevents local governments headed by women mayors from over-indebtedness and thus leads to better fiscal discipline in these localities.

In the relevant literature, the research considers the abovementioned theories and derives several observations in this field. Anzia and Bernhard (2022) point out that women prefer to deal with areas of local government that are not related to the enhancement of economic development. Anessi-Pessina et al. (2016) and Funk and Philips (2019) confirmed that the mayor's gender influences public spending and tax collection. On the other hand, according to empirical results that local governments with women leaders show lower levels of debt, other research (e.g., Avellaneda et al., 2022) shows that women have a positive effect on the fiscal performance of local governments. It is confirmed by the Canadian Institute of Chartered Accountants (2009) and the International Federation of Accountants (2018), who claim that a higher tendency to increase public spending and increase taxes among women in leading positions of local governments is connected with the assumption, that the fiscal performance hinges on whether political institutions generate sufficient revenue to meet citizens' demands for services and capital without significantly escalating debt. Krogstrup and Wälti (2011) point to the fact that women are naturally more caring and place more emphasis on protecting their family members and future generations, which the author associate with the fact that women want to minimize budget deficits and debt levels in order not to create new debts or deepen existing debts for future generations, for their descendants.

In the context of the paper's focus, the relationship between women's representation in politics and public debt, considering the local level of the government is examined, assuming the negative effect of local female authorities on local indebtedness. Given that expectation is based on the risk aversion characteristic for women, as discussed by Krogstrup and Wälti (2011) and Cabaleiro-Casal and Buch-Gómez (2018). At the local level, being women the local authorities, their risk aversion might contribute to a better fiscal discipline, which in terms of local indebtedness means lower local debts (Balaguer-Coll & Ivanova-Toneva, 2021; Cuadrado-Ballesteros et al., 2023; Hernández-Nicolás et al., 2018). The literature on gender

perspectives in local indebtedness works with this assumption. However, this paper offers further insights into this relationship, considering the EU's area, which is one entity but heterogeneous inside.

1.2 Literature review

The gender-based literature on political decision-making mentions, assumes, and examines several gender stereotypes related to various aspects of public finance, as well as local public finance and local public management (risk aversion, corruption, re-election prospects, public expenditure on social categories, fiscal discipline). When considering the topics related to local financial management, the majority of gender-oriented research deals with the area of local government revenues (Avellaneda et al., 2022; Casarico et al., 2019, 2022; Funk & Philips, 2019; Schild, 2013) and local government expenditures (Cabaleiro-Casal & Buch-Gómez, 2018; Funk & Philips, 2019; Hernández-Nicolás et al., 2018; Holman, 2015) or the effect on the nature of public spending (Funk & Philips, 2019; Hernández-Nicolás et al., 2018). Despite the numerous research about local indebtedness in the EU (Ashworth et al., 2005; Basílio & Borralho, 2022; Bröthaler et al., 2015; Cornille et al., 2022; Frouté, 2021; Galiński, 2023a, 2023b; Kovács & Stion, 2013; Lentner, 2014; Maličká, 2017; Micheli, 2020; Simionescu & Cifuentes-Faura, 2023; Zabler, 2021) the relationship between the local debt and the presence of women in leadership positions in local government is limited.

The limited literature on gender perspectives in local indebtedness usually tests the inverse relationship between women's representation in local politics and local indebtedness. Cabaleiro-Casal and Buch-Gómez (2018) focused on the municipalities of the Spanish region of Galicia, where in connection with the applied pro-cyclical policies, following the EU Stability and growth pact, and in connection with the reduced fiscal deficit, they confirmed that the mayor's gender is an explanatory variable to the way these fiscal adjustments were made. In Spain, research was also conducted in this area by Hernández-Nicolás et al. (2018), who confirmed that in the case of local governments led by women, they had lower annual interest and debt repayment obligations, which is evidence of better fiscal discipline. The relationship between the presence of women in city councils

is also negatively associated with the issuance of municipal bonds in Japan (Suzuki & Avellaneda, 2017). In their research, Balaguer-Coll and Ivanova-Toneva (2021) confirmed that female mayors headed local governments increase the probability of financial sustainability, budgetary stability, and legal debt limit. Research on reducing budgetary deficits was also processed by Cabaleiro-Casal and Buch-Gómez (2020), and Hernández-Nicolás et al. (2018). They claim that the presence of women increases debt repayment in local governments. Cuadrado-Ballesteros et al. (2023) also conducted a study where, unlike previous research (Cuadrado-Ballesteros et al., 2022), they took into account the percentage of women in the municipal council, not only the gender of the mayor, confirming that Spanish municipalities tend to show lower levels of public debt during the periods when a female mayor heads the municipality. Besides, we should notice, that the inverse relationship between indebtedness and the presence of women in leadership positions is also confirmed in the private sector by Huang and Kisgen (2013), who confirmed that female executives are less likely to issue debt compared to male executives in the corporate area. According to the findings of Gómez-Miranda et al. (2022), Spanish municipalities with women mayors are connected with a lower risk of default.

On the other hand, some studies did not confirm the relationship between gender and municipal debt. Hayo and Neumeier (2016) examined this relationship within 21 OECD countries and did not find a significant difference in this area with a connection with gender. Similar results were also obtained by other Japanese, Italian studies and a fraction of Spanish studies, which confirmed that the gender of the mayor did not affect the level of public debt (Brusca et al., 2015; Guillamón et al., 2011; Suzuki & Avellaneda, 2018).

The ambiguous effect of women in local politics on local indebtedness raised the attention of gender-based literature, focusing on the question of the sufficient level of women in politics. Cuadrado-Ballesteros et al. (2022) and Cuadrado-Ballesteros et al. (2023) discuss how many women are enough to observe improvements in local public outcomes. They warn that this relationship is present only if the share of female councilors in the municipality council is high enough. This result is based on the theory of critical mass, which states that a minority

can influence the majority only when individuals become a cooperative minority (Dahlerup, 1988). However, it is necessary to realize that the inverse relationship between the number of women in local governments and the level of debt is present only if the number of female supervisors or councilors is sufficient (Cuadrado-Ballesteros et al., 2023).

Another branch of gender-based literature discusses the differences in women's representation in politics from the point of view of economic development countries (EIGE, 2024a; Erlich & Beauvais, 2023; Sundström & Wängnerud, 2016). Different initial economic conditions within the EU are proven by, e.g., Monfort et al. (2013), Beyaert and García-Solanes (2014), and Strielkowski and Höschle (2016). When considering women's representation in local politics, Sundström and Wängnerud (2016) and EIGE (2024a) distinguish between old and new EU members (that refers to different initial economic conditions of EU countries) and observe lower levels of women in local politics in new EU member countries.

Cabaleiro and Buch (2024) discuss the possible impact of the fiscal autonomy of local governments on the relationship between women's representation in politics and local public debt, while recent studies (Horváthová et al., 2012; Maličká et al., 2017; Maličká & Martinková, 2018) point to differences in extensions of the local public sector in the EU countries. Young democracies that are new EU member states overcame a transition in recent decades and implemented public sector and public finance reforms, including fiscal decentralization, in the same vein as old EU members. Naturally, respecting the differences between countries in the EU, the degree of fiscal decentralization referring to fiscal autonomy granted to local governments varies across EU countries. As mentioned by Oates (1989), Freitag and Vatter (2008), Baskaran (2010), and Galiński (2023b), the increasing degree of fiscal decentralization affects local indebtedness.

1.3 Research questions and hypotheses development

Despite the growing body of research on gender representation and fiscal performance, there is a noticeable gap in the literature regarding the impact of female political representation on local government indebtedness across multiple countries.

Stimulated by this gap, we became moved to reply to the following research questions (RQ) and hypotheses (H).

RQ1: Do more women in local political functions improve local public finances?

Most studies have focused on national-level analyses or individual country cases, leaving the local level relatively unexplored. Therefore, this paper seeks to address this gap by examining the relationship between women's representation in local politics and local indebtedness in twenty-seven EU member countries from 2011 to 2021.

Based on findings of previous research mentioned hereinbefore that evidences the inverse relationship between women's representation in local politics and local indebtedness, we will test the following hypothesis:

H1: Higher levels of women in local politics are associated with better fiscal discipline and lower local public debt.

We expect that the presence of female local politics will show a statistically significant negative relationship with local indebtedness, supporting the notion that female leadership contributes to improved fiscal performance at the local level.

Besides the main research question *RQ1* and main hypothesis *H1*, we develop additional research questions and hypotheses to provide more insights into the problem.

Following the findings that higher women representation contributes to better fiscal outcomes only if there is "enough of women" (e.g., Cuadrado-Ballesteros et al., 2022, 2023), we consider the differences in women's representation in local politics among EU countries. We divide the sample of EU countries into countries with lower and higher levels of women's representation in local politics than the EU's average and set the second research question and hypothesis.

RQ2: Does the varying level of female representation in local politics across countries influence the inverse relationship between women in local politics and the levels of local indebtedness?

H2: The share of women in local politics higher than the EU's average is a significant moderator of the inverse relationship between women in local politics and local indebtedness.

We expect that the presence of female local politics will show a statistically significant negative relationship with local indebtedness when there are enough women in local politics.

By considering the heterogeneous nature of the EU discussed (Cabaleiro & Buch, 2024; Horváthová et al., 2012; Maličká et al., 2017; Sundström & Wängnerud, 2016), we provide further analysis of subsamples based on the EU accession moment and the degree of fiscal decentralization.

RQ3: Do different economic and fiscal arrangements in the countries influence the inverse relationship between women in local politics and local indebtedness?

This approach allows us to capture the different economic circumstances and extensions of the local public sector in the EU countries and to do so, we set the following hypotheses.

H3.1: The earlier moment of EU accession is a significant factor in the inverse relationship between women in local politics and local indebtedness.

H3.2: The higher degree of fiscal decentralization is a significant factor in the inverse relationship between women in local politics and local indebtedness.

New EU members are young democracies that have overcome a transition in recent decades. The degree of fiscal decentralization refers to fiscal autonomy granted to local governments. We expect that the presence of female local politics will show a statistically significant negative relationship with local indebtedness in old EU countries and countries with higher fiscal autonomy granted to local governments.

To test the stated hypotheses, we use panel data and employ regression analysis, with the gender perspective expressed as the share of women in the posts of mayors and local councilors.

2. Research methodology

2.1 Data, variables, and assumptions

To achieve the main goal of the research, annual data on twenty-seven EU countries were collected from publicly available databases provided by the EU – the Eurostat database and the Gender statistics database (GSD) under the EIGE. Due to data availability, the final monitored period is 2011–2021. Based on the previous research on gendered political

decision-making in the field of local indebtedness, we define an econometric model based on panel data, where local public debt is a dependent variable, while women's political representation in local governments serves as an explanatory variable.

To express the local indebtedness, we used a variable of local public debt in terms of the percentage of the GDP (Tab. 1) extracted from the Eurostat database (Eurostat, 2024).

Data on women's representation in local politics were extracted from EIGE's GSD database (EIGE, 2024b). This database posed certain limitations about the period, which started in 2011, and certain constraints in the time series. Thus, concerning limitations in the availability of the other variables, we employ data for 2011, 2013, 2015, 2017, 2019, 2020, and 2021. Two types of variables on women's representation in local politics were collected, the share of female mayors and the share of female local councilors. Similar variables expressing the women in local politics were employed by Balaguer-Coll and Ivanova-Toneva (2021), Funk and Philips (2019), Hernández-Nicolás et al. (2018) and Cuadrado-Ballesteros et al. (2023). We proceed with the assumption that local governments with a woman mayor or more woman councilors achieve lower debt levels, which has a desired effect on the fiscal performance and also on the fulfillment of the obligations related to the debt (Balaguer-Coll & Ivanova-Toneva, 2021; Cabaleiro-Casal & Buch-Gómez, 2020; Canadian Institute of Chartered Accountants, 2009; Cuadrado-Ballesteros et al., 2022, 2023; Hernández-Nicolás et al., 2018; International Federation of Accountants, 2018; Krogstrup & Wälti, 2011).

To control local indebtedness, we collected a set of variables of a financial socio-economic, demographic, and geographical nature from the Eurostat database (Eurostat, 2024), which can influence the fiscal performance at the local level of the government (Balaguer-Coll et al., 2016; Sacchi & Salotti, 2016; Suzuki & Avellaneda, 2018).

To express the business cycle, economic growth, and economic strength of the EU countries, we employ the variable based on the GDP per capita. We assume that with the growth of GDP per capita, the indebtedness of municipalities decreases. The assumption is based on research by Adam and Bevan (2005), Balaguer-Coll et al. (2016), Delgado-Téllez and

Pérez (2020), while Balaguer-Coll et al. (2016) use the variable of net savings as a proxy to the wealth accumulation level. The increasing GDP per capita generates resources to decrease indebtedness. The indicator of the GDP per capita also points to different initial economic conditions and levels of wealth, which are evident in the EU (Beyaert & García-Solanes, 2014; Monfort et al., 2013). Preliminary investigations indicated that the variable of GDP per capita in the EU is correlated with the EU accession, which also refers to different economic development among EU countries (Strielkowski & Höschle, 2016). The variable of tax revenues generated in the public sector mirrors the business cycle. Tax revenues increase in the expansion phase and present the resources contributing to decreasing the public debt. Besides, Casalin et al. (2020) mention that to ensure financial stability in terms of efficient management of public debt, tax collection must be managed efficiently.

The longevity variables are often included in the research in public finance to measure the awareness of the electorate (Katsimi & Sarantides, 2011), which increases with increasing age. According to Benito et al. (2023), an aware electorate punishes local authorities with bad economic results. As the control variable, we include the variable of median age, in which, based on the literature, we assume that the older electorate participates more intensively in local public affairs and thus engages in the activities of political authorities. The socio-economic structure of the population is expressed by the variable of dependency ratio (used, e.g., by Chortareas et al., 2016; Galiński, 2023b), which we assume that the higher this ratio is, the higher the indebtedness is, because the economically inactive population raise higher pressure on public budgets, thus generates negative effects on public finance surplus and the sustainability of local authorities, which means that increasing need of provided public services could increase the level of indebtedness (Galiński, 2023a; Hagen & Vabo, 2005; Rodríguez et al., 2016; Valkama & Oulasvirta, 2021).

Except for local indebtedness, the local fiscal performance is mirrored in local public revenues. However, higher revenue in the capital budget signalizes investments in local development (e.g., infrastructure) that mirror the capital expenditure, too (Balaguer-Coll et al., 2016).

Especially in new EU member countries, voluminous capital investments at the local level are tied to EU structural funds that require co-funding. The co-funding at the local level, where local units suffer from insufficient resources due to a limited tax base, is provided at the base of the use of returnable financial resources (Maličká, 2017; Standar & Kozera, 2020). Thus, we expect a positive relationship between local indebtedness and local public revenues.

Fiscal decentralization influences the local fiscal performance when local authorities are granted autonomy in the decision-making about the local public revenues and expenditures (Oates, 1989), as well as in the field of the use of returnable financial resources. To express

the degree of fiscal decentralization, we employ the variable of expenditure decentralization similarly to Galiński (2023b). The impact of the expenditure decentralization on local indebtedness might be two-fold. As mentioned herein localities granted higher fiscal autonomy can focus more on using returnable financial resources. It is in line with the findings of Galiński (2023b). On the contrary, Baskaran (2010) mentions that a high level of expenditure decentralization tends to significantly reduce public debt. Freitag and Vatter (2008) support his findings on the sample of Swiss cantons when more decentralized cantons of Switzerland tend to have smaller deficits during years of economic crisis.

Tab. 1: Variables and descriptive statistics

Variables	Characteristics	Source	Observations (number)	Mean	Min	Max	Std. dev.	CV
Dependent variable								
<i>Local public debt</i>	Consolidated gross public debt as % of GDP, sector S1313 (local government)	Eurostat (2024)	133	3.856	0.000	13.300	3.180	0.824
Explanatory variables								
<i>Female mayors</i>	% of female mayors/council leaders	EIGE (2024b)	189	14.063	2.500	39.000	7.841	0.557
<i>Female local councilors</i>	% of female councilors	EIGE (2024b)	184	27.697	12.400	43.700	7.414	0.268
Control variables								
<i>Local public revenues</i>	Government revenue as % of GDP, sector S1313 (local government)	Eurostat (2024)	189	10.366	0.500	35.800	7.117	0.687
<i>Tax revenues general government</i>	Total tax receipts as % of GDP, sector S13 (general government)	Eurostat (2024)	189	36.723	20.600	48.200	6.162	0.168
<i>Fiscal decentralization</i>	% of local government expenditure (S1313) on general government expenditure (S13)	Eurostat (2024)	189	22.040	0.909	66.667	13.563	0.615
<i>Urbanization</i>	Share of population in cities and towns and suburbs as % of total population	Eurostat (2024)	189	67.403	37.800	99.900	13.09	0.194
<i>LnGDPpc</i>	Natural logarithm of the GDP per capita, GDP in market prices	Eurostat (2024)	189	10.044	8.548	11.543	0.636	0.063
<i>Median age</i>	The median age of the population	Eurostat (2024)	189	41.928	34.500	47.600	2.331	0.056
<i>Dependency ratio</i>	% of the population aged less than 14 + over 65 on the population aged between 14 and 65	Eurostat (2024)	189	51.953	38.900	62.200	4.841	0.093

Source: own

From the point of dynamic changes in the demography and geography, that is evident in the EU, we employ an indicator of urbanization, where we assume that with a higher degree of urbanization, the indebtedness of local governments increases. This statement is supported by many authors since smaller cities or small villages have limited access to foreign resources Farnham (1985), Windisch (2019), and more urbanized areas need more investments in infrastructure (Galiński, 2023b).

2.2 Methods

The econometric strategy consists of standard panel data estimation techniques focusing on fixed-effect models (FEM) and random-effect models (REM). Similarly proceed, e.g., Casarico et al. (2022), Galiński (2023b). We considered the use of dynamic models (Delgado-Telléz & Pérez, 2020; Hayo & Neumeier, 2016), but the constraint posed by the incomplete period 2011–2021 has led us to not employ them. Having the unbalanced panel of twenty-seven EU countries in the period 2011–2021, we use the FEM with time effects to estimate the relationship between women's representation in local politics and local indebtedness in the EU. When researching the full sample of twenty-seven EU countries, the FEM is tested against the REM using the Hausman test (null hypothesis: GLS estimator is consistent). In the case of further division of the sample into sub-samples, the REM models cannot be estimated. In all estimations, to test the significance of the time effects, the Wald joint test on time dummies is performed (null hypothesis: no time effects).

When examining the gender perspective, we run several models. The first step of the analysis covers the full sample of twenty-seven EU countries. We estimate three baseline models with three different manners of expressing women's political representation in the local public sector. First, we employ the indicators expressing the share of women in the post of mayors; second, we employ the indicators focusing on the share of female local councilors; third, we include both indicators in the estimation. The baseline estimation follows Formula (1):

$$\begin{aligned} \text{Local public debt}_{i,t} = & \alpha_i + \beta_1 \text{Women's political representation}_{i,t} + \\ & + \sum_{j=1}^m \beta_j x_{i,t} + u_{i,t} \end{aligned} \quad (1)$$

where:

*Local public debt*_{*i,t*} as a dependent variable represents a local public debt of country *i* at time *t*; α_i – represents the constant (value of the dependent variable at zero independent variables); *Women's political representation*_{*i,t*} as an explanatory variable captures first, the share of women in the post of mayors; second, the share of female local councilors; third, both indicators of country *i* at time *t*;

$\sum_{j=1}^m \beta_j x_{i,t}$ represents the sum of coefficients (β_j) of control variables ($x_{i,t}$);

$u_{i,t}$ represents the error term.

As a robustness check, we follow the idea of Cuadrado-Ballesteros et al. (2022, 2023), that an inverse relationship between the number of women in local governments and the level of debt is present only if the number of female supervisors or the number of councilors is sufficient. For this reason, we divide the full sample into two subsamples according to the average share of female mayors in the sample. After, we run again three models for each subsample.

In the second step of the analysis, we refer to the observed heterogeneous nature of the EU when considering the different economic and local democratic circumstances of EU member countries. We provide further analysis of the subsamples of EU countries. First, we consider the moment of the EU accession referring to the year 2004, which points to the different economic circumstances within the EU; second, we consider the degree of fiscal decentralization, which points to the different extensions of the local public sector in the EU countries. Again, we run three models for each subsample.

3. Results

3.1 Results of baseline estimations

In baseline estimations, the main assumption of an inverse relationship between women's political representation at the local government level and local indebtedness is partially supported by observed results (Tab. 2). When considering the women's political representation expressed by female mayors, we observe and negative statistically significant beta coefficient supporting our expectations. The variable indicating the shares of female local councilors in the twenty-seven EU countries is not statistically significant. When including both variables in the same estimation, the variable related

Tab. 2: Results of baseline estimations

Variables	Model 1	Model 2	Model 3
Constant	9.8718*** (7.8453)	8.0887 (7.9560)	9.8066 (7.3112)
Local public revenues	0.1953** (0.0524)	0.2472** (0.0658)	0.2158*** (0.0603)
Tax revenues general government	-0.1235*** (0.0525)	-0.1228** (0.0581)	-0.1287** (0.0551)
Fiscal decentralization	0.1723*** (0.0505)	0.1688*** (0.0466)	0.1788*** (0.4722)
Urbanization	0.0128* (0.0073)	0.01798** (0.0068)	0.0175*** (0.0065)
LnGDPpc	-0.3707 (0.4488)	-0.2303 (0.5137)	-0.3786 (0.4826)
Median age	-0.2117 (0.1252)	-0.2140* (0.1225)	-0.2135* (0.1105)
Dependency ratio	0.1002*** (0.0341)	0.0873*** (0.0309)	0.0902*** (0.0294)
Female mayors	-0.0304*** (0.0110)		-0.0315*** (0.0106)
Female local councilors		0.0012 (0.0242)	0.0127 (0.0224)
R²	0.7492	0.7348	0.7503
Wald test p-value	<0.0001	<0.0001	<0.0001

Note: *** significant at 0.01, ** 0.05, and * 0.10 significance level; standard errors in parentheses; based on the results of Hausman test FEM models are used.

Source: own

to the share of female mayors is statistically significant, indicating the inverse relationship between female mayors and local indebtedness, while the variable focusing on female local councilors is not statistically significant.

In the baseline estimations, variables of a financial socio-economic, demographic, and geographical nature were included to control for local indebtedness.

Local public revenues mirroring the fiscal performance of local governments are in a positive relationship with local indebtedness, as expected, supporting findings of, e.g., Maličká (2017), and Standar and Kozera (2020). The increase in local public revenues might originate in the revenue collection focusing on financing the capital investments in the localities. With the EU enlargement since 2004, new EU members enjoy the EU funds drawing. Usually, the use of earmarked grants

is tied to co-funding, which leads to the use of returnable financial resources when localities do not have sufficient revenue to cover the investments.

When considering the effects of the business cycle, we employed GDP per capita and tax revenues generated in the public sector. We observe a negative relationship between both business cycle indicators and local indebtedness, in line with the discussion of Adam and Bevan (2005), Delgado-Téllez and Pérez (2020), and Casalin et al. (2020). Tax revenues and GDP per capita increase in the expansion phase and present the resources contributing to decreasing the public debt. However, while the variable referring to tax revenue is statistically significant, the variable expressing the GDP per capita is not statistically significant.

The variable expressing the degree of fiscal decentralization (expenditure decentralization)

is in a positive relationship with the dependent variable. Based on the assumption that higher degrees of fiscal decentralization indicate higher levels of authority and autonomy granted to local governments (Oates, 1989), and thus to more intensive use of returnable financial resources, our results support the findings of Galiński (2023b), but not the findings of Basaran (2010) and Freitag and Vatter (2008).

The variable concerning the rate of urbanization is in a positive relationship with local indebtedness. With a higher degree of urbanization, the indebtedness of local governments increases when smaller cities or small villages have limited access to foreign resources Farnham (1985), Windisch (2019), and more urbanized areas need more investments in infrastructure (Galiński, 2023b).

Variables related to the demographic and socio-economic characteristics of the population in EU countries are variables based

on the median age and dependency ratio. In the case of the median age, an expected negative relationship with the dependent variable is observed in line with the discussion and findings of Katsimi and Sarantides (2011), and Benito et al. (2023). The older electorate is supposed to be more aware. Local authorities take this into account in terms of their behavior, opportunism, and fiscal manipulation, especially when considering their re-election prospects. In the case of dependency ratio, observed results are in line with the findings of Hagen and Vabo (2005), Rodríguez et al. (2016), Valkama and Oulasvirta (2021), and Galiński (2023a). The higher the share of the economically inactive population, the higher the indebtedness, because the economically inactive population raises higher pressure on public budgets, thus generating negative effects on public finance surplus and the sustainability of local

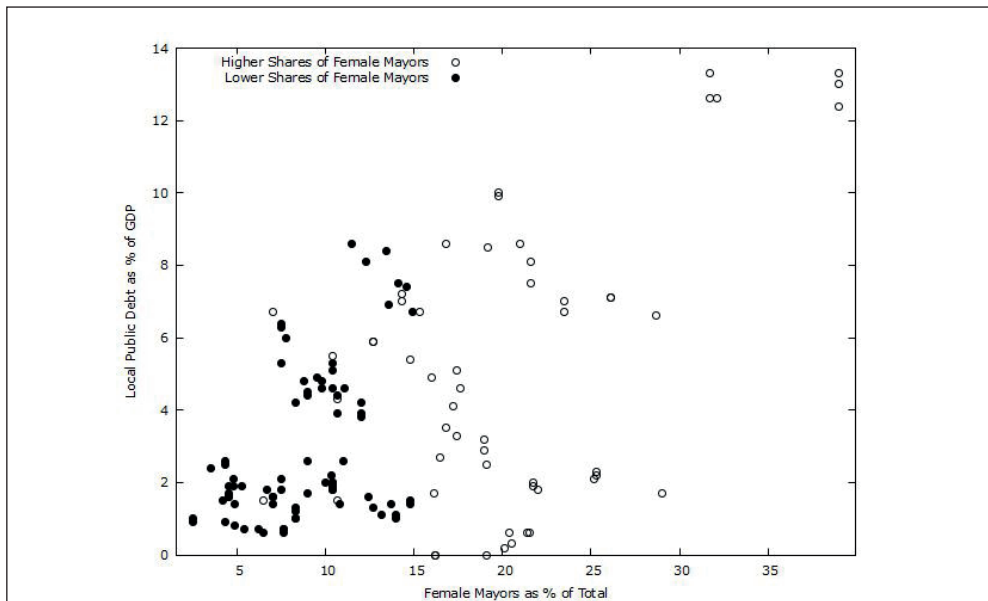


Fig. 1: Inference of local indebtedness and female mayors according to shares of female mayors compared to the average value

Note: Countries with a low share of women's representation with shares below the average value of 14.06 in the period 2011–2021 are Austria, Bulgaria, Croatia, Cyprus, Czechia, Germany, Greece, Italy, Lithuania, Luxembourg, Poland, Portugal, Romania, and Slovenia. Countries with a high share of women's representation with shares above the average value of 14.06 in the period 2011–2021 are Belgium, Denmark, Estonia, Finland, France, Hungary, Ireland, Latvia, Malta, Netherlands, Slovakia, Spain, and Sweden.

Source: own

authorities, which means that increasing need of provided public services could increase the level of indebtedness.

3.2 Considering differences in the share of female mayors

Following the idea of Cuadrado-Ballesteros et al. (2022, 2023), that an inverse relationship between the number of women in local governments and the level of debt is present only if the number of female supervisors or the number of councilors is sufficient, we provide the robustness check by splitting the full sample into two subsamples according to the average share of female mayors in the sample (14.06% for the 27 EU countries; Tab. 1) into two groups: first, countries with an average share of female mayors in the period

2011–2021 lower than the EU average, and second, countries with an average share of female mayors in the period 2011–2021 higher than the EU average. After, we run again three models for each subsample.

Using the factorized scatterplot (Fig. 1), we observe that countries with lower shares of female mayors tend to have lower local public debts, but when controlling for the other determinants of local indebtedness (Tab. 3), the results show that the female mayor explanatory variable is not statistically significant in these countries. For the factorized boxplots and time-series plots projecting the dynamics of the variables in the question, see the Appendix. Oppositely, the statistically significant negative relationship between female mayors and local indebtedness is observed in the case

Tab. 3: Results of estimation considering the share of women's representation in local politics

Variables	Model 1		Model 2		Model 3	
	Low	High	Low	High	Low	High
<i>Constant</i>	22.4352** (7.7155)	-10.8572 (29.2000)	18.1246*** (3.9737)	-12.1921 (26.8300)	19.5242*** (3.9526)	-12.4458 (25.9967)
<i>Local public revenues</i>	0.1031 (0.0975)	0.1916 (0.1241)	0.1346 (0.1533)	0.2143 (0.1204)	0.1413 (0.1570)	0.2113* (0.1096)
<i>Tax revenues general government</i>	-0.0791 (0.0975)	-0.07450* (0.0350)	-0.0733 (0.0897)	-0.0659* (0.0364)	-0.0909 (0.0964)	-0.0735* (0.0361)
<i>Fiscal decentralization</i>	0.0977** (0.0371)	0.2641** (0.1026)	0.0848** (0.0318)	0.2512** (0.1023)	0.0937** (0.0345)	0.2631** (0.1031)
<i>Urbanization</i>	0.0153* (0.0085)	0.0186 (0.0194)	0.0220* (0.0121)	0.0188 (0.0212)	0.0228* (0.0120)	0.0196 (0.0221)
<i>LnGDPpc</i>	-0.9040** (0.3793)	-0.0083 (2.9379)	-0.6790* (0.3486)	0.0666 (2.7649)	-0.7802** (0.3388)	0.0989 (2.73583)
<i>Median age</i>	-0.4180*** (0.1247)	-0.2011 (0.1214)	-0.3641*** (0.0963)	-0.2134 (0.1528)	-0.3694*** (0.0961)	-0.2160 (0.1625)
<i>Dependency ratio</i>	0.1204*** (0.0341)	0.3597** (0.1260)	0.0873*** (0.0309)	0.3751** (0.1345)	0.1007*** (0.0269)	0.3693** (0.1431)
<i>Female mayors</i>	-0.0262 (0.0169)	-0.0133* (0.0069)			-0.0313 (0.0196)	-0.0147** (0.0066)
<i>Female local councilors</i>			0.0219 (0.0228)	-0.0061 (0.0478)	0.0224 (0.0232)	0.0110 (0.0441)
<i>R²</i>	0.7389	0.8524	0.7312	0.8496	0.7388	0.8526
<i>Wald test p-value</i>	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Note: *** significant at 0.01, ** 0.05, and * 0.10 significance level; standard errors in parentheses; FEM models are used.

Source: own

of countries with higher shares of female mayors. The variable of female local councilors remains statistically insignificant.

3.3 Considering differences in the initial economic conditions (EU accession point of view)

Preliminary investigations of the considered dummy variable referring to the EU accession (before or after the year 2004; old = 0, new = 1) indicated that the variable of GDP per capita in the EU is positively correlated with the EU accession (Spearman coefficient of correlation computed due to binary character), which also refers to different economic development among EU countries (Strielkowski & Höschle, 2016). Finally, the EU accession binary variable was omitted from estimations due to exact collinearity.

Again, from the factorized scatter plot (Fig. 2) it is evident that new EU members tend to have lower local public debts.

For the factorized boxplots and time-series plots projecting the dynamics of the variables in the question, see the Appendix. However, except for one estimation (Tab. 4), the results show that the variable expressing women's representation in local politics is not statistically significant. Besides, contrary to previous analysis, the variable focusing on the GDP per capita is statistically significant in estimations conducted on the sample of old EU members.

3.4 Considering differences in the degree of fiscal decentralization

Considering the differences in the degree of fiscal decentralization (FD), we divide the full sample according to the average degree of expenditure decentralization in the sample (22.04%; Tab. 1) into two subsamples: first, countries with an average expenditure decentralization in the period 2011–2021 lower than the EU average, and second, countries with an average degree of expenditure

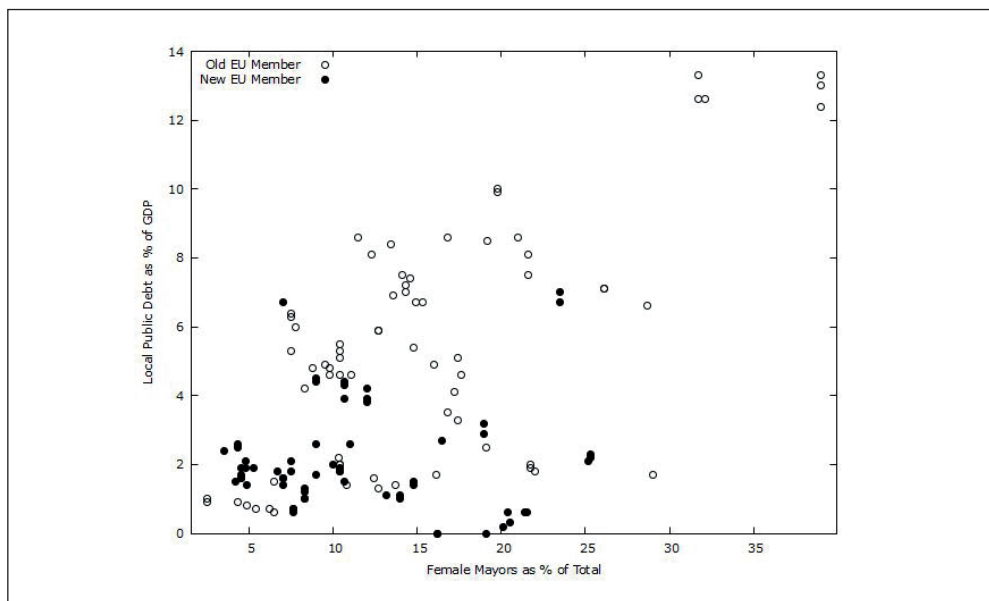


Fig. 2: Inference of local indebtedness and female mayors according to EU accession

Note: Old EU members are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and Sweden. New EU members are Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

Source: own

Tab. 4: Results of estimation considering the moment of EU accession

Variables	Model 1		Model 2		Model 3	
	New	Old	New	Old	New	Old
<i>Constant</i>	10.2243 (15.2246)	35.6787** (12.1168)	21.2481* (11.0979)	36.7550** (14.2224)	15.8110 (10.5323)	35.6467** (14.4539)
<i>Local public revenues</i>	0.2227** (0.0824)	0.1200 (0.1234)	0.3134** (0.1176)	0.1336 (0.1186)	0.2747** (0.1138)	0.1200 (0.1235)
<i>Tax revenues general government</i>	-0.2204*** (0.0458)	-0.0611 (0.0446)	-0.2630*** (0.0523)	-0.0584 (0.0450)	-0.2570*** (0.0497)	-0.0612 (0.0468)
<i>Fiscal decentralization</i>	0.1960*** (0.0569)	0.1066*** (0.0306)	0.1577** (0.0603)	0.1031** (0.0368)	0.1801** (0.0690)	0.1068** (0.0374)
<i>Urbanization</i>	-0.0015 (0.0138)	0.0100 (0.0112)	0.0012 (0.0160)	0.0090 (0.0122)	0.0036 (0.0160)	0.0100 (0.0132)
<i>LnGDPpc</i>	-0.7855 (1.3264)	-2.2306** (0.9152)	0.3343 (1.3931)	-2.3339** (1.0283)	-0.1406 (1.4638)	-2.2287* (1.0673)
<i>Median age</i>	0.0331 (0.3754)	-0.2062** (0.0798)	-0.4627 (0.5509)	-0.2013** (0.0815)	-0.2268 (0.5444)	-0.2062** (0.0802)
<i>Dependency ratio</i>	-0.0132 (0.0783)	0.0023 (0.0369)	-0.0062 (0.0809)	-0.0032 (0.0376)	-0.0080 (0.0803)	-0.2062 (0.0802)
<i>Female mayors</i>	-0.0389** (0.0157)	-0.0106 (0.0064)			-0.0264 (0.0173)	-0.0105 (0.0068)
<i>Female local councilors</i>			-0.0527 (0.0346)	-0.0046 (0.0282)	-0.0375 (0.0319)	0.0002 (0.0297)
<i>R²</i>	0.8155	0.8150	0.8152	0.8137	0.8248	0.8150
<i>Wald test p-value</i>	0.0021	0.0003	<0.0001	0.0002	<0.0001	0.0004

Note: *** significant at 0.01, ** 0.05, and * 0.10 significance level; standard errors in parentheses; FEM models are used.

Source: own

decentralization in the period 2011–2021 higher than the EU average. After, we run again three models for each subsample.

Using the factorized scatterplot (Fig. 3), we observe that countries with lower degrees of expenditure decentralization tend to have lower local public debts, but when controlling for the other determinants of local indebtedness (Tab. 5), the results show that the female mayor explanatory variable is not statistically significant. For the factorized boxplots and time-series plots projecting the dynamics of the variables in the question, see the Appendix. The relationship between the female mayor variable and local indebtedness is negative and statistically significant in the case of countries with higher rates of fiscal decentralization. The variable of female local councilors remains statistically insignificant.

In countries with higher degrees of FD, the assumed impact of female mayors on local indebtedness is observed, when female mayors are in an inverse relationship with local indebtedness.

4. Discussion

The inverse relationship between women's political representation at the local government level and local indebtedness is partially supported by observed results of baseline estimations (Tab. 2).

When considering women's political representation expressed by female mayors, we confirm hypothesis *H1* when we observe a negative statistically significant beta coefficient. This finding supports our expectations and is consistent with the related literature, including studies by the Canadian Institute of Chartered Accountants

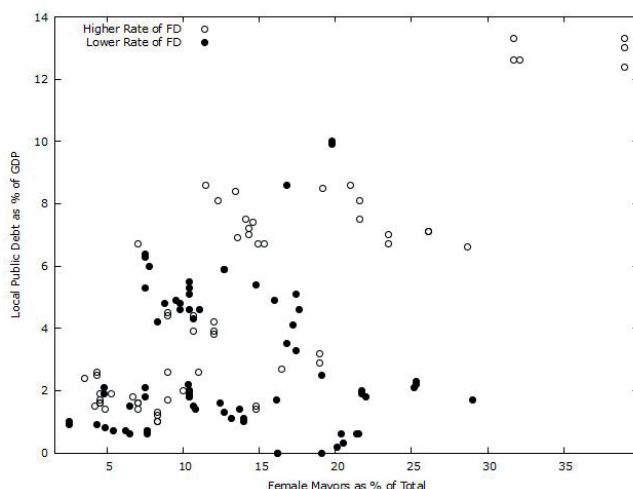


Fig. 3: Inference of local indebtedness and female mayors according to the degree of FD compared to the average value

Note: A low rate of FD is a rate of FD below the average value of 22.04 in the monitored period, the subsample consists of Austria, Belgium, Bulgaria, Cyprus, France, Germany, Greece, Hungary, Ireland, Luxembourg, Malta, Portugal, Slovakia, Slovenia, and Spain. A high rate of FD is the rate of FD above the average value of 22.04 in the monitored period, the subsample consists of Croatia, Czechia, Denmark, Estonia, Finland, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, and Sweden.

Source: own

Tab. 5: Results of estimation considering the degree of FD – Part 1

Variables	Model 1		Model 2		Model 3	
	Low	High	Low	High	Low	High
Constant	12.2608 (19.2660)	11.3948 (11.5406)	12.1629 (19.2273)	10.3965 (8.0541)	12.4864 (19.0639)	12.3308* (6.6189)
Local public revenues	0.1930** (0.0790)	0.0857 (0.0918)	0.1603 (0.0959)	0.1988* (0.0963)	0.1593 (0.0973)	0.1596* (0.0878)
Tax revenues general government	-0.0831 (0.0856)	-0.2151** (0.0870)	-0.0603 (0.0876)	-0.2894* (0.1094)	-0.0690 (0.0905)	-0.2595** (0.1147)
Fiscal decentralization	0.2027** (0.0893)	0.1879** (0.0781)	0.2106** (0.0916)	0.0433 (0.0479)	0.2086** (0.0280)	0.0670 (0.0563)
Urbanization	0.0168 (0.0171)	0.0052 (0.0117)	0.0162 (0.0175)	0.0292 (0.0188)	0.0163 (0.0170)	0.0253 (0.0180)
LnGDPpc	-0.4410 (1.4971)	-0.221574 (0.7997)	-0.3354 (1.5083)	0.8816 (0.5495)	-0.3809 (1.4865)	0.5359 (0.5535)
Median age	-0.2956** (0.1332)	-0.2533 (0.1655)	-0.3412** (0.1248)	-0.4477** (0.1895)	-0.3263** (0.1281)	-0.4469** (0.1638)
Dependency ratio	0.1145** (0.0392)	0.1375** (0.0610)	0.1271*** (0.0375)	0.1591*** (0.0577)	0.1240*** (0.0395)	0.1653** (0.0538)

Tab. 5: Results of estimation considering the degree of FD – Part 2

Variables	Model 1		Model 2		Model 3	
	Low	High	Low	High	Low	High
<i>Female mayors</i>	−0.0165 (0.0147)	−0.0319** (0.0122)			−0.0132 (0.0134)	−0.0269** (0.0108)
<i>Female local councilors</i>			−0.0227 (0.0190)	0.0324 (0.0296)	−0.0167 (0.0182)	0.0487 (0.0325)
<i>R²</i>	0.7764	0.7888	0.7759	0.8081	0.7777	0.8226
<i>Wald test p-value</i>	0.0286	<0.0001	<0.0001	<0.0001	0.0003	<0.0001

Note: *** significant at 0.01, ** 0.05, and * 0.10 significance level; standard errors in parentheses; FEM models are used.

Source: own

(2009), Krogstrup and Wälti (2011), International Federation of Accountants (2018), Hernández-Nicolás et al. (2018), Cabaleiro-Casal and Buch-Gómez (2020), Balaguer-Coll and Ivanova-Toneva (2021), Cuadrado-Ballesteros et al. (2022, 2023). Considering *RQ1*, more women in local politics improve local public finance through better fiscal discipline caused by lower levels of local indebtedness.

Accentuating the importance of the explanatory variable and focusing on the idea of Cuadrado-Ballesteros et al. (2022) and Cuadrado-Ballesteros et al. (2023), that an inverse relationship between the number of women in local governments and the level of debt is present only if the number of female mayors or the number of councilors is sufficient, we divided the full sample into two subsamples according to the average share of female mayors in the sample. The statistically significant negative relationship between female mayors and local indebtedness is observed in the case of countries with higher shares of female mayors, which supports the statement of Cuadrado-Ballesteros et al. (2022) and Cuadrado-Ballesteros et al. (2023) and confirms the hypothesis *H2*. Considering *RQ2*, the observed negative effect of women's representation in local politics on local indebtedness is present in countries where there is a higher level of women's representation than the EU average, in line with the question of "enough women."

The indicator of the GDP per capita points to different economic conditions and levels of wealth, which are evident in the EU (Beyaert & García-Solanes, 2014; Monfort et al., 2013; Strielkowski & Höschle, 2016). When

splitting the sample into new and old member EU states considering the level of the initial GDP per capita, we do not observe an evident statistically significant relationship between women's representation in local politics and local indebtedness. Hence, our results do not confirm hypothesis *H3.1*. Instead, we observe an evident negative statistically significant impact of the GDP per capita on local indebtedness in old EU members, which is in line with the findings of Adam and Bevan (2005), and Delgado-Téllez and Pérez (2020).

Considering the variable on fiscal decentralization (expenditure decentralization) is important because it points to the degree of authority granted to local governments (Oates, 1989). Many EU countries have decentralized fiscal systems, while new EU members implemented fiscal decentralization by a certain time delay due to the change in their democratic regimes (Horváthová et al., 2012; Maličká et al., 2017). However, the EU is heterogeneous when considering the degree of fiscal decentralization (Maličká & Martinková, 2018). This led us to run an analysis on the subsamples created considering the differences in the degree of fiscal decentralization. In countries with higher degrees of FD, the assumed impact of female mayors on local indebtedness is observed, when female mayors are in an inverse relationship with local indebtedness. The increasing degree of fiscal decentralization increases the local indebtedness, as assumed by Galiński (2023b). A higher degree of FD increases indebtedness, but this is disrupted by the presence of women, which tends to reduce indebtedness in this case as well. In countries where more authority is

granted to local governments (degree of expenditure decentralization higher than average), the impact of female mayors on local public debt is negative signaling the accordance with the findings of Krogstrup and Wälti (2011), Hernández-Nicolás et al. (2018), Cabaleiro-Casal and Buch-Gómez (2020), Balaguer-Coll and Ivanova-Toneva (2021), Cuadrado-Ballesteros et al. (2022, 2023). This result supports the hypothesis *H3.2*. Considering *RQ3*, different fiscal arrangements between different government levels (expressed by the degree of fiscal decentralization) influence the inverse relationship between women's representation in local politics and local indebtedness, but different initial economic conditions (expressed by the EU accession moment) do not.

4.1 Policy recommendations

The impact of gender on many aspects of local financial performance has been analyzed in previous studies (Avellaneda et al., 2022; Cabaleiro-Casal & Buch-Gómez, 2018; Casarico et al., 2019, 2022; Funk & Philips, 2019; Hernández-Nicolás et al., 2018; Holman, 2015; Schild, 2013). In line with the aim and findings of this paper, recent literature focusing on gender effects on local indebtedness concludes with the inverse relationship between female mayors and local indebtedness (Cabaleiro-Casal & Buch-Gómez, 2020; Cabaleiro & Buch, 2024; Cuadrado-Ballesteros et al., 2022, 2023; Gómez-Miranda et al., 2022; Hernández-Nicolás et al., 2018).

Based on the research findings, we can derive several policy implications to shape public policies to enhance local fiscal performance and improve local financial management. Due to still persistent women's underrepresentation in local politics in many EU countries (EIGE, 2024a), it is crucial to identify and address systemic barriers that hinder women's participation in local politics, such as societal norms, lack of childcare support, and insufficient campaign funding. Implementing policies to remove these barriers can create an enabling environment for women. In addition, offering incentives for political parties and local governments that actively promote and achieve gender diversity, such as financial rewards, public recognition, and additional resources for gender-inclusive initiatives, can further support this goal. In this spirit, emphasizing the legislation on gender balance and gender quotas argues, e.g., Balaguer-Coll and

Ivanova-Toneva (2021), Gómez-Miranda et al. (2022), and Cabaleiro and Buch (2024). It is in line with EIGE's (2024a) recommendations that promote more women in politics to achieve higher gender diversity.

Furthermore, from the point of public fiscal and budgetary policies and other potential stakeholders (e.g., practitioners and banks), it would be beneficial to consider the optimal degree of fiscal decentralization including the local indebtedness regulation, and various socio-economic and demographic factors that influence local indebtedness, as proven, e.g., by Maličká (2017), Balaguer-Coll and Ivanova-Toneva (2021), and Cabaleiro and Buch (2024). Among them, the female share of the population seems to be an important factor when researching female mayors (Cabaleiro & Buch, 2024).

The current state of the social need for gender equality is often presented by international organizations, e.g., United Nations (2019) and EIGE (2024a). Facilitating platforms for sharing best practices and experiences among EU member countries can be highly beneficial, while noticeable differences in women's political representation are evident within the EU (EIGE, 2024a; Gómez-Miranda et al., 2022). Countries with successful gender-inclusive policies and better fiscal outcomes can serve as models for others, promoting widespread adoption of effective strategies and contributing to improved public finance management across the EU. Mentioning the case of Spain in the section Introduction, where the question of gender perspectives in local political decision-making is one of the best developed by the academia among the EU countries, breaking the glass ceilings through the legislation on gender balance in politics is evident (Balaguer-Coll & Ivanova-Toneva, 2021; Cabaleiro & Buch, 2024; Gómez-Miranda et al., 2022).

Conclusions

In the current era, gender-based literature focusing on the impact of gender stereotypes on economic and fiscal categories enjoys increasing attention. In the literature on public finance, research questions discuss different attitudes of women and men in political decision-making, while an increase in women's representation in politics is promoted due to the observed positive effects of women's attitudes related to risk aversion, less corruption, and interest in social areas. All this has

a measurable impact on public finance categories such as public revenue, public expenditure, and public debt contributing to higher welfare of the inhabitants and better fiscal performance in the public sector at both national and subnational levels of government.

This paper examines the relationship between women's representation in local politics and the local indebtedness of twenty-seven EU member countries in the period from 2011 to 2021. Based on the findings of previous research, we assume the inverse relationship, when higher levels of women in local politics are tied with better fiscal discipline in terms of lower local public debt. Using the panel data, we run regressions, where the gender perspective – women's political representation in the local public sector, is expressed as the share of women in the post of mayors and councilors of local governments. Referring to the evident heterogeneous nature of the EU when considering the EU member countries, we provide further analysis of the subsamples of EU countries. The EU accession moment, which points to different economic circumstances within the EU, and the degree of fiscal decentralization, which points to the different extensions of the local public sector in the EU countries are considered.

Our results support the assumptions raised by previous gender-based literature on local indebtedness. More women in local politics improve local public finance by lowering levels of local indebtedness. We observe a statistically significant negative relationship between female mayors and local indebtedness. The variable of female local councilors is not statistically significant at all. Our findings support the idea, that an inverse relationship between the number of women in local governments and the level of debt is present only if the number of female supervisors is sufficient. We observed the negative effect of women's representation in local politics on local indebtedness in countries where there is a higher level of women's representation than the EU average. Additionally, we found out that the inverse relationship in the question is present in countries with a higher degree of expenditure decentralization. The moment of the EU accession seems to not have an evident impact on local indebtedness. We can conclude, that different fiscal arrangements between different government levels influence the inverse relationship

between women's representation in local politics and local indebtedness, but different initial economic conditions do not.

The findings of this research provide several important policy implications such as encouraging the adoption of gender quotas and targeted recruitment strategies to increase the number of female mayors. The study shows that higher female representation in these positions is associated with lower local public debt and according to that, local policymakers should identify and eliminate barriers that hinder women's participation in local politics, such as societal norms, lack of childcare support, and insufficient campaign funding. This can be achieved through targeted policies and support programs.

The research has several limitations that should be considered. Different legal and financial regulations across EU countries make it challenging to compare data and draw uniform conclusions. Economic conditions and political stability vary between countries, influencing local governments' ability to manage debt and respond to financial challenges. The level of fiscal decentralization, or the degree to which local governments have financial independence, differs across countries, affecting their ability to incur and manage debt. External factors, such as global economic crises or pandemic situations, can significantly influence the financial health of local governments and their ability to manage debt. Despite these challenges, such research is crucial for understanding the financial health of local governments and effectively managing their debt at this level.

Future research opportunities at the country level should delve deeper into the characteristics of female political representatives, e.g., political affiliation, which might affect the expenditure composition, including local indebtedness, as mentioned, e.g., by Hernández-Nicolás et al. (2018), Cabaleiro-Casal and Buch-Gómez (2020), Anzia and Bernhard (2022), and Cabaleiro and Buch (2024). Another research on gender perspectives in political decision-making might focus on case studies of good practices of gender-balanced governments, based on which policymakers can legislatively stipulate gender diversity in local governments, as well as create supportive environments that encourage women's participation in local politics (Balaguer-Coll & Ivanova-Toneva, 2021; EIGE, 2024a). Additionally,

there is a need for more comprehensive data collection at the local level to better understand the problem of how gender representation affects fiscal performance considering questions related to the public sector, e.g., corruption and public procurement (Bauhr & Charron, 2021; Cifuentes-Faura et al., 2022).

We believe that the results of our research, supporting the participation of women in local politics and pointing to the positive impact of their presence on local indebtedness, could influence policymakers and the general public, which can ultimately improve the level of public finances across EU countries.

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Appendix

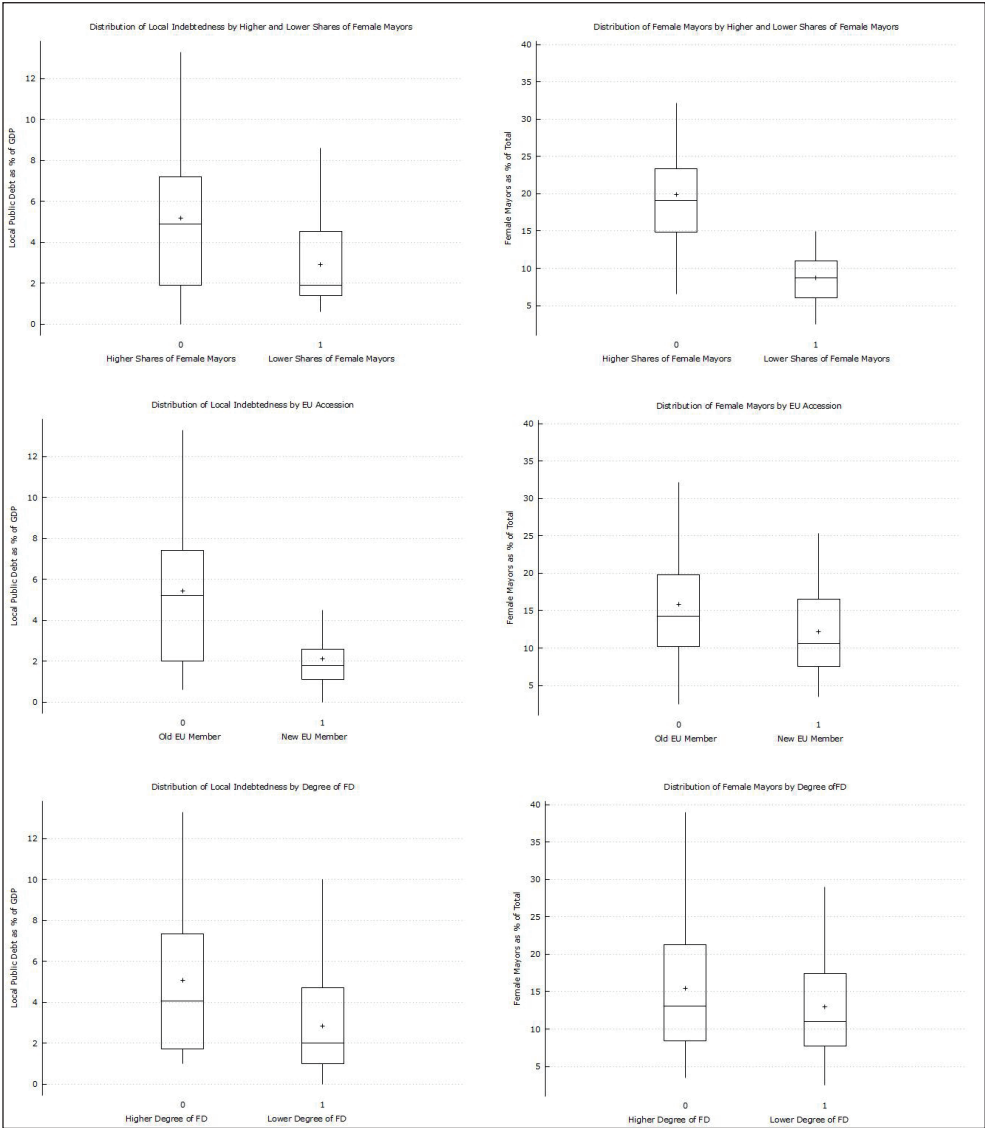


Fig. A1: Distributions of local indebtedness and women’s representation in 27 EU countries in 2011–2021 factorized by share of women mayors, a moment of EU accession, and degree of fiscal decentralization

Note: Countries with a low share of women’s representation with shares below the average value of 14.06 in the period 2011–2021 are Austria, Bulgaria, Croatia, Cyprus, Czechia, Germany, Greece, Italy, Lithuania, Luxembourg, Poland, Portugal, Romania, and Slovenia. Countries with a high share of women’s representation with shares above the average value of 14.06 in the period 2011–2021 are Belgium, Denmark, Estonia, Finland, France, Hungary, Ireland, Latvia, Malta, Netherlands, Slovakia, Spain, and Sweden. Old EU members are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and Sweden. New EU members are Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. A low rate of FD is a rate of FD below the average value of 22.04 in the monitored period, the subsample consists of Austria, Belgium, Bulgaria, Cyprus, France, Germany, Greece, Hungary, Ireland, Luxembourg, Malta, Portugal, Slovakia, Slovenia, and Spain. A high rate of FD is the rate of FD above the average value of 22.04 in the monitored period, the subsample consists of Croatia, Czechia, Denmark, Estonia, Finland, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, and Sweden.

Source: own

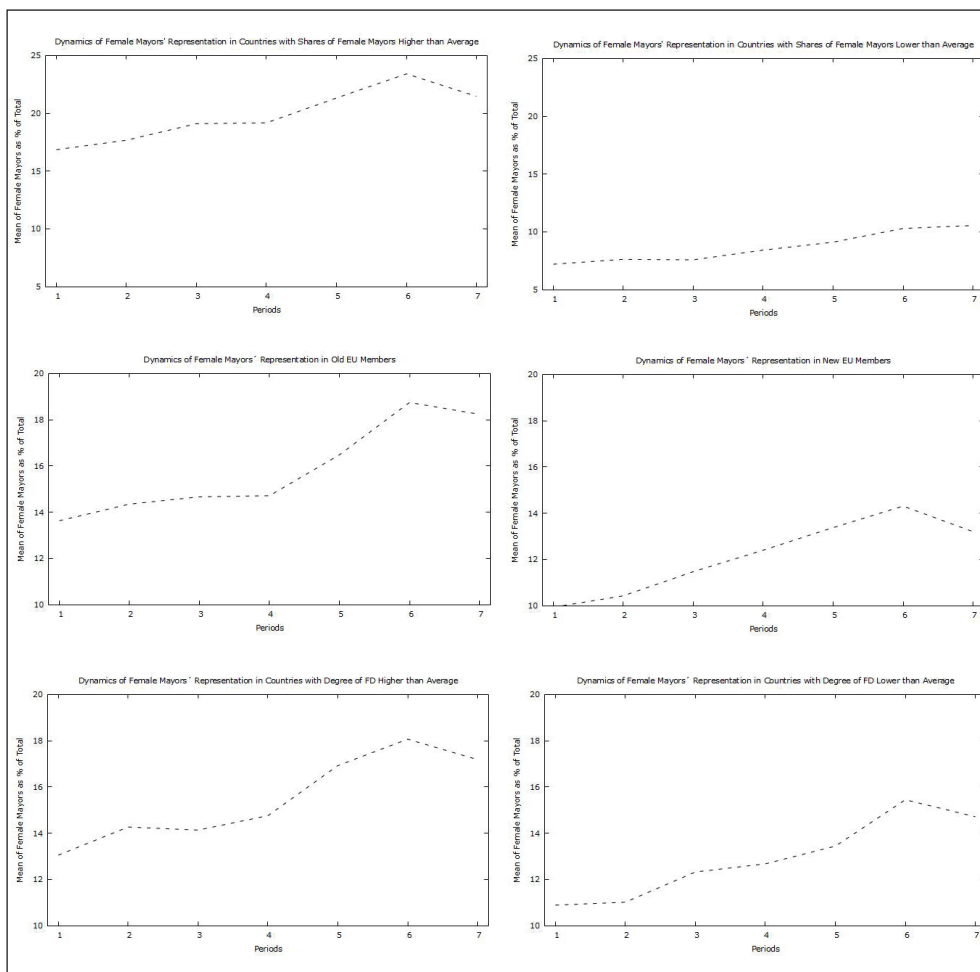


Fig. A2:

Dynamics of women's representation in 27 EU countries in 2011–2021 according to share of women mayors, a moment of EU accession, and degree of fiscal decentralization

Source: own

Attitudes of manufacturers toward the value attributes of regional product brands

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Abstract: The increasing consumption of regional products is pivotal in fostering regional development, a phenomenon analyzed in various academic discourses. This article aims to contribute to the existing knowledge base by exploring the attributes of regional brands of products, specifically from the perspective of regional producers (regional brand of product holders). Unfortunately, this topic remains underexplored within academia, resulting in the need for an in-depth investigation. The article undertook a comprehensive analysis of articles in reputable databases such as Web of Science and Scopus, focusing on brand, brand equity, and regional product brands to address this research gap. The primary objective of this article is to describe the attitudes of regional brand producers towards attributes of brand equity in the case of regional brand products. The paper also presents the outcomes of quantitative marketing research. The research employed the computer-assisted web interviewing (CAWI) method, collecting data between November and December 2023. The presented research is based on a substantial sample of 101 respondents from the Czech Republic. The statistical software IBM SPSS Statistics and XLSTAT program were subsequently used for data calculation and presentation. Semantic differential, descriptive statistics, and hierarchical cluster analysis were applied to the data analysis. It was found that some groups of regional producers have similar attitudes toward the attributes of regional product brands. All results and findings are then discussed. Exploration advances the understanding of regional product brands' dynamics and provides a valuable foundation for future research in this field.

Keywords: Region, regional products, regional branding, brand equity of regional products, regional producers.

JEL Classification: M30, M31, M37.

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Introduction

The scientific literature has no generally accepted definition of the region. Regions currently represent a significant part of each country, mainly due to their rich natural and cultural diversity, which shapes local traditions, customs, and specialties. The term region has its origins

in the Latin word “regio,” which can be interpreted as bounded, landscape, or direction (Žižka et al., 2013). Maier and Tödtling (1998, p. 32) define a region as “a territory created by merging elements of subsystems of the spatial structure according to certain content criteria into diverse functional and hierarchically organized

territorial units.” Skokan (1999) characterizes a region as an area defined based on common features or criteria. As Vukovic et al. (2017) add, these common features include regional identity, cohesion, tradition, shared history, experience, and unique language. From the point of view of marketing, a region represents a complex structure consisting of independent subsystems, including municipalities, cities, micro-regions, businesses, associations of citizens, and entrepreneurs (Ježek et al., 2007). Together, these entities create networks of mutual relations with actors at higher levels, such as ministries, government and European Union bodies (Paulíčková, 2005). The Czech Republic is divided into eight cohesion regions and 14 self-governing regions (Rúian, 2023). Similarly to many EU countries, the Czech regions show differences caused by historical development, regional differences, and geographical, economic, and natural conditions.

These differences strengthen the development of regional marketing and the very concept of regional product brands. The emergence of regional product brands is connected with the development of preferences and needs of the modern society of the 21st century, which is influenced by modern technologies, new concepts, and current challenges. In the last few years, the issues of ecology, sustainability, and healthy lifestyle have also come to the fore, which currently significantly influence consumer behavior (Ober & Karwot, 2022; Rutkowska et al., 2020). Exporting foreign products to local markets is another critical factor influencing consumer behavior, even if this type of goods is often associated with lower quality and low selling prices (Crhová, 2016). The combination of these factors and the partial deglobalization trend contribute to the development of regional brands (RB) and increase the popularity of this marketing concept among consumers. Based on the literature review below, the authors of this article set the following research objective (RO):

RO1: Find out the attitudes of producers (holders of regional product brands in the Liberec Region) towards individual attributes of the value of regional product brands.

In addition to the research objective, the authors also set two supporting research objectives:

RO1.1: To reveal the same level of attitudes among the identified groups of holders of regional product brands in the Liberec Region.

RO1.2: To identify the importance of value attributes of regional product brands from the perspective of manufacturers (regional brand holders).

Finding the answers to the research objectives can help businesses decide whether having their products certified with the label of regional product brands is worth it. At the same time, they can fill a research gap and provide new insight into the investigated issue.

1. Theoretical background

In this section, a literature search will be presented using the following keywords: brand, brand value, and regional product brand.

1.1 Brand

According to Burešová (2019), “brand” has been used for centuries to differentiate the goods of individual manufacturers. The word brand originally comes from the Proto-Germanic “brandr,” which means to burn one’s mark into something or to stigmatize and was usually used to express and depict the ownership of captured people or animals (where branding is still used today) (Jones, 2017). As Beverland (2021) states, defining a brand is relatively problematic with regard to historical events, as there is no single definition that captures all aspects with which the issue of brand marketing works. Tab. 1 shows some of the identified brand definitions.

From the definitions in Tab. 1, it is clear that the brand in today’s knowledge represents an interconnected concept of various systems from the fields of psychology, marketing, and company management. Customer perception can be included among the most important key factors in companies’ marketing management. It is for this reason that companies try to create a positive brand image in the eyes of customers so that customers perceive the brand positively and want to buy it regularly (Kaputa, 2011). Related to this comes the issue of so-called brand equity, which focuses on the identification of individual brand attributes and the explanation of their impact on the overall value of the brand from the point of view of the manufacturer or consumers (Aaker, 1996; Keller, 2007).

1.2 Brand value

Just as defining the term “brand” was problematic, it is also difficult to define “brand equity.” Tab. 2 shows individual definitions and authors.

Tab. 1: Overview of definitions of the keyword “brand”

Author	Definition
American Marketing Association (Mauer et al., 2022)	A name, expression, design, symbol, or any other feature that identifies one seller's goods or services as distinct from those of other sellers. The legal term for a brand is a trademark. A brand can identify a single item, a group of items, or all of a seller's items. When used for a company, the term “trade name” is preferred.
Aaker (2003)	A brand is a tool for distinguishing a company's name and/or symbols from competitors' products or services.
John Philips Jones (Brown, 2016)	A brand is a product that provides functional benefits and added values that some customers appreciate enough to buy.
Keller (2007)	A brand is a product that adds additional dimensions that differentiate the brand from products created to satisfy the same need.
Parmentier (2011)	A brand is a storehouse of meanings driven by a combination of marketer intentions, consumer interpretations, and numerous associations in a sociocultural network storehouse of ideas.
Veloutsou and Ballester (2018)	The evolving mental set of real (offer-related) and emotional (human) characteristics and associations that express the benefits of an offer identified through a symbol (set of symbols) and distinguish that offer from others on the market.

Source: own based on Brown (2016) and Cohen (2011)

Tab. 2: Summary of definitions of the keyword “brand equity”

Author	Definition
Sadiq (2020)	Brand equity is the additional value that a company can generate from a product with a well-known name compared to a generic alternative. Companies can establish brand equity for their products by making them memorable, easily recognizable, and highly reliable. Brand equity consists of three essential components: consumer perception, the resulting positive or negative effects, and the overall value. Consumer perception, which includes both knowledge and experience with a brand and its products, is crucial in building brand equity. The perception that a group of consumers has about a brand directly leads to either positive or negative effects.
Aaker (1996)	Brand equity represents a set of assets (and liabilities) associated with the brand name and symbol that increase (or decrease) the value that the product or service brings to the firm and/or customer.
Farquhar (Orth et al., 2005)	The added value that the given brand gives to the product. A product is something that offers a functional benefit (e.g., toothpaste, life insurance, or a car). A brand is a name, symbol design, or brand that enhances the value of a product beyond its functional purpose.
Febriandika et al. (2020)	Brand equity referred to the asset valuation of a brand for accounting purposes. Brand equity was construed to be the asset valuation of a brand.
J. Walker Smith (Elliott et al., 2018)	Brand equity is the difference between the value of the brand to the consumer and the value of the product without the brand.
Burmann et al. (2009)	Brand equity is defined as present and future valorization derived from internal and external brand-induced performance. This definition includes three major categories: psychological brand equity, behavioral brand equity and financial brand equity. The conceptual proximity of the first two categories leads to a comprehensive and widely accepted term: brand strength. From this perspective, brand strength is merely used as a substitute for psychological or behavioral brand equity.

Source: own (based on the sources mentioned)

There are a large number of definitions focusing on brand equity in the marketing scientific discipline, and, as in the case of the definition of the term “brand,” there is no unified consensus that would help to better understand the issue of brand value. As in the previous case, several different approaches can be used to define the concepts of brand equity (Elliott et al., 2018). These approaches include, e.g., the financial perspective on the calculation of brand value (financial-based brand equity), the calculation of brand value from the customer’s point of view (consumer-based brand equity), and a corporate approach to creating brand value (corporate brand equity). In the early 1990s, Sattler (1994) closely examined 41 studies in Europe and the USA focusing on the issue of measuring value and concluded that at that time, at least 26 different methods of measurement could be identified. This has resulted in several different brand value measurement models working with specific attributes that have an overall effect on the final brand value.

Based on the given definition (Tab. 2) and for further investigation, Aaker (1996) created one of the first brand value models based on five essential attributes. These attributes include brand loyalty, brand awareness, perceived quality, brand associations, and other brand equity assets. From the definition and the model itself, conclusions can be drawn that managing brand value (assets) also includes work with the investments needed to create and strengthen these assets. A second important point is that each asset that Aaker’s brand equity model works with creates product value in different ways. Coordination and mutual synergy between these assets are essential for effective planning and building a valuable brand. The last and the most important conclusion that follows from the application of Aaker’s model is that all coordination of assets (liabilities) leads to the creation of “brand value for the customer” and “brand value for the company itself.” Therefore, in order for assets and liabilities to be the basis of brand value, they must be defined by a name, symbol, or other essential elements of the brand.

The second important model that influenced the development of building brand value is the CBBE model. The CBBE model (customer-based brand equity) was created by Kevin L. Keller, who approached the issue of building brand value from the customer’s point

of view. According to Keller (2007), the strength of brand equity lies in consumers’ favourable opinion of the brand. The primary attributes of the model include brand salience, brand performance, brand imagery, customers’ judgment, customers’ feelings, and resonance. At the beginning of building the brand’s value, it is vital to build the highest possible level of brand knowledge among the group of potential customers (this is subsequently connected to the issue of brand identification on the part of the customers). The goal of other marketing activities is for customers to create their own opinions about the brand, to trust the selected brand, and then, through these tools, to create a positive attitude towards the brand and the overall image of the company. The companies themselves achieving positive value within the CBBE model can expand their brand portfolio more quickly; customers become less sensitive to price increases thanks to building loyalty, and eventually have no problem sacrificing their free time and resources to find the same product in new distribution channels. This model also considers that the customer is influenced by his head (reason) and heart (emotions) in his consumption behavior.

If we compare the attributes of both models, we find that both described models (Aaker, 1996; Keller, 2007) work with similar attributes, which impact brand equity. As part of this issue, several studies were carried out to verify the influence of individual attributes on the brand’s overall value. However, the professional literature on regional product brands has not examined this phenomenon.

1.3 Regional product and regional product brands

A specific group of brands that needs to be adequately explored in the literature is the group of regional product brands. According to the Association of Regional Brands (2023b) (ARB), the first regional brands in the Czech Republic were created after 2004, and many authors still do not agree on their unified theoretical definition within the marketing discipline (Chalupová & Prokop 2016; Kašková & Chromý, 2014). Tab. 3 displays examples of identified regional product definitions and regional product brands.

The conducted research, described in the articles in the Web of Science and Scopus databases, mainly focuses on the following areas:

Tab. 3: Overview of the definitions of the keywords “regional product” and “regional product brand”

Author	Definition
Krnáčová and Kirnová (2015)	A regional product is the result of human activity that is unique and associated with the region. This product is handcrafted from local ingredients.
Van Ittersum et al. (2007)	A regional product is a product whose quality and origin are linked to a particular region. An important attribute is that the product is sold using the name of the region of origin.
Fernández-Ferrín et al. (2018)	Consider such a product to be a regional product that is produced locally and has an exceptional quality resulting from the specific conditions of its geographical origin.
Butoracová-Šindleryová and Hoghová (2020)	If we perceive the regional product as a summary of the region's offer to its actual and potential customers – space, products, services, and activities, then it is also necessary to realize that by the term “customers” we mean not only visitors to the region but also its inhabitants, tourists, entrepreneurs and investors. It is through the product that the region can provide its values.
Association of Regional Brands (2023a)	Regional labeling is one of the ways to make a particular region more visible, draw attention to exciting products produced there, and make it easier for visitors to the region to find their way around the services offered. The uniqueness and differences of individual regions characterize the Czech Republic. This uniqueness of individual regions can be related to the historical development of individual territorial units and factors such as culture, traditions, customs/habits, natural resources, and geographical location.
Čadilová (2011)	Regional labeling is one way to make rural regions more visible and to support the development of a socially, culturally, and environmentally oriented economy in areas that are interesting for their natural and cultural wealth. The main supported group is local entrepreneurs (artisans, farmers, small and medium-sized enterprises), whose abilities and skills help to spread the region's good name. On the contrary, identification with the region means a unique marketing opportunity for them.
Stoklasa et al. (2014)	Regional brands support local businesses (especially small farmers, artisans, and micro-enterprises) for promotion, diversification of economic activities in the country, and revitalization of the local economy. It increases regional solidarity for the local population and initiates various forms of regional cooperation between entrepreneurs, public authorities, the voluntary sector, and nature conservation. From an environmental point of view, it supports local production and consumption by reducing the traffic burden, supporting eco-friendly production, and expanding the possibilities for sustainable tourism.

Source: own (based on the sources mentioned)

- Awareness of regional product brands (Goudis & Skuras, 2020; Margarisová et al., 2018; Pícha & Skořepa, 2018);
- Consumer behavior (Charton-Vachet & Lombart, 2018; Stoklasa & Matušínská, 2021);
- Characteristics of customers of regional product brands (Jadudřová et al., 2018; Pícha & Skořepa, 2018);
- Characteristics of regional product brands (Butova et al., 2019; Daifen et al., 2019; Margarisová & Vokáčová, 2016).

These areas of research on regional product brands show similar results – approximately 40% of respondents are aware of regional brands, and these respondents have higher education, higher income, and are over 40 years old (Stoklasa & Matušínská, 2021). Based on the analysis of this research, it can be concluded that regional product brands offer a research gap precisely in the value of regional brands from the point of view of regional brand owners.

2. Research methodology

This section provides more detailed information about respondents, the methodology of the questionnaire survey, a description of the basic data set and the method of data collection, and a description of the evaluation methods used.

2.1 Respondents

A total of 101 responses were received based on the questionnaire survey, and the total return of the questionnaires was 59.41%. Tab. 4 shows the distribution of respondents according to selected characteristics.

Tab. 4: Description of respondents

		N	N (%)
Respondents according to the type of regional brand (RB)	The Jizera Mountains Regional Product	59	58.4
	Bohemian Paradise Regional Product	16	15.8
	The Lusatian Mountains and Mácha Region Regional Product	14	13.9
	The Giant Mountains Original Product	9	8.9
	Others (e.g., RB provided by the region, non-owners of RB)	3	3.0
Respondents' field of business	Crafts (e.g., woodworking, metalworking, jewelry)	44	43.6
	Food production	31	30.7
	Providing services and experience	3	3.0
	Others (e.g., agricultural activity, beekeepers)	23	22.8
Period of ownership of RB	Less than 3 years	16	15.8
	3–10 years	59	58.4
	Longer than 10 years	24	23.8
	Currently does not own RB	2	2.0

Source: own

2.2 Questionnaire survey methodology and data collection

Before the authors implemented the questionnaire survey, they led in-depth interviews with selected holders of regional product brands. In-depth interviews were conducted with four representatives, each with a different regional brand of products. During the implementation of the in-depth interviews, parts of the questionnaire were pilot-tested (mainly parts related to the semantic differential and scale questions). Based on the feedback from the in-depth interviews, a pilot questionnaire was created and sent to eight entities. After receiving the feedback, a final questionnaire was prepared and forwarded to all entities from the prepared database of owners of regional product brands in the Liberec Region.

The basic data set of this research was all owners of regional product brands in the Liberec

region. The authors created a unified database of these owners from the available secondary data, which numbered 170 entities. The identified entities in the database were classified according to their affiliation with the type of regional product brands. Four basic owner groups were created: The Jizera Mountains Regional Product, the Bohemian Paradise Regional Product, The Lusatian Mountains and Mácha Region Regional Product, and The Giant Mountains Original Product. Data on individual owners were obtained from publicly available sources (e.g., member lists, web overviews) of individual regional product labeling providers. The database created this way became the basic set for the subsequent questionnaire survey.

The final questionnaire contained 12 questions and was created via the click4survey.cz platform. The structure of the final questionnaire

was divided into four areas and contained a combination of open, closed, and scale questions. The main areas of the questionnaire can be defined as follows: (i) ownership of the regional product brand and definition of business activity; (ii) determination of attitudes towards selected attributes of the value of regional product brands; (iii) determining attitudes towards the current certification processes of regional product brands; and (iv) identification questions.

The questionnaire survey was carried out using the CAWI method from November to December 2023. During the data collection, the respondents were reminded twice to complete the questionnaire via e-mail.

2.3 Methods used for data evaluation

Various statistical methods were used to evaluate the data obtained from the questionnaire survey. Concerning the structure of the questionnaire and the presented data, the methods evaluating the second and third parts of the questionnaire survey will be described here. The statistical program IBM SPSS Statistics was used for all statistical calculations. For the visualization of the data obtained from the semantic differential, an extension to the Microsoft Excel program, namely the XLSTAT, was utilized.

The second part of the questionnaire was created with regard to the use of the semantic differential method. The semantic differential is a method that helps measure respondents' attitudes and preferences on ordinal scales (Osgood et al., 1957) where the respondent has to place his degree of preference or attitude on one value of the scale between two opposite alternatives (e.g., expensive/cheap) (Tahal, 2022). Thanks to this, the method is suitable for detecting minor deviations in the behavior of respondents. The method was used to measure manufacturers' attitudes (holders of RB) towards individual attributes of the regional product brands' value. Descriptive statistics, especially methods of averaging quantities, appear to be suitable for analyzing data obtained from the semantic differential. To display data in graphic form, it is recommended to use ray graphs or different types of line graphs (Tahal, 2022). The semantic differential is an established measurement tool used in many scientific fields (e.g., psychology, sociology, marketing, or linguistics) (Disman, 2000; Miovský, 2006; Osgood et al., 1957; Tahal, 2022).

With regard to the research objective *RO1.1*, the authors decided to use the methods of descriptive statistics and a hierarchical cluster analysis. Due to the nature of statistical methods, this type of cluster analysis can be included in the group of multivariate exploratory procedures (Řezanková et al., 2007). From a marketing point of view, it can help researchers to reveal similar behavior of the investigated cases (e.g., searching for similar segments in terms of consumer orientation; searching for segments of customers or producers with the same opinions, attitudes, or preferences). For individual segments, the measured observations should be homogeneous within the created cluster, and at the same time, individual clusters should be heterogeneous (Rabušic et al., 2019). As an input method for calculating distances in multidimensional space, the authors used the between-groups linkage method. In this method, the distances of a point to all points of the grouping are first calculated, and then average values are created from them (Rabušic et al., 2019). An icicle chart or a dendrogram is often used for data visualization within cluster analysis.

In the third part of the questionnaire, respondents were asked to select a maximum of five of the most important value attributes of regional product brands. This part was evaluated using frequency distribution.

3. Results

3.1 Identification of producers' attitudes towards individual attributes of the value of regional product brands (*RO1*)

With regard to the literary research carried out, individual attributes of the value of regional product brands were identified. These attributes were subsequently presented to manufacturers in the form of a semantic differential. The attributes in the semantic differential were chosen based on the selected definitions, Aaker's and Keller's model of brand value, or from information obtained during in-depth interviews. After the pilot testing of the semantic differential, the authors, based on the feedback received from the manufacturers, decided to place contradictory statements on the individual opposites instead of one-word statements. These statements helped manufacturers to understand individual contradictory statements better. Fig. 1 shows the attitudes of all manufacturers regarding

selected value attributes of regional product brands. Fig. 2 shows a similar problem with regard to individual affiliations of regional product brands. Both images were constructed using the calculated averages of a seven-point scale.

With respect to the obtained results, the authors have found that the producers (owners) of regional product brands have a significant relationship with the individual attributes of the value of regional product brands.

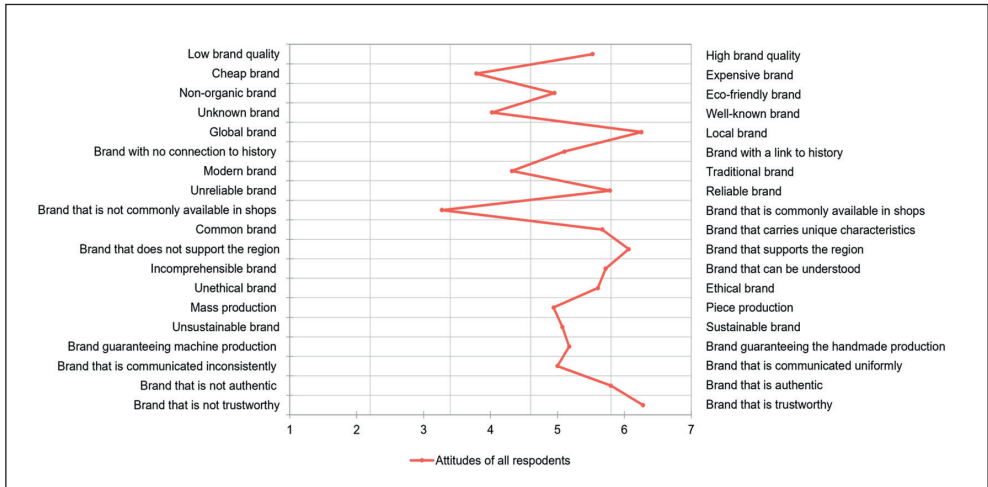


Fig. 1: Semantic differential of all respondents

Source: own

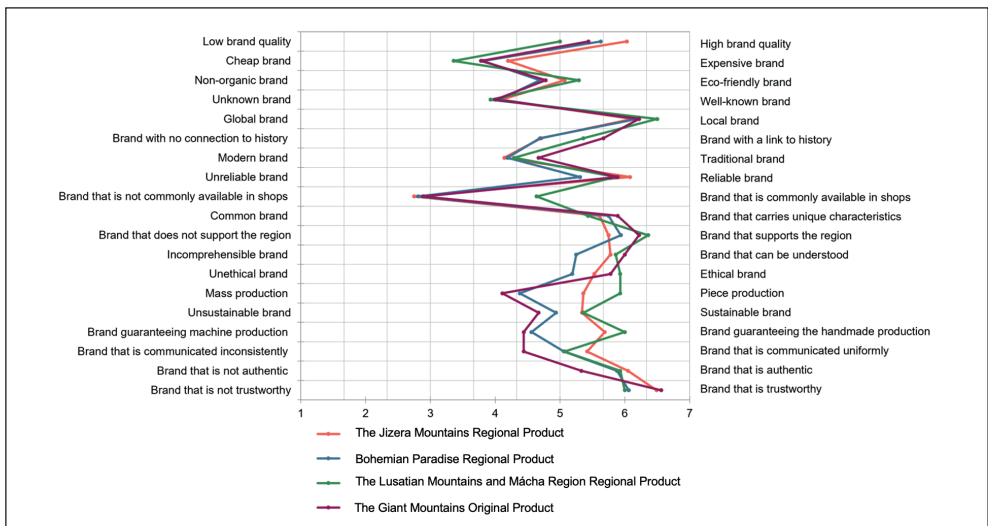


Fig. 2: Semantic differential of respondents by the type of regional product branding

Source: own

The most important attributes, according to all producers of regional product brands, are the attributes of trustworthiness, locality, authenticity, reliability, and the attributes related to the support of the region. It should be mentioned that at least three of the mentioned attributes (locality, authenticity, support of the region) are specific to the group of regional product brands. Within the measurement of attitudes, however, the exception remains the availability attribute. This means that manufacturers tend to lean towards the fact that regional brands of products are not quite commonly available in stores, and customers have to purchase them at specialized sales points (e.g., from regional manufacturers themselves, in specialized stores of regional product brands). Based on the above findings, manufacturers take neutral positions in the three investigated attributes, namely the attributes of price, brand knowledge, and brand tradition. Therefore, it is impossible to determine whether the producers perceive this group of regional product brands as cheaper or more

expensive, better known or more traditionally oriented based on the obtained data.

3.2 Revealing the degree of agreement in the attitudes of the surveyed producers (RO1.1)

The data presented in Fig. 2 provide a partial answer to the research objective RO1.1, which the authors of the article decided to support with a statistical calculation.

The authors used the method of hierarchical cluster analysis. In Fig. 3, a dendrogram was created to help identify homogenous clusters.

The dendrogram revealed an identical level of attitudes towards the value attributes of regional product brands between the two groups of regional product brand owners. Specifically, it can be seen that the owners of the regional brands Bohemian Paradise Regional Product and The Giant Mountains Original Product have the same level of attitude towards the examined attributes of the value of regional product brands. Based on the graphic determination,

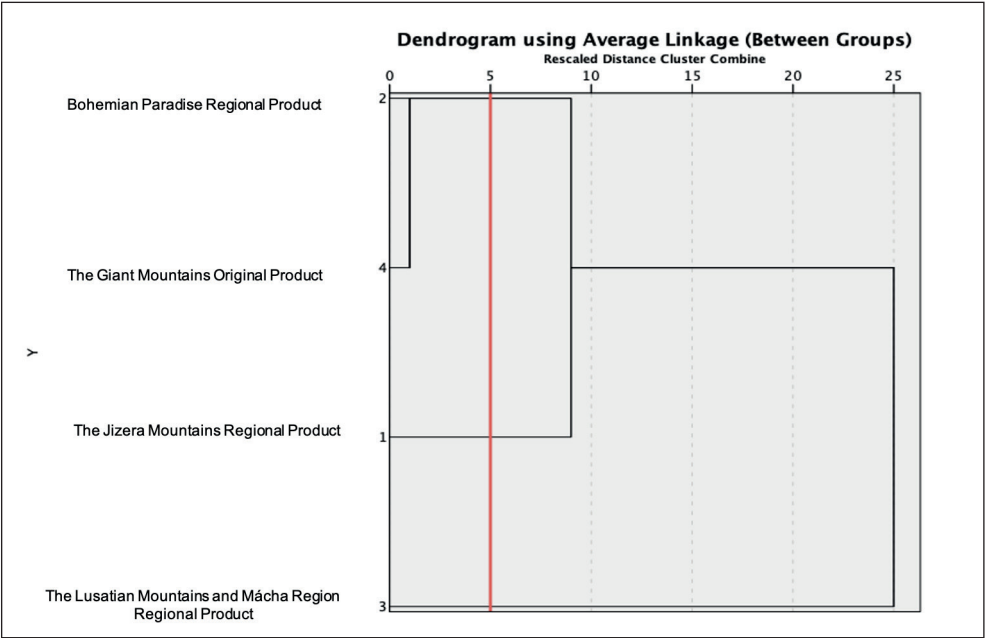


Fig. 3: Dendrogram using average linkage (between groups)

Source: own (calculation in IBM SPSS Statistics)

Tab. 5: The key of the created clusters

Case	Clusters
The Jizera Mountains Regional Product	Cluster 1
Bohemian Paradise Regional product	Cluster 2
Giant Mountains original product	Cluster 2
Lusatian Mountains and Mácha Region Regional Product	Cluster 3

Source: own (calculation in IBM SPSS Statistics)

the authors created three clusters (segments) according to the key given in Tab. 5.

In addition to completing the information, Tab. 6 shows the average values of attitudes to individual attributes in the created clusters.

Based on the presented semantic differentials above (Figs. 1–2), it is noticeable that the most significant changes in calculated averages can be seen in attributes related to brand availability.

Tab. 6: Average values of attitudes to individual attributes

Attributes	Clusters			Total
	1	2	3	
Brand quality	6.034	5.535	5.000	5.526
Perceived price	4.203	3.795	3.357	3.788
Brand ecology	5.068	4.733	5.286	4.955
Brand knowledge	4.102	4.030	3.929	4.023
Brand locality	6.119	6.205	6.500	6.257
Brand history	4.712	5.177	5.357	5.106
Brand tradition	4.136	4.427	4.286	4.319
Brand reliability	6.085	5.601	5.857	5.786
Brand availability	2.746	2.851	4.643	3.273
Brand uniqueness	5.610	5.819	5.429	5.669
Support of the region	5.746	6.080	6.357	6.066
Clarity	5.780	5.625	5.857	5.722
Brand ethics	5.525	5.483	5.929	5.605
Produced quantity (piece/mass)	5.356	4.243	5.929	4.943
Brand sustainability	5.339	4.802	5.357	5.075
Production technology	5.695	4.504	6.000	5.176
Piece/machine production	5.424	4.754	5.071	5.001
Uniformity of communication	6.051	5.604	5.929	5.797
Brand authenticity	6.492	6.309	6.000	6.277

Source: own (calculation in IBM SPSS Statistics)

3.3 Importance of value attributes of regional product brands from the perspective of manufacturers (RO1.2)

The research objective RO1.2 focused on the importance of individual attributes in determining the value of regional product brands. The importance was verified using

a multiple-choice question in the third part of the questionnaire survey, where respondents could select a maximum of five most important attributes. Tab. 7 contains the frequencies of the responses obtained.

Brand quality, locality and brand credibility are the most important attributes for producers of regional brands (Tab. 7). On the other

Tab. 7: Importance of attributes for RB producers

Attributes	N	N (%)
Brand quality	87	18.5
Brand locality	73	15.5
Regional brand credibility	61	13.0
The uniqueness of the regional brand of the product	53	11.3
Brand quantity produced	43	9.1
Piece/mass production	22	4.7
Brand ecology	20	4.2
Brand tradition	19	4.0
Reliability of the regional brand	18	3.8
Brand knowledge	16	3.4
Brand clarity	13	2.8
Brand authenticity	11	2.3
Brand price	11	2.3
Brand ethics	10	2.1
Brand sustainability	6	1.3
Cultural significance	4	0.8
Regional brand availability	4	0.8
Historical significance	0	0.0
Production technology	0	0.0
Total	471	100.0

Source: own (calculation in IBM SPSS Statistics)

hand, the less important factors are regional brand availability, historical significance and production technology.

4. Discussion

The authors managed to obtain several new findings that may help fill the research gap in the area of the identification of measures of manufacturers' attitudes. The first one concerns the very attribute of the availability

of regional product brands. The surveyed manufacturers agreed that regional product brands represent a product segment that is not characterized by extensive distribution channels. Based on the research carried out, it can be concluded that the manufacturers, on the contrary, expect customers to purchase this type of product at specialized sales points (e.g., at regional manufacturers, in specialized stores of regional product brands). A similar

fact was stated in the research of Stoklasa and Pitrunová (2020). They further point out that although these products are not characterized by their availability, the surveyed consumers would appreciate the broader availability of this type of product (e.g., availability in supermarkets, online shopping). Another significant finding relates to the price attribute. The research presented above revealed that a relatively neutral attitude towards the terms (expensive/cheap) was found among the surveyed producers. From research that was oriented to the analysis of the consumer side (Charton-Vachet & Lombart, 2018; Pícha & Skořepa, 2018; Stoklasa & Matušínska, 2020), it follows that typical customers of regional products are consumers with a higher education, older than 40 years and with a higher income. In their research, Stoklasa and Pitrunová (2020) further demonstrated that a large part of their research respondents (43.2%) assign a relatively higher price to regional product brands. Conducting further research on individual attributes of regional brands can help in gaining a deeper understanding and more precise interpretation of attitudes towards them. By investigating specific characteristics and qualities of these brands, we can uncover valuable insights that may not have been apparent before.

As far as a hierarchical cluster analysis is concerned, the authors managed to verify that the two groups of respondents (holders of the regional label Bohemian Paradise Original Product and The Giant Mountains Original Product) have a similar level of attitudes towards the value attributes of regional product brands. The measured values point out that the cluster created in this way is the most different from the other groups in the attitudes regarding the attribute of quantity produced, sustainability of the brand, production technology, and uniformity of communication. This contradiction may be caused by a greater representation of companies focusing on mass production through machine processing (e.g., breweries, and mills) and, furthermore, by a higher number of respondents focusing on orchards and agricultural activities. From the measured values, it can be inferred that owners of the Regional product of the Lusatian Mountains and Mácha Region brand hold the highest average values for attitudes towards individual attributes of regional product brands. These are followed by the owners of the Regional product of the Jizera

Mountains and the owners of the remaining two regional product brands. Finding out the specific reasons for the differences in the measured attitudes is not the subject of this article. Since this issue was not investigated within the segment of regional product brands, it is impossible to compare the measured findings with similar research.

The most important attributes mentioned by the interviewed producers of regional product brands in the Liberec Region included the attributes of quality, locality, trustworthiness, and uniqueness. On the contrary, uniform communication, production technology, historical significance, and availability remained the least important attributes. Several interesting findings can be observed in Tab. 7. One of them may be, for example, that the brand knowledge attribute is more important to the surveyed regional manufacturers than the unified brand communication attribute. From a theoretical point of view, however, communication represents a starting point for sharing information towards target customers, through which the awareness and overall knowledge of the brand increases (Aaker, 2003; Karlíček, 2018; Keller, 2007). Another interesting finding is connected to the already mentioned attribute of the availability of regional products, which corresponds to the logic and assumptions presented in the previous paragraph. It can be traced that the level of importance of the attribute of availability of regional product brands is not a priority for the owners of regional product brands. Based on the evidence presented, it can be inferred that the producers operate under the assumption that consumers will seek out regional products in niche markets, leading them to assign a lower priority to this particular attribute. However, this issue is much more complex, as it goes against the basic principles of regional product brands that do not enable their intensive distribution (short distribution routes characterize regional products), although consumers would welcome a change in this matter (Horská et al., 2020; Stoklasa & Pitrunová, 2020).

Conclusions

The main research objective of this article was to identify the attitudes of producers (owners of regional product brands in the Liberec Region) towards the individual attributes of the value of regional product brands. The authors

also focused on finding answers to whether there is agreement in the attitudes towards the attributes of regional product brands from the perspectives of the investigated manufacturers and how much importance they attach to each attribute. All results were obtained from a questionnaire survey and evaluated using various methods of research and data analysis (semantic differential, methods of descriptive statistics, and cluster analysis). These results were subsequently presented and discussed in earlier sections of the article. Within the research, the authors successfully recorded the respondents' attitudes and their direction in relation to the examined attributes. Furthermore, the authors managed to verify that two groups of holders of regional product brands (specifically holders of the regional label Bohemian Paradise Regional Product and Giant Mountains Original Product) have a similar level of attitudes towards the value attributes of regional product brands. The article also states that among the most important attributes, the surveyed producers rank quality, locality, trustworthiness, and uniqueness. The least important attributes are uniform communication, production technology, historical significance, and availability. The research is the first of its kind and contains certain limitations that need to be considered when attempting to generalize the results. The first limitation is its regional focus. This research was conducted only within one out of 14 regions in the Czech Republic. The authors are aware of such constraints and are preparing to conduct research in other regions of the Czech Republic in subsequent scientific activities. The second limitation is the inability to generalize the research results. The authors selected only a part of the total population under study, as it is impossible to verify the size of the total number of units in the base sample in the Czech Republic due to the lack of knowledge and information about the total number of holders of regional product brands. The total number cannot be specified because every year, new applicants occur in some regions of the Czech Republic; even the most significant Czech association, such as ARB, does not include a final correct number of regional brand owners (because not every region in Czech republic is included in this regional branding system). That means that a lot of producers can apply in these other independent systems, and due to a lack

of system control, the total number of producers of regional brands of products cannot be specified. For these reasons, the authors currently do not recommend generalizing or extrapolating the results achieved.

Despite the above-mentioned limitations, the authors have managed to contribute to filling the research gap presented by the issue of regional product brands. This scientific paper can help small entrepreneurs and businesses understand the problematic aspects of RB from the point of view of other RB holders and their attitudes. Due to this insight, this paper can also contribute to businesses when the subjects are considering the application process for becoming an RB holder. Additionally, this article can serve as a tool to open a discussion on a new approach to the investigated issue or as an opportunity for conducting new research in this academic area.

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Customer engagement in Facebook brand communities: A case study from automotive in the Czech Republic

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Abstract: Social media is a valuable medium for customer engagement, maintaining existing customers and for acquiring prospective customers. Social media platforms are increasingly adopted as strategic communication tools for building brand equity and consumer engagement. The main objective of this study is to examine the roles of company-created content on Facebook in enhancing brand visibility and interaction between brand and consumer response. In this study, four official Facebook profiles from automotive brands were collected and surveyed and then the data were analyzed in detail using content analysis. Evaluation using the uses and gratification theory and the application of correspondence analysis of content related to the consumer's point of view brings new insights to brand communication using social media. The findings document how selected categories according to user gratification theory influence users' engagement. Both quantitative analysis of brand communication via Facebook and a qualitative survey of the posts with top engagement show differences in the marketing strategy of automotive brands in their social media communication. The findings of best-published posts could also be used as an example for benchmarking. The research provides a theoretical and practical understanding of social media marketing that can guide managers' decision-making when developing and improving their social media marketing activities focused on brand communities.

Keywords: Social media, brand community, engagement rate, uses and gratification theory, dialogic communication.

JEL Classification: M31, M37.

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Introduction

Today, people all around the world use social media in its various forms and for a number of purposes (Appel et al., 2020; Datareportal, 2023a). Social media (SM) is considered a collective term for websites and applications and the type of media that are based on conversation and interaction between people online (Strauss & Frost, 2012; Tuten & Solomon, 2015).

The use of social media for business communication is an integral element of 21st century marketing (Alalwan et al., 2017; Felix et al., 2017).

The popularity of SM use has changed customers as well. It is important for companies and their brands that especially young people, as digital natives, who are members of Generation Z, Y and, in developed countries,

Generation X, use social media every day (Datareportal, 2023b; Statista, 2023a). Individuals also use SM platforms to communicate their feelings about their activities related to a company, product or service, or brand. Further, previous research (e.g., Bozkurt et al., 2021; Dessart et al., 2015) suggests that interacting on social media encourages customers to contribute to brand value directly (through purchasing) and/or indirectly (through referring, influencing, and suggesting).

Currently, consumers require immediate access, interactive communication, up-to-date information, and immediate response on-demand and at their own convenience at any time. Especially younger generations of consumers are turning away from traditional media like television, radio, newspapers and magazines and consistently demand and consume media that are built on ICT use, including the new forms of traditional media mentioned above. Companies are adapting to this change as well and many of them use SM as a tool to directly and regularly communicate with their online brand communities (Bozkurt et al., 2021; De Vierman et al., 2017; Novianti & Balqiah, 2023; Kotler et al., 2022).

These online brand communities, according to Jahn and Kunz (2012), are, e.g., Facebook or Instagram brand pages, through which the companies deliver unique and interesting content to (potential) consumers. Members share common interests, can participate in the community, interact with each other, and also communicate with their fellow network contacts (De Vierman et al., 2017).

Social media is becoming a valuable medium for the development of customer engagement, for acquiring prospective customers, and for maintaining the loyalty of existing customers. SM platforms are now increasingly being adopted as strategic platforms for building brand equity and consumer engagement (Dessart et al., 2015; Raji et al., 2020).

Social networks (SNs) such as Facebook or Instagram have provided a platform for organizations to maintain engagement with their customers through the use of organization-generated visual content (Dhanesh et al., 2022). Santini et al. (2020) found that customer engagement has substantial value for companies, and directly impacts firm performance, behavioral intention, and word-of-mouth. An organization's SM profile is also considered a fan

page or an online brand community (De Vierman et al., 2017; Jahn & Kunz, 2012) that can contribute to the brand loyalty of the customer (Fernandes & Moreira, 2019; Santini et al., 2020; Zamrudi et al., 2016) and ultimately increase the purchase intention (Darsham, 2018; De Prez, 2022; Haili et al., 2014).

Most companies and industries are still looking for how to effectively use networking sites like Facebook and Instagram. Hendricks (2015) in relation to the automobile industry stated that if people view their automobiles as reflections of themselves, then it is no wonder social media is such a powerful marketing tool for automotive brands around the world. People use SM to fulfil their needs (see UGT (uses and gratification theory)), express themselves, share information about the things they love, and communicate about their automobiles' natural fit to this assumption. A group on SM where users support a specific brand online is defined as an online brand community where users can communicate with the brand (company) and with others who share their interests through SM (Huang et al., 2021; Mutinga et al., 2017). It is assumed that knowing that the members of the community have the same interests will motivate the members of the online community not only to actively participate but also build interactions with the brand and other community members (Novianti & Balqiah, 2023).

Most research studies focus on particular issues, such as purchase behaviour, customer relationship management, brand management, innovation management, and employee recruitment (e.g., Bartók & Matošková, 2022; Felix et al., 2017; Mičík et al., 2022; Novotná, 2018). However, only a limited number of researchers have considered studying SM content as a part of companies' marketing communication using brand communities (Dwivedi et al., 2021; Raji et al., 2020). Furthermore, although recent research has explored customer engagement (e.g., Cvijikj, & Michahelles, 2013; Dolan et al., 2016; Shahbazznezhad et al., 2021), in the extant literature still lacks empirical studies to assess customer engagement in response to SM marketing practices, especially in the automobile industry.

This study will focus on detailed research in a specialized area of social media application in a marketing and management context with the aim to enrich current literature and provide new insights for branding development in this

field. The study aims to address theoretically and managerially important research gaps in the marketing of the automobile industry by exploring the following three research questions (RQs):

RQ1: How do selected automotive brands apply social media marketing for developing and maintaining their online brand communities?

RQ2: What factors demand consideration when managing communication between the automotive brand and their customers via social media profiles?

RQ3: Does the type of communication approach measured by selected content categories influence users' level of engagement on automotive brands' social networks?

The paper proceeds as follows. First, it provides a definition and conceptualization of branding via social media marketing, followed by a research question and hypotheses. Next, the research methodology is presented. This is followed by a section with the research analysis and results. Then follows a section that contains a discussion and conclusion. Finally, implications and limitations for automotive brands on SNs are presented.

1. Theoretical background

1.1 Company's profile on social media, online brand community and engagement

Generally, specific objectives of social media marketing (Lee, 2022; McDonald, 2023) are usually focused on generating engagement using selected companies' profiles on SM, stimulating sales, increasing brand awareness, improving brand image, reducing marketing costs, and creating interaction with SM users and other stakeholders (Alalwan et al., 2017; Appel et al., 2020; Chmielecki & Lisowski, 2013; Dwivedi et al., 2021). Communication between companies and their customers using social media firm profiles helps to build brand loyalty beyond traditional methods (Alves et al., 2016).

Companies also analyze conversations in social media with the aim of understanding how consumers view their products and brands (Dwivedi et al., 2021; Vendemia, 2017). Insights gained from SM platforms are pivotal for companies to understand their products and brands' present position (Siahaan & Prasetyo, 2022). Furthermore, conversations between companies and their customers and between

customers on SM provide companies with new ideas for how to support brand awareness, brand recognition, and brand recall (Alves et al., 2016).

Felix et al. (2017) emphasize that specific objectives and challenges in SM may depend on factors such as the industry sector, the size of the company, and the difference also between B2B and B2C communication. The effectiveness of SM marketing may also depend on the specific needs of communication that consumers assign to companies and brands within the SM in selected industry sectors (Rival IQ, 2023). It should be underlined, in the context of this study, that the automobile industry is highly competitive (Nagy & Jámor, 2018; Statista, 2023b) and using social media data can be a very efficient way for automobile companies to enhance their marketing targets and objectives.

In the car industry, it is commonly known that the brand of a car refers to the company (or brand) that manufactures the car. For example (in the Czech context), brands like Mercedes, Škoda, and Volvo are usually associated with the company's reputation, image, and overall quality of its cars. In addition to the brand's reputation (Syty, 2014), the car's brand can also influence the design and styling of the partial model. Both, company and model, differentiate car brands and influence buyers' decisions (EY Czech Republic, 2023).

These insights are valuable because the analyzed information from SM could be actual, highly personal, and reflects the true position of a company's product or service, and brand image from the consumer point of view. The visible and important factor in SM media data is customer interaction on the brand profile, e.g., on social networks. The analyzed "picture" often serves to represent the company's client's needs and wishes. Further, free, accessible and available insights from SM could be essential for companies' decision-making and market analysis purposes (Az-Zahra et al., 2021; Dwivedi et al., 2021). Previous research (e.g., Dessart et al., 2015; Novianti & Balqiah, 2023) has shown that community members' trust in a brand strongly and positively impacts brand loyalty and this has high value for the marketing of automotive brands (Mutinga et al., 2017).

Users of SM platforms such as Facebook or Instagram can share company posts across

multiple communities of the network, which are then freely accessible online to a larger audience. Companies, using data mining, can for active monitoring of the consumer experience use the findings as essential aspects of their future marketing activities. Brand positioning can be analyzed both through big data from SM and through research probes examining communication in more detail, which can be vital in a competitive market analysis and for the necessary decision-making process.

Company-created content (Raji et al., 2020) represents the application of marketing strategy using profiles on Facebook or Instagram. There is the opportunity to expand brand awareness through the messages disseminated on selected SNs (Bozkurt et al., 2021). Companies' profiles on SN engage their users and support sharing of information and other promotional activities aimed mainly at existing and prospective consumers. The purpose of this part of the study is to contribute to the understanding of how social media content influences users' engagement behavior (Shahbaznezhad et al., 2021).

Customer engagement in SM is an important marketing outcome. Santini et al. (2020) found that customer engagement has substantial value for companies, and directly impacts firm performance, behavioral intention, and word-of-mouth. Engaged customers can play a key role in driving business performance by primarily providing word-of-mouth (WOM) about products, services, and brands (Brodie et al., 2011). For marketers, it is important to understand what drives customer engagement across interaction with company profiles on Facebook or Instagram is important because customer engagement initiatives have also a positive impact on financial returns (Kulikovskaja et al., 2023; Unnava & Aravindakshan, 2021). The company SM profile has the power to influence customers' behavioral manifestations that have a brand or firm focus (Van Doorn et al., 2010).

Strong and successful brand equity becomes an important factor for automotive brands to differentiate themselves from competitors and ensure uniqueness (Adetunji et al., 2018) in the eyes of their brand community members (Grover & Mandan, 2017). Therefore, it is important to know which factors or features of the automobile are seriously taken into consideration in the decision-making process and

which attributes and other assets of automotive brands are important for consumers (EY Czech Republic, 2023). As such, this study sets out to examine the differential effects of social media marketing communications with the focus on company-created content in terms of brand community on social media.

The following hypotheses were framed based on the literature and specific situation in the automobile industry in the selected country:

H1: Car brands that are more active in communication on their official Facebook profiles (number of posts/2022) achieve a higher engagement rate.

H2: The types of expositive resources (text, graphic, audio-visual) influence the level of engagement per post.

1.2 Uses and gratification theory and communication on social media

This study uses content analysis to examine in detail the communication of selected automotive brands, especially on Facebook. Uses and gratification theory (UGT) is based on the origins of social and psychological needs and explains the concept of why people use media (Katz et al., 1973; Ruggiero, 2000). In the past, UGT focused on traditional media, while today, this theory is also suitable for researching social networks (Dolan et al., 2016; Muntinga et al., 2017). In other words, SM fulfils many expectations of both mass and interpersonal communication. They are a new dominion of human activity and also a new dominion for UGT research (Ruggiero, 2000) and this research follows that call. The basic questions in UGT research remain the same and this study brings an answer to the question of what gratifications users receive from the brand community on selected social media in the automobile industry?

In communication on SM, a brand's overt goal is to attract users (followers) by providing value, or gratification, through its content (Lin & Lu, 2011). Therefore, companies should design content on, for example, their official Facebook profile in a way that creates value for individual SM users to build a stronger level of engagement and facilitate brand communication. Individuals are motivated to fulfil their needs and wants, and that's how individuals take particular actions or access content on selected SM.

For example, Whiting and Williams (2013) provide a list of several gratifications in the context of SM. This study follows a new approach by Dolan et al. (2016) and their model, based on UGT, that shows how an organisation can stimulate positively valenced engagement behaviour through SM. From this perspective, the research objective is focused on identifying which types of gratification bring the highest engagement of users of automotive brand profiles on SM. Four key categories of gratifications (Dolan et al., 2016; Eger & Gangur, 2024) are categorised into four main groups based on the level of information, entertainment, remunerative and relational content.

The following research hypotheses were developed based on the literature above related to UGT:

H3: Greater implementation of the categories relational + remunerative + entertainment will yield a higher level of engagement per post.

H4: There exist differences in the communication of automotive brands on social networks according to the UGT categories.

1.3 Dialogic communication and companies' social media

Companies in a number of sectors have established and maintained an interactive online presence via SM and consistently seek how to better engage with potential and existing customers (Alalwan et al., 2017; Capriotti et al., 2023). Another recognized theory that now also focuses on evaluating communication through social media is dialogic communication theory. From this point of view, it is important to mention that social networks are also tools that can help expand and stimulate dialogue between companies and customers.

Big data from social networks and new methodological possibilities seem like a new research opportunity (Shahbaznezhad et al., 2021; Sommerfeldt & Yang, 2018). In this part of the conducted study, the research follows the recommendation by Capriotti et al. (2021), where effective communicative exchange involves continuous interactions between the organization and the online users, and further among the online users themselves, within the selected social network. The next important dimension is conversation, where recipients of the communication interact with the communicator and engage in conversations. It is assumed that greater implementation

of conversational exchange will represent a higher level of interaction. Capriotti et al. (2021) evaluated reaction, viralization and conversation rate.

The research will explore how experts responsible for selected automotive brand profiles on social networks implement dialogic communication (Buchanan-Oliver & Fitzgerald, 2016). Hence, the following hypothesis is framed based on literature:

H5: The selected automotive brands on social networks achieve a greater reaction rate than the viralization rate or conversation rate.

2. Research methodology

Relevant and widely available data sources are critical to evaluating brands and obtaining information about customer insights, as demonstrated, e.g., in research by Siahaan and Prasetyo (2022), who also used Facebook as a data source in the automobile sector. To capture the quantitative data, the researchers used the analytical tool ZoomSphere (2022), which allows one to investigate the official Facebook profiles of selected automotive brands. This tool captures statistics about only publicly available social media posts through the API platform.

2.1 Sample selection

The quantitative part of the conducted research focuses on describing posting practices and selected engagement metrics of official Facebook profiles of selected automotive brands from the Czech Republic in 2022. The research takes into account the top ten passenger automotive brands with the highest sales in the Czech Republic in 2021 (Car Importers Association, 2023). However, these brands often use a global Facebook account and it is not possible to determine from publicly available sources, for example, the number of followers from the Czech Republic, which is necessary for engagement rate calculations. Therefore, the study focused on the official Facebook profiles of Hyundai CZ, Mercedes-Benz Czech Republic, Kia Czech and Toyota Czech Republic, where such data were available.

The researchers simultaneously collected, mapped, and coded posts published by selected automotive brands from their official Facebook profiles in detail with the aim of answering the posed research questions. For this purpose, six months of 2022 and three months

from the first half of 2023 were chosen, two with the highest sales (June, May), two with the lowest sales (February, July) and two with average sales of passenger automobiles in the Czech Republic per month (January, October).

2.2 Data analysis

The ZoomSphere tool was used to extract quantitative data from the selected automotive brands' official profiles on Facebook (946 posts = 4 automotive brands/2022). The data were imported into an Excel file and the researchers conducted a descriptive analysis. Engagement metrics are commonly monitored to measure the effectiveness of communication using SNs. The research used engagement rate/year and, according to the survey by Rival IQ (2023), engagement rate per post (by follower) as the two primary metrics.

Engagement rate is a metric that is commonly used in analyzing social media (Dessart et al., 2015; Kim & Yang, 2017; Rutter et al., 2016) and is continually refined by other parameters that enter into the calculation. In the study, two variants of engagement rate are used. First, engagement rate per year (year 2022) = the total number of likes + comments + shares divided by the total number of followers (ER 2022 per follower). Second, engagement rate per post by follower (6 months/2022) = total number of likes + comments + shares per post divided by the total number of followers, then multiplied by 100. Additionally, we applied a specific engagement rate that puts the average of the brand's registered automobiles for the years 2021 and 2022 into the denominator (ER 2022 per automobile).

Next, using the collected data, an evaluation is conducted of the communication with the focus on the key dimensions of dialogic communication on SN according to Capriotti et al. (2021). To gain new insights into the communication of automotive brands through social networking sites, the values reaction rate, viralization rate and conversation rate indicators are calculated.

Furthermore, the unit of analysis is the post for a selected day. Post-level data were collected directly from publicly available profiles on Facebook for the selected period (629 posts/1, 2, 5, 6, 7, 10/2022, 291 posts/1, 2, 5/2023). The data were imported (May 2023 and April 2024) in chronological order on the posting date into an Excel file (post type, number of likes/

reactions, comments and shares). At the same time, the content was coded. Post-coding follows two perspectives. The first focuses on the coding of the UGT categories. The second encodes the content of the posts according to categories that correspond to what people look for when they choose an automobile. These categories were inspired by research by Statista (2022) and EY Czech Republic (2023) and the following categories were used: safety, price, brand, design, driving comfort, efficient operation, customer service, celebrity, engine.

Before the main content analysis, two pilot studies were conducted for the purpose of improving the codebook and training coders. Pilot study 1 tested the first version of the codebook in order to clarify the categories. The level of agreement was 86–91% (two sub-samples). Further, based on findings and discussion, the codebook was revised and improved. Pilot study 2 tested the revised code book. The sample of the second pilot study consisted of new posts from the Facebook profiles from two automotive brands published in one month that were not included in the final sample and which represent approximately 10% of the final sample's size. The level of satisfactory agreement was 94–96% (two sub-samples). This represents the required intercoder reliability. Finally, once the categorization and coding had been completed, descriptive statistics and correspondence analysis were conducted using Statistica. Correspondence analysis is used because it is a useful tool to uncover the relationships among categorical variables (Doey & Curta, 2011); it is a powerful statistical tool (Beh, 2004) with a clear graphical presentation.

In addition to the quantitative analysis of the communication of selected automotive brands on Facebook, a qualitative evaluation of the posts with the highest engagement is carried out. For each brand, the top posts were ranked and the top three are listed in Appendix 1. The qualitative approach used an expert evaluation of selected top posts aimed at content categories, application of call-to-action, UGT categories and differences between automotive brands in published content. The purpose of the qualitative part of this research study is to gather information about the communication that Facebook administrators and marketing experts use to reach engagement with the public via the company's Facebook profile. This mixed-methods research approach

allows researchers to explore a research problem in more detail from both perspectives (Creswell, 2014; Gray, 2009).

3. Results

3.1 Engagement rate and engagement rate per post (by follower)/year 2022

The list of selected automotive brands and basic information about their communication on their official Facebook profiles using the ZoomSphere tool for the year 2022 are

shown in Tab. 1. The data provide an example of the use of Facebook in the automotive industry by selected top automotive brands in the Czech Republic. The data show the number of posts published during the year 2022 on the Facebook profiles, the number of followers at the end of this year and values related to the level of reaction (likes + comments + shares). Tab. 1 presents the value of engagement rate per post (year 2022) for the four selected automotive brands.

Tab. 1: Automotive brands and engagement rate

	Facebook											
	No. of posts				Lik	Com	Sha	Followers	ER 2022 per follower	ER per post by F%	ER 2022 per auto-mobile	Average auto-mobiles 2021/2022
Automotive brands	S	L	V	P								
Mercedes-Benz CZ	0	3	43	359	14,655	300	259	54,294	0.28	0.069	1.96	7,777.5
Hyundai CZ	0	56	28	239	104,442	7,785	2,505	135,873	0.84	0.261	5.91	19,402.0
Kia Czech	0	16	38	237	56,096	16,655	2,133	57,744	1.30	0.446	7.49	9,997.5
Toyota CZ	0	79	69	111	94,093	2,854	1,727	42,187	2.34	0.903	8.73	11,300.5

Note: S – statuses; L – links; V – videos; P – photos; Lik – likes; Com – comments; Sha – shares; ER – engagement rate; ER per post by F% – engagement rate per post by follower; the types of posts – measures from the Zoomsphere tool.

Source: own

Additionally, the engagement rates per average of the brand's registered automobiles for the years 2021 and 2022 are presented. The values of ER 2022 per follower, ER per post (by follower) and ER 2022 per automobile have the same order for these three metrics of the selected automotive brands.

As can be seen from the data in the Tab. 1, hypothesis *H1* is not confirmed. Active automotive brands on their official Facebook profiles (number of posts/2022) do not achieve a higher engagement rate. Conversely, the two brands with fewer posts scored higher in all three metrics monitored.

As mentioned above, currently, engagement rate per post (by follower)/year is used to compare, for example, differences in results of companies' communication on SN (Rival IQ, 2023). The researchers mapped the communication of the selected brands on Facebook for the selected 6 months/2022. Thus, Tab. 2 presents the results of this partial task and the finding of engagement rate per post (by follower) mentioned. At the same time, the types of expositive resources (text, graphics,

audio-visual) and the level of their engagement per post are mapped.

Detailed content analysis was performed for 629 posts (2022), out of which only 11 would be in the text category in terms of source type. Tab. 2 shows that Toyota achieved a very high and distinct engagement rate per post (by follower). The photo post type is the most used in terms of medium, 364 of these posts were analyzed with an average value of 0.43. A slightly higher value was achieved by the photo album type, with an average of 0.46. Surprisingly, the multimedia type of post video scores even lower overall than the photo and photo album for individual automotive brands, with an average of only 0.12. As can be seen in Tab. 2, there are large differences between the minimum and maximum engagement rate per post (by follower) values for the text, photo and photo album post types (*H2*). Therefore, we added the qualitative assessment of the top published posts, as we consider this to be important in terms of benchmarking for managing brand communication on social media (Appendix 1).

Tab. 2: Expositive resources (text, graphic, audio-visual) and the level of engagement rate per post

Automotive brand	Facebook			
	No. of posts	Engagement rate per post (by follower)		
		Min	Max	Average
Text				
Mercedes-Benz CZ	1	0.02	0.02	0.02
Hyundai CZ	4	0.01	0.10	0.06
Kia Czech	2	0.02	0.04	0.03
Toyota CZ	4	0.77	2.06	1.40
Photo				
Mercedes-Benz CZ	118	0.00	0.23	0.08
Hyundai CZ	90	0.01	1.26	0.29
Kia Czech	89	0.02	4.95	0.36
Toyota CZ	67	0.07	2.38	1.00
Photo album				
Mercedes-Benz CZ	70	0.01	0.83	0.08
Hyundai CZ	50	0.02	1.24	0.25
Kia Czech	30	0.01	0.52	0.16
Toyota CZ	17	0.10	3.05	1.33
Video				
Mercedes-Benz CZ	20	0.00	0.24	0.06
Hyundai CZ	17	0.00	0.45	0.09
Kia Czech	13	0.01	0.25	0.06
Toyota CZ	37	0.03	0.92	0.28

Source: own

3.2 UGT categories and differences among automotive brands in their communication via official Facebook profile

RQ3 focuses the research on the UGT content categories and on the analysis of content categories related to the automotive brand. As mentioned above, brand communication via SM should attract users (followers) by providing value, or gratification, through published content. To examine the published content in detail, the researchers coded the selected sample of posts (Tab. 2) and performed correspondence analysis with the aim to get a deep understanding of the public relations and brand communication of the selected automotive brands on SM. In order to obtain sufficient data

for the correspondence analysis, the input data for 2022 was extended to include data for three months of 2023. Tabs. 3–4 present the final findings of the coding process.

After assessing the categories for each automotive brand, the result from Tab. 3 showed a significant χ^2 value of 67.2451 ($p < 0.001$), which indicated significant differences among the automotive brands' categories of posts on their official Facebook profiles. Two dimensions were extracted and Statistica can display the result in 2D in the form of a biplot (Fig. 1). In this model Dimension 1 explains the greatest variance in the model followed by Dimension 2, in summary 99.88% of variance is explained in this two-dimensional map.

Tab. 3: UGT content categories and frequency of occurrence (Facebook, 6 months of 2022 + 3 months of 2023)

UGT content	Hyundai CZ	Toyota CZ	Mercedes-Benz CZ	Kia Czech
Informational	171	132	224	116
Entertaining	21	14	7	10
Remunerative	19	11	4	19
Relational	26	24	54	68

Source: own

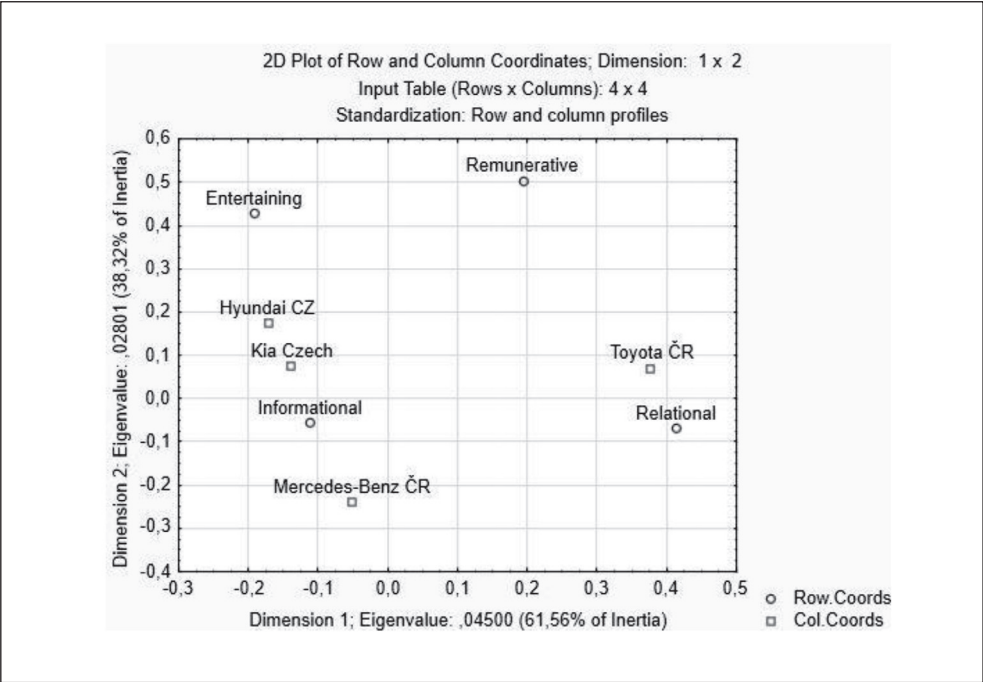


Fig. 1: Two-dimensional correspondence analysis map (UGT categories of automotive brands on Facebook)

Source: own (using software Statistica)

Tab. 3 and Fig. 1 show that the least used content categories according to UGT were entertaining and remunerative content. Kia Czech and Hyundai CZ use remunerative content more than the other two brands. Informational content dominates for Mercedes-Benz CZ and Hyundai CZ. Entertaining content is closest to the brands Hyundai CZ and Toyota CZ. Kia Czech and Mercedes-Benz CZ pay attention to posts with relational content. In general,

the correspondence map shows that each automotive brand has a different content category to promote itself. Thus, *H4* is supported. Hypothesis *H3* is related to hypothesis *H4* and focuses on achieving engagement rate by the UGT content categories. As can be seen from the coding of the 920 posts of the four automotive brands, remunerative content actually achieved the highest values. However, informative content also achieved high values

Tab. 4: UGT categories and engagement rate per post

UGT categories	No. of posts	Engagement rate per post			SD
		Min	Max	Average	
Informational content	643	0	4.23	0.32	0.526
Entertaining content	52	0	2.31	0.22	0.375
Relational content	172	0.01	3.77	0.33	0.517
Remunerative content	53	0	4.95	0.56	0.955

Source: own

and even surpassed relational and entertaining content. Hypothesis *H3* is, therefore, only partially confirmed and the subsequent qualitative analysis of the top posts (Appendix 1) provides further information that documents what achieved the highest engagement.

It should also be noted that Tab. 4 shows not only the maximum values achieved, but also that, in fact, for each category, there were posts published that users were not interested in and did not respond to.

Researchers, in this case, are mindful of assumptions and limitations when applying Chi-square test. Low frequencies in several items affect the calculation of the Chi-square, but at the same time, they are evidence of the observed issue of the content of communication on the social network. Performing correspondence analysis does not necessarily need to calculate a Chi-square test as it provides a multivariate graphical technique to explore relationships

within selected categorical data. Fig. 2 visualizes the strength and patterns of relationships between different selected categorical variables. The generated output from Statistica, shows that in the model used, Dimension 1 explains the greatest variance in the model followed by Dimension 2, in summary, 86% of variance is explained in this two-dimensional map.

Tab. 5 and Fig. 2 show how selected categories that are relevant to the automobile correspond with the selected four automotive brands on their Facebook profiles. It should be noted here that some categories are low in frequency (e.g., safety, price) compared to, e.g., brand and design. As can be seen from Fig. 2, the category brand is most closely associated with Hyundai CZ and Kia Czech. Design and driving comfort were the most often coded for the Mercedes-Benz CZ Facebook profile. Kia Czech works more with celebrities on Facebook than other brands, while Toyota CZ had

Tab. 5: Content categories related to the automotive brand and frequency of occurrence (Facebook, 6 months of 2022)

Content category	Hyundai CZ	Toyota CZ	Mercedes-Benz CZ	Kia Czech
Safety	2	14	2	8
Price	10	4	1	6
Brand	120	101	61	53
Design	36	21	101	35
Driving comfort	20	14	50	14
Efficient operation	18	19	39	26
Customer service	5	19	11	3
Celebrity	5	15	2	26
Engine	21	6	22	10

Source: own

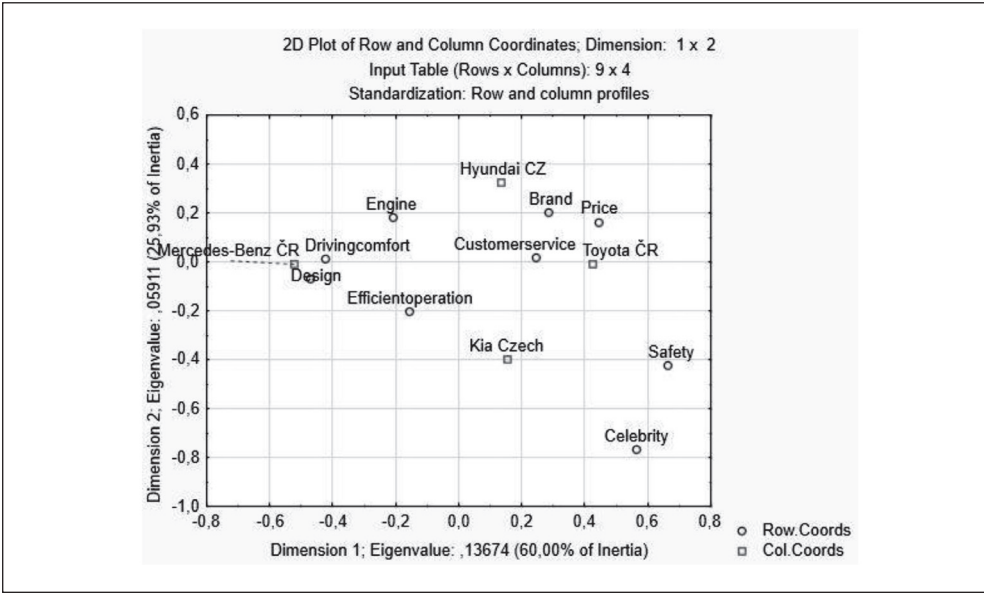


Fig. 2: Two-dimensional correspondence analysis map (automotive categories of automotive brands on Facebook)

Source: own (using software Statistica)

relatively more posts focused on the category safety. In general, this correspondence map also reveals that automotive brands use different content categories to promote themselves.

Additionally, for the sample of posts analyzed in detail, we observed how many of them were focused on electromobility (exceptionally hydrogen). It is evident that this is a topical issue, with Mercedes-Benz CZ and Hyundai CZ at 30.4%, Toyota CZ and Kia Czech at 18.8%.

3.3 Key dimensions of dialogic communication and selected automotive brands on Facebook

Furthermore, to assess reaction, viralization and conversation rate from the dialogic communication point of view using the approach by Capriotti et al. (2021), the same data for the year 2022 were used. Tab. 6 presents findings that support hypothesis H5. The dialogic communication of the selected automotive

Tab. 6: Car brands and dimensions for dialogic communication

Automotive brand	Facebook							
	No. of posts	Likes	Shares	Comments	Followers	Reaction rate (%)	Viralization rate (%)	Communication rate (%)
Mercedes-Benz CZ	405	14,655	259	300	54,294	0.067	0.001	0.001
Hyundai CZ	323	104,442	2,505	7,785	13,5873	0.238	0.006	0.018
Kia Czech	291	56,096	2,133	16,655	57,744	0.334	0.013	0.099
Toyota CZ	259	94,093	1,727	2,854	42,187	0.861	0.016	0.026

Source: own

brands on their official Facebook profiles achieved the highest level for reaction index.

Taking a closer look at the data in Tab. 6, we find that Kia Czech is very successful in the communication rate indicator, and its Facebook profile clearly receives more comments from users than the compared brands. Toyota CZ then achieved a relatively high number of reactions and shares in relation to the lower number of posts published. Dialogic communication is enhanced by the use of hashtags and hyperlinks in published posts. The following is information about the frequency of published posts with the monitored interactive elements, Mercedes-Benz CZ 98%, Hyundai CZ 58%, Toyota CZ 58% and Kia Czech 40%. Comparing these data with Tab. 5, this research shows that the number of hashtags and hyperlinks did not affect the selected indicators from dialogic communication, rather the opposite.

4. Discussion

The integration of SM into organizations' overall communication and marketing strategy has changed their communication activities and PR. Marketing communication using SM has the potential to improve brand equity and can enhance consumer responses that could further effectively influence the consumer decision-making process (Alalwan et al., 2007; Dessart et al., 2015; Tajudeen et al., 2018).

Siahaan and Prasetyo (2022) underline that insights gained from SM platforms are also important for companies to understand their products and brands' present position. Companies and experts responsible for branding are looking for the optimal potential of content published on their official SM profiles with the aim of enhancing the acceptance of their brands and stimulating favourable behaviours from their SM users/consumers. Social media is a form of interactive communication and allows them not only to inform users but also to maintain a relationship with them and even turn them into content creators in so-called branding communities (De Vierman et al., 2017; Kumar & Kumar, 2020).

The automotive industry is highly competitive, which requires that automotive brands actively communicate with existing and prospective customers (Rebeiro, 2023; Shukri et al., 2015; Svobodová et al., 2019). Companies should carefully analyze and follow SM users' opinions in order to achieve a competitive advantage in the automotive market.

The first finding from this research shows that a higher number of posts published on a company's official Facebook profile does not mean a higher engagement rate. This finding underlines the need for a more detailed and in-depth analysis of automotive brands' social media communication. Brand community engagement is evolving as a prominent relationship marketing variable and needs further consideration (Kumar & Kumar, 2020). Moreover, the Hootsuite study emphasizes that it is true that on the one hand good engagement rate is between 1% to 5%, but on the other hand, the more followers the SM profile has, the harder it is to achieve a higher engagement rate (Sehl & Tien, 2023).

Second, the conducted research mapped the types of expositive resources (text, graphics, audiovisual) and the level of their engagement per post using detailed data from four automotive brands' official Facebook profiles (Tab. 2). The photo and photo albums categories achieved higher engagement than the multimedia video type of post. In this part, the research follows a study by Dhanesh et al. (2022) and examines the role of visuals in enhancing public engagement. It should be also mentioned, that the relationship between image content and engagement is more complicated. For example, Li and Xie (2020) underlined that image characteristics also affect user engagement. High-quality and professionally shot pictures consistently lead to higher engagement, but our research did not evaluate the quality of the posted photos.

The key part of this research evaluated companies' communication on their official Facebook profiles using the UGT categories. The results (Tab. 3, Fig. 1) indicated significant differences among the selected automotive brands. It is evident that managers responsible for branding communication are not taking advantage of UGT insights and are unaware of the potential effectiveness of entertaining and remunerative content. The analysis shows how the application of UGT can influence the behaviour of brand community members and adds to the research findings by Dolan et al. (2016). The results can be very useful in practice in managing companies' communication on SN. In addition, available field studies confirm that social media does indeed have a significant impact on car buyers (De Prez, 2022), and similarly, nearly half of the dealers

intentionally use social media to target and drive sales (Seymour, 2024).

Expanding the content analysis provides insights into how automotive brands are communicating content on their social networks. As a reminder, the categories were determined based on two international surveys (EY Czech Republic, 2023; Statista, 2022). The findings show differences and, as mentioned by Raji et al. (2020), company-created content represents the application of marketing strategy using their profile on Facebook.

To complete the analysis of the communication of the selected four automotive brands on their official Facebook profile using UGT, we added an analysis of basic indicators from dialogic communication (Capriotti et al., 2021). The results show that the two automotive brands, which published fewer posts on their official Facebook profiles achieved higher values in the selected indicators, namely in reaction rate and viralization rate. Surprisingly, the number of hashtags and hyperlinks does not correlate with the achieved level of dialogic communication indicators. Also, this finding resulted in important implications for company communication and practitioners as well as for researchers focused on SM.

Detailed qualitative analysis of the top posts shows that the selected automotive brands use different strategies for SM marketing and maintaining communication with users. Mercedes-Benz CZ mostly published posts that were informative and aimed at promoting the brand and the efficiency, high quality, and technical characteristics of Mercedes engines and automobiles, and the posts did not use a action. The people responsible for communication on the SM of this brand often use links and a hashtag. An analysis of Hyundai's Facebook posts demonstrates a slightly different strategy. This brand, like the previous one, mainly publishes posts in the photo or photo album form. The content is mostly informative in relation to the promotion and popularization of the Hyundai brand, as well as the technical characteristics and advantages of the offered automobiles. Each of the five selected top-performing posts of this brand contained a call-to-action to support the interaction of followers with the brand page. The use of external links is lower.

The analysis of Kia's Facebook content strategy differs from the previous two in that all the top posts offer some sort of reward for

SM profile users (contest, UGT = remunerative). Top posts apply call-to-action but do not use external links and hashtags. The fourth brand whose social pages on Facebook were analyzed and researched is Toyota in the Czech Republic. This brand also published mostly informational posts. Calls-to-action are used with less emphasis, but external links quite often.

Liadeli et al. (2023) mentioned that one of the most common mistakes of SM campaigns is the lack of an overall content strategy. The conducted research from the automobile industry brings evidence and maps brand communication from social media in the context of the Czech Republic. To create online communities around their brands, managers must understand the nature of online behaviour (Brogi, 2014; Coelho et al., 2018).

In summary, the findings of this research provide additional knowledge needed for understanding SM marketing that can guide managers' decision-making when developing and improving their strategic marketing activities on SM. First, the study offers insights into understanding the role of the content format through how this variable may influence the effectiveness of specific types of posts on SM customer engagement behavior. Exploring these relationships to the detailed level of individual content types (including top posts) is crucial for managers as they can understand how and why the selection of a suitable format of the post and selected content will engage users, which means prospective or current customers of the car brand. The SM platform can be used in the form of an online brand community. Second, findings also provide insight, into how to adjust content characteristics depending on the SM platform, they intend to use to maximize content effectiveness. Third, our findings can guide SM marketers in identifying effective communication when conducting brand-related activities. A start point may be to monitor metrics such as UGT categories, and interactions with specific contents. Finally, consumers engage in different behaviors based on their attitudes. Marketers can segment SM users based on these attitudes, as well as on their motivations for using SM, and provide desired or expected gratification.

4.1 Research limitations

This research was focused on company profiles on Facebook in the context of the automobile

industry in Czech Republic, further, it is important to investigate the role of the type of platform (Facebook vs. Instagram) in facilitating social media engagement behavior.

Second, unfortunately, it is not possible to get relevant data (publicly accessible) for all top car brands concerning their Facebook profile and assess engagement rates. Thus, the study investigated four car profiles in depth in a selected context and time.

Third, an online brand community is a user group created online around a brand. Commonly, followers are a key measure for this research, but in fact, not only followers may interact with the brand page. Conversely, some followers may only be lurking.

Fourth, the study was focused on Facebook alone, and further research should investigate the marketing communication of automotive companies through other social media with new relevant indicators, such as LinkedIn, Twitter, and YouTube.

Last, this study did not directly investigate users. Researchers are unable to consider and research the characteristics of users who are engaged with posts on selected car brand profiles.

Conclusions

Companies are encouraged to continuously monitor online conversations and to engage in communication with their followers via social media networks. This research has built on previous theoretical underpinnings relating to company communication and social media with a focus on online brand communities. The conducted research demonstrates how selected brands in the automotive sector apply social media marketing, and what factors demand consideration when practitioners manage communication between an automotive brand and their customers using the brand community on SM with the general aim to enhance the brand visibility. Using knowledge from UGT, as well as paying attention to the types of expositive resources, yields higher engagement. This is also evident in the evaluation of communication from a dialogic communication perspective. The best posts with a message that meets users' needs in relation to social media communication are evidence of this and an example for benchmarking.

The research results are dependent on the selected automotive brands in the context

of the Czech Republic in the post-COVID 19 era. Further research could expand the existing knowledge of automotive brand communication on SM and include additional variables that would be capable to better capture the current situation in the area of the automotive industry and their customers on Facebook.

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Appendix

Tab. A1: Top posts (four automotive brands)

Date	Type of post	R	C	S	Content categories	Call-to-action	UGT categories	Link/hashtag	ERP	Electric car	Brief information about content
Mercedes-Benz Czech Republic											
14 May 2023	Video	600	20	39	Brand	No	Entertaining	Yes	1.20	No	Video focusing on the history of transport and women (Mother's Day), brand promotion
10 May 2023	Photo album	465	157	5	Driving comfort	No	Informational	Yes	1.14	No	Presentation of new Dolby system for Mercedes
7 January 2022	Photo album	394	46	16	Efficient operation	No	Informational	Yes	0.83	Yes	Information and photo album about the new luxury eco-prototype
Hyundai CZ											
19 July 2022	Photo	2,713	70	8	Engine	Yes	Informational	No	2.05	Yes	Photo of two concept cars with smileys and a question for user selection
1 February 2023	Photo album	1,600	245	4	Design	Yes	Relational	Yes	1.36	Yes	Call for user votes on two versions of the Kona
3 July 2022	Photo album	1,470	258	17	Engine		Informational	Yes	1.28	No	Photos of two IONIQ car models (with smileys) and question for followers about their choice
Kia Czech											
14 October 2022	Photo	1,100	1,600	171	Brand	Yes	Remunerative	No	4.95	No	Contest – Kia is official sponsor of FIFA World Cup, question and answers, photo with logo
12 May 2023	Photo	2,100	77	6	Driving comfort	No	Relational	No	3.77	No	Inviting users to vote on whether they prefer to be a driver or a passenger in the car
28 January 2022	Photo	711	1,100	101	Brand	Yes	Remunerative	No	3.3	No	Contest – Kia customer prize, photo of auto detail with logo and question and answers
Toyota Czech Republic											
15 February 2023	Photo album	1,700	62	76	Brand	No	Informational	Yes	4.23	No	Sad event, information about the death of the son of the founder of the brand
10 February 2023	Photo album	1,300	94	25	Brand	No	Informational	No	3.26	No	Photo album, a memory of a legendary car model
30 January 2023	Photo	1,300	68	16	Design	No	Informational	Yes	3.18	No	Photo of off-road car model plus question

Note: R – reactions; C – comments; S – shares.

Source: own

The influence of the Big Five, WOM communication and satisfaction on consumer loyalty in the Republic of Serbia

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Abstract: The concept of consumer loyalty plays an important role in business existence in the current competitive business environment. Consumer loyalty is researched in different ways by considering the characteristics of the consumer's personality, mutual communication between consumers, and their satisfaction with the company, products/services and numerous other determinants. Consumer personality is a potential marketing strategy for increasing loyalty towards a company, product and/or service, because many customers choose products that match their personality. The manner of communicating and conveying the experience of the product also depends on the consumer's personality traits, and this further affects a consumer's loyalty. Also, consumer satisfaction is another concept of qualitative and quantitative assessment of consumers after purchase, and it is a predictor of consumer loyalty and a free source of promotion for the company. The authors' goal is to examine the relationship between the concept of consumer personality, word of mouth (WOM) communication, consumer satisfaction, and loyalty on the mobile phone market in the Republic of Serbia, and then to make relevant conclusions about the mutual influence of the given factors in relation to the conducted empirical analysis. The data was obtained with the help of an online survey questionnaire, while the results were processed in statistical software packages for social sciences SPSS and AMOS. The research results show that all the researched variables included in the paper (Big Five, WOM communication, satisfaction) significantly influence consumer loyalty on the aforementioned market in the Republic of Serbia. The research explicitly builds on and contributes to previous literature on brand management, as it analyzes important predictors of consumer loyalty within a specific research area. Future studies could strengthen the existing literature by analyzing consumer loyalty towards a specific brand.

Keywords: Big Five, WOM communication, satisfaction, consumer loyalty, Republic of Serbia.

JEL Classification: M30, M31.

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Introduction

The concept of consumer loyalty is a key topic for marketing researchers. Consumer loyalty research was focused on identifying factors that determine loyalty, determining the strength of the relationship between those factors, and regarding their relationship with two possible outcomes of loyalty: purchase intention and loyalty action (purchase). The type and characteristics of the product/service, product price, the market size (in terms of the number and structure of consumers), as well as the intensity of the offer, i.e., competitors, significantly determine the strength of the connection between loyalty determinants, loyalty intention, and action (Chesnokova et al., 2014; Rowley, 2005).

However, the circumstances in which companies seek to develop attractive consumer loyalty strategies have changed drastically in recent years, especially in the period during and after the global pandemic. Namely, word of mouth (WOM) communication became the main factor in shaping consumers' preferences and attitudes and their intention for first and repeat purchases (Mauri & Minazzi, 2013; Meiners et al., 2010). WOM communication between consumers is intensified in the virtual environment to the extent that it becomes the basic source of consumer information, brand evaluation, and final consumer choice. The influence of the company and its messages, especially propaganda ones, on the creation of consumer preferences and attitudes is decreasing, while the influence of WOM is becoming far more significant. The latest research on different product/service categories confirms this within the dairy industry (Nguyen et al., 2022), banking industry (Hasan et al., 2020), tourism and hospitality (Serra Cantallops & Salvi, 2014), sports service (Alguacil et al., 2018), the automobile industry (Choi et al., 2022), the airline industry (Seo et al., 2020), and mobile commerce (Stefko et al., 2023).

However, individuals differ in their propensity for WOM. There are individuals who predominantly spend their free time in the virtual space, exchanging information and experiences through various platforms, especially through social media (SM). They intensively transmit and receive information and satisfy all their information needs on SM. On the other hand, there are individuals who are sceptic of information transmitted via virtual means,

and selectively consider the usefulness and relevance of information from such sources. Individuals' inclinations towards WOM, including eWOM, depend on various factors, such as personality characteristics, the degree of satisfaction with existing purchases, and the degree of attachment to the brand and/or company (Alguacil et al., 2018; Hosseinali et al., 2014; Kazemi et al., 2013).

Personality characteristics affect all aspects of a person's behavior, including their buying and consumption behavior. Personality traits are internal psychological characteristics that determine and reflect the way a person responds to their environment (Hall & Lindzey, 1998). Personality is complex to research because it cannot be seen, and only the effects of its manifestation can be analyzed. According to personality traits, individuals differ in openness, friendliness, rationality, emotionality, creativity, and impulsiveness. Trait theory is one of the five personality theories that explicitly explains a set of personality characteristics that can be used to describe and understand people's general predispositions. One personality trait manifests in a different way in each individual. According to Allport (1961), one person's stubbornness is different from any other person's stubbornness, and the way one person's stubbornness interacts with their extraversion and creativity cannot be duplicated by any other individual. In accordance with the above, there are two schools of trait theory. The first school believes that all people have the same set of traits and that each of them is different because the degree of manifestation of each trait is different. Another school considers that individual differences arise from a combination of traits, which varies from person to person, so that each person has their own set of specific traits (Sternberg, 2000). Beginning with this second school, the approach that is dominantly used in personality trait research began with Galton (1884), and continued with Big Five model (McCrae & Costa, 1990). This model is considered one of the primary benchmarks in personality trait theory. A large number of authors use this model in research, given that it explicitly explains human behavior (Anastasiei & Dospinescu, 2018; Rahman et al., 2018; Seo et al., 2020). Therefore, the paper contributes to the trait theory of personality by examining set variables in the mobile phone market in Serbia.

Individuals' preferences for WOM depend on the degree of satisfaction with previous purchases. In addition to the fact that satisfied consumers buy more and more often than those who are not satisfied, they spread positive information about the brand and the company (Hasan et al., 2020). On the other hand, dissatisfied consumers spread negative information about the brand and company to other consumers, and change the brand if their dissatisfaction is cumulative. However, the degree of satisfaction determines not only the inclination towards but also the intensity of eWOM. It has been proven that a higher degree of satisfaction results in more intense WOM and influence on consumers' intentions and/or future purchases (Anastasiei & Dospinescu, 2018; Kazemi et al., 2013; Seo et al., 2020).

The mobile phone industry is one of the most dynamic, since technological progress and knowledge have influenced the necessity to intensively innovate in order to satisfy increasingly demanding consumers. In order to maintain their market positions, mobile phone manufacturers must find new bases for product differentiation and create additional benefits for consumers. The dominance of smartphones and their use in searching for information, mobile shopping through apps/websites, entertainment, and giving reviews has radically changed the way of competing in the aforementioned market (Gibson, 2021; Nica, 2021; Stehel et al., 2021). This has become more pronounced in recent years due to the global pandemic. This is confirmed by data that reveals that the number of smartphones sold in the world increased every year between 2009 and 2019. A slight downward trend was noted and researched in 2020 (1.35 billion), as compared to 2019 (1.54 billion), but a slight increase was noted and researched in 2021 (1.43 billion) as compared to 2020 (Statista, 2022). According to the Republic Institute for Statistics of Serbia, 95.5% of individuals owned a mobile phone in 2021, which is 1.4% more than was the case in 2020; of the total number of mobile phone owners, 93% use a mobile phone for chatting over the internet, 84.7% use it to send online messages (Skype, Viber, Whatsapp, Messenger), 74.3% use it to participate in social networks, and 74.3% use it to search information about products and services (Republic Institute for Statistics of Serbia, 2022). Previous data indicates that, in future years, companies must

develop attractive and experiential marketing means to achieve consumer satisfaction and loyalty in order to retain their consumers (Marques & Dias, 2022). This further means that it is necessary to analyze the factors that influence the decision-making process, such as WOM communication generated by consumers (Choi & Lee, 2017), trust and perceived risk (Guo et al., 2018), personal characteristics (Seo et al., 2020), satisfaction (Andronie et al., 2021; Lăzăroiu et al., 2020), and intention to purchase products and services (Boonsiritomachai & Sud-On, 2020).

Starting with the importance of WOM for the purchasing decisions of modern consumers, their attraction and retention, the characteristics of consumers' personalities and the degree of their satisfaction as predictors of WOM and consumer loyalty, the main research goal of the authors in this paper is to examine whether these variables have an impact on consumer loyalty in the field of mobile phones trade in the Republic of Serbia.

In the research model, personality characteristics and consumer satisfaction are the two antecedents of WOM. Personality characteristics were investigated according to the Big Five model (extroversion, acceptability, conscientiousness, neuroticism, and openness), whereby the connection between the five personality characteristics individually and the degree of consumer satisfaction with the individual's tendency towards WOM were tested. In the second part of the model, an individual's tendency towards WOM is viewed as a direct antecedent of consumer loyalty, and consumer satisfaction is viewed as both a direct and an indirect antecedent of consumer loyalty. This paper contributes to filling the gap in the existing literature through several aspects. First, new variables are integrated into the research in order to get to know and understand the factors that influence consumer loyalty in the researched market in the Republic of Serbia. Second, the contribution of the paper is reflected in the small number of researches in this field in the Republic of Serbia. Third, the applied statistical analysis (SEM model) provides more indicative results, on the basis of which relevant conclusions were reached in the interpretation of the concepts of the Big Five, WOM communication, consumer satisfaction and loyalty. Finally, the Republic of Serbia is characterized by numerous migrations, and

therefore the integration of different peoples who also exhibit different personal characteristics. Based on the analysis of personal characteristics and set hypotheses, certain conclusions can be drawn in relation to whether the population of Serbia is cordial and prone to recommendations or antisocial and closed to communication. The starting assumption is that the more consumers are prone to WOM and satisfied with the brand, the higher their loyalty to the brand will be in the future. On the basis of the conducted empirical research, as well as existing research, we will be able to conduct a comparative analysis and provide guidelines for the strategic response of the company.

1. Theoretical background

1.1 Big Five and WOM communication

The characteristics of an individual's personality significantly influence all aspects of their behavior, including their purchasing and consumption behavior. Through their behavior, a person strives to achieve an ideal version of themselves, and their shopping and consumption behavior should enable and reinforce this. Personality is defined as the pattern of thoughts, feelings, attitudes, habits and behavior of each individual that persists over time in different situations, distinguishing one individual from others (Guilera et al., 2019). The personality traits of an individual as a consumer are analyzed in marketing on the basis of a personal concept (Casidy et al., 2009). In consumption, the personal concept represents the attitude that a person has about themselves which is manifested through purchases. However, individuals change over time – they adopt new personality traits and develop a different way of thinking. This means that the concept of personality traits is a dynamic category and should be continuously researched (Pervin, 2003).

A person's self-awareness is a key factor of the personal mindset. According to James (1892), there are three types of personal identity. Material identity is the first one, and it focuses on the individual, family and his or her property. Social identity is the second, and it shows how other people perceive the individual. The third is the spiritual identity, and it shows the inner being (attitudes, motives, emotions, opinions, and wishes). According to Cooley (1998), an American sociologist, social identity is the most popular. He described the forming

of identity as a reflection in the mirror, which means that every person forms their identity according to the manner in which other people see him or her.

The model that is dominantly used in the analysis of personality traits is the Big Five model of McCrae and Costa (1990), which involves five dimensions: extroversion, acceptability, conscientiousness, neuroticism, and openness. Extroversion, as a trait, refers to people who are active, communicative, fun and optimistic. Research shows that extroverted people have a positive attitude towards the social environment (Gerber et al., 2011). Additionally, extroversion manifests itself through the characteristic of robustness. People who possess such traits show a strong potential for leadership (Bartone et al., 2009; Judge & Bono, 2000). Based on the research, affinity towards leadership can only be observed in the example of extroversion or conscientiousness (Bartone et al., 2009). Accordingly, this research was operationalized based on the following three personality traits: talkative, social, assertiveness (McCrae & Costa, 1990). Acceptability is a trait of individuals who are soft-hearted, kind-hearted, and trusting, and who appreciate the quality of interpersonal orientation. Emotions are more powerful and harder to power in people who are characterized by acceptability, i.e., pleasantness (Finley et al., 2016). Also, people who are pleasant want to maintain positive relationships in their social environment (Jensen-Campbell & Graziano, 2001). In this research, the acceptability dimension was formed based on the following emotions: rough and careful (McCrae & Costa, 1990). Conscientiousness refers to people who are organized, reliable, diligent, self-disciplined, punctual, tidy, ambitious and persistent (Kumaraju et al., 2011). Research shows that conscientiousness has a positive correlation with egocentric perfectionism (Stoeber et al., 2009), although the differences between high conscientiousness and perfectionism are significant. On the one hand, people who strive for perfectionism are not pleased with the realized results, and are usually motivated by the lack of success. On the other hand, people who possess the characteristic of conscientiousness are motivated by the desire for success and show satisfaction with finished tasks (Hewitt & Flett, 2007). Analyzing a large number of traits, the following personality traits were applied in the paper within the dimension of conscientiousness:

fundamental, lazy, and efficient (McCrae & Costa, 1990). Neuroticism, as a trait, concerns people who are nervous, emotional, and insecure. Such persons very often have unrealistic ideas, are prone to psychological problems and often react inappropriately. The emotions operationalized in the research are caring, fast knitting, and relaxed (McCrae & Costa, 1990). Openness is the characteristic of people with broad interests, who are creative, original, and imaginative. Such persons very often appreciate working on themselves, have a higher level of tolerance, and explore the unknown. The following personality characteristics were applied in this paper: original, values artistic experiences, and imaginative (McCrae & Costa, 1990).

Knowledge of personality characteristics is key to understanding the consumers' tendency towards WOM, as it is one of the main factors influencing consumer behavior in the process of searching, choosing and using products. When making a purchase decision, consumers go through different levels of risk (Mundel et al., 2018). It is believed that consumers publishing their recommendations and conveying their personal experience can significantly mitigate the risk of a purchase (Li & Du, 2011). In conditions of saturation of information obtained through mass media and doubts about the truth and objectivity of such information, WOM becomes the most relevant source of information in the purchase process for many consumers (Anastasiei & Dospinescu, 2018; Boonsiritomachai & Sud-On, 2020; Seo et al., 2020). Consequently, WOM represents a reliable source of information in modern conditions, which has a huge influence on the formation of consumer attitudes and future purchase intentions.

Namely, an individual's tendency towards WOM is largely determined by their personality traits. Research conducted by Hosseinali et al. (2014) indicated a significant connection between most personality characteristics according to the Big Five model (extroversion, agreeableness, openness, and neuroticism) and the tendency to transmit WOM. Thus, for example, the authors Anastasiei and Dospinescu (2018) point out that each personality trait is related to that personality's tendency towards WOM, especially in the online environment (e-WOM). Hence, it is posited:

H1: There is a significant positive relationship between the Big Five and WOM communication.

1.2 WOM communication and consumer satisfaction and loyalty

Understanding the relationship between consumer satisfaction and WOM communication is key to managing the intention of satisfied consumers to spread positive WOM about the company and its brands (Popp & Woratschek, 2017). Namely, WOM communication can be positive or negative, and it is directly related to the degree of consumer satisfaction.

When consumer expectations are not met, the consumer is prone to negative WOM, which shows their frustration and increasing anxiety, and warns of them wanting and/or seeking compensation (Yang & Mundal, 2022). The propensity for negative WOM is greater than simply complaining to the company. This outcome is extremely unfavorable because it is transmitted to a large number of people in a viral environment via eWOM (Yang & Mundal, 2022). They spread brand hate (Zhang et al., 2020). Continued dissatisfaction leads to switching to another brand.

Positive WOM, on the other hand, is a favorable outcome for the company, and it is related to the fulfillment of consumer expectations, i.e., their satisfaction. Satisfied consumers convey positive comments that have a positive impact on brand reputation (Iqbal et al., 2021). This situation helps the company attract new customers and increase their propensity to make purchases. Satisfied consumers promote the company without direct compensation from the company, which has much more credibility than the company's promotional messages. The connection between consumer satisfaction and their intention, i.e., the desire to talk about their satisfaction to other consumers was first confirmed in marketing research almost three decades ago. The positive relationship between satisfaction and WOM intention is particularly pronounced in the service market due to the intangible nature of services, as proven by research (Prayag et al., 2017).

However, consumer satisfaction does not necessarily lead to WOM. There are studies that have not confirmed a positive relationship between these variables. Swanson and Hsu (2012) came to the conclusion that customers who are satisfied with their purchases do not necessarily recommend the company or convince others to buy. The relationship between satisfaction and positive intentions towards eWOM has also not been confirmed in the field of restaurant services (Yang, 2017).

On the basis of the aforementioned, we formulated the following hypothesis:

H2: There is a significant positive relationship between consumer satisfaction and WOM communication.

Numerous studies have shown that WOM communication directly and proportionally positively affects consumer loyalty, i.e., future purchase intention (Skackauskiene et al., 2016). The strength of the relationship between these two variables is conditioned by the level of consumer loyalty conveyed by WOM, that is, indirectly by the level of realized satisfaction as a predictor of loyalty (Wang et al., 2010). More loyal consumers show a greater tendency to express their positive attitudes and brand recommendations than those consumers who are less loyal (Worthington et al., 2010).

However, the question arises of whether consumers' greater tendency towards positive WOM means greater loyalty to the brand in the future. Therefore, the inverse relationship between these two variables was not the subject of the author's research, i.e., whether WOM tendency can be considered an antecedent of brand loyalty. Therefore, it is posted:

H3: There is a significant positive relationship between WOM communication and consumer loyalty.

1.3 Consumer satisfaction and loyalty

Consumer satisfaction is the evaluation of customers after a purchase, and is based

on the concept of value (Lin & Wang, 2006). According to Yang et al. (2017), satisfaction can be measured by observing the variations in the feeling felt before and after the customer uses any product or service. Satisfaction leads to loyalty, which means that satisfaction is a necessary antecedent for consumers to become loyal (Moreira et al., 2016).

Ensuring satisfaction is the main tool for creating long-term consumer loyalty and achieving superior business performance. In the long run, realized customer satisfaction has a positive impact on future cash flow, market share and profits. Satisfied consumers are less sensitive to price changes and cross-selling (Kazemi et al., 2013; Rahi & Ishaq, 2020). Greater business performance is also the result of the influence of satisfied consumers on attracting new consumers (Samar & Mazuri, 2019).

Previous studies have shown that a satisfied customer is a free source of brand and business promotion, which reduces the cost of attracting new customers. In accordance with the aforementioned research, we hypothesize the following:

H4: There is a significant positive relationship between customer satisfaction and loyalty.

2. Research methodology

2.1 Research sample

The research was conducted in the territory of Serbia between June and August 2022, and the total number of respondents was 300. An online survey questionnaire was distributed

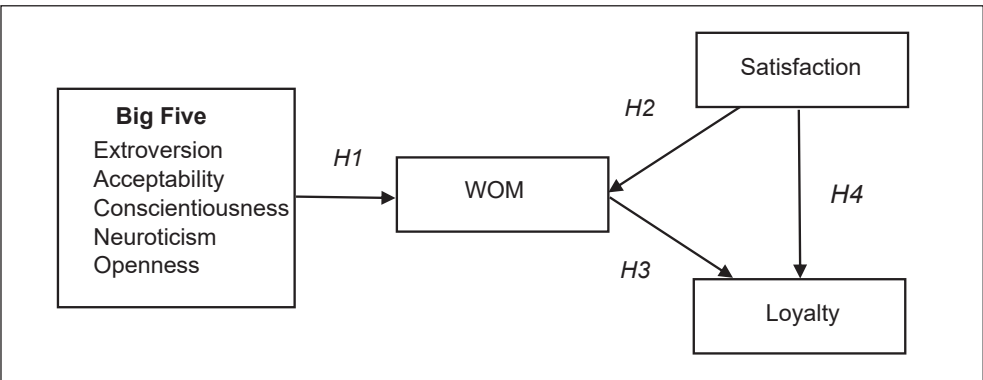


Fig. 1: Conceptual research model based on the developed hypotheses

Source: own

Tab. 1: Demographic characteristics of the respondents

Element	Number of respondents	Percentage share (%)
Gender	294	100.00
Male	105	35.71
Female	189	64.29
Age	294	100.00
Up to 20 years	24	8.16
21–30 years	207	70.41
31–40 years	63	21.43
Education	294	100.00
High school	62	21.09
College/university	95	32.31
Faculty/master	137	46.60
Status	294	100.00
Employed	215	73.13
Unemployed	34	11.56
Student	45	15.31

Source: own

to a simple random sample. The survey questionnaire was formulated in such a way that the respondents had to answer each question. The respondents were informed at the beginning of the questionnaire that the questionnaire is anonymous and that the data will only be used for research purposes. The number of questionnaires used in the paper is 294, due to the elimination of extreme points in the SPSS program, based on the box plot diagram. The demographic characteristics of the sample are shown in Tab. 1.

2.2 Measures

Empirical research was conducted with the help of survey methods, while an online questionnaire structured as follows was used to collect information. First, the posed questions included the demographic characteristics of the respondents, followed by statements related to the dimensions of the consumer's personality and statements related to WOM communication with consumers, consumer satisfaction, and loyalty. A total of 14 items were adapted from McCrae and Costa (1990) to measure personality constructs: *extroversion* – 3 items (e.g., "I am

a talkative person"); *acceptability* – 2 items (e.g., "I am a rough person"); *conscientiousness* – 3 items (e.g., "I am a fundamental person"); *neuroticism* – 3 items (e.g., "I am a caring person"); and *openness* – 3 items (e.g., "I am a original person"). To measure *WOM* communication with consumers, 2 items were adapted in accordance with Liu (2006), while *satisfaction* was examined based on 2 items which were adapted in accordance with Fornell (1992). Findings regarding consumer *loyalty* were adapted from Aaker (1997) and Ratchford (1987), and were measured by 4 items. The respondents expressed their degree of agreement with the offered statements using a five-point Likert scale, wherein grade 1 means completely disagree and grade 5 means completely agree. Cronbach reliability estimates were used to assess the internal consistency of the scales.

2.3 Statistical analysis

In order to reach relevant conclusions, data analysis was performed in the statistical software packages for social sciences (The Statistical Package for Social Sciences – SPSS, version 21) and AMOS (version 18). Regarding

the statistical analyses, descriptive statistics were used first, followed by exploratory factor analysis (EFA). Cronbach's alpha coefficient was used as a measure of the internal consistency of findings within the obtained factors. In addition, the fit of the model was examined through confirmatory factor analysis (CFA) by calculating the values of several important fit indices (χ^2/df , CFI, TLI, IFI, GFI, NFI, RFI, RMSEA). In order to examine the significance and strength of the relationships in the proposed model, the model of structural equations (structural equation modeling – SEM) was applied. In particular, the strength of the tested relationships was evaluated by analyzing the values of standardized regression coefficients. Before that, the assumptions of the application of SEM

analysis were examined, that is, the properties of linearity, normality, and multicollinearity were tested.

3. Research results

3.1 Validation of a research tool

The first step of the analysis was to calculate the arithmetic mean and standard deviation for each statement within the five dimensions of the Big Five. The goal of the descriptive analysis is to determine the homogeneity and heterogeneity between the views of the respondents. The results are presented in Tab. 2.

By interpreting the results of the arithmetic mean and standard deviation, it can be noted that the respondents generally believe that all the factors examined in the paper (Big

Tab. 2: Values of descriptive statistics (arithmetic mean and standard deviation) and factor loading – Part 1

Manifest variables	Mean	SD	Factor loading	Source of manifest variables
Extroversion				
Talkative	4.61	0.743	0.839	McCrae and Costa (1990)
Social	4.57	0.726	0.842	McCrae and Costa (1990)
Assertiveness	4.01	1.041	0.832	McCrae and Costa (1990)
Acceptability				
Rough	4.00	1.335	0.249	McCrae and Costa (1990)
Careful	4.49	0.682	0.232	McCrae and Costa (1990)
Conscientiousness				
Fundamental	4.61	0.738	0.839	McCrae and Costa (1990)
Lazy	3.59	1.497	0.851	McCrae and Costa (1990)
Efficient	4.59	0.625	0.844	McCrae and Costa (1990)
Neuroticism				
Caring	4.66	0.677	0.844	McCrae and Costa (1990)
Fast knitting	4.18	1.075	0.841	McCrae and Costa (1990)
Relaxed	4.22	1.076	0.840	McCrae and Costa (1990)

Tab. 2: Values of descriptive statistics (arithmetic mean and standard deviation) and factor loading – Part 2

Manifest variables	Mean	SD	Factor loading	Source of manifest variables
Openness				
Original	4.42	0.791	0.830	McCrae and Costa (1990)
Person values artistic experiences	4.47	0.986	0.834	McCrae and Costa (1990)
Imaginative	4.47	0.840	0.835	McCrae and Costa (1990)
WOM				
I would recommend the brand to other people (Wom1).	3.74	1.630	0.825	Liu (2006)
I would like to share my experience of buying the brand with other people (Wom2).	4.91	0.334	0.825	Liu (2006)
Satisfaction				
I am satisfied with this brand and its performance (S1).	3.71	1.697	0.601	Fornell (1992)
My choice to buy this brand was a wise one (S2).	4.47	1.013	0.601	Fornell (1992)
Loyalty				
Whenever possible I choose my favorite brand, the price difference between individual brands affects my intention to buy my favorite brand (LOY1).	4.83	0.434	0.820	Aaker (1997)
I want to pay a higher price when buying my favorite brand and without thinking (LOY2).	4.48	0.990	0.752	Aaker (1997)
I buy my favorite brand because I am satisfied and acquainted with the brand (LOY3).	4.44	0.914	0.583	Ratchford (1987)
I think it is the best choice for me (LOY4).	4.30	1.039	0.648	Ratchford (1987)

Source: own

Five, *WOM*, *satisfaction*, *loyalty*) influence their behavior when it comes to consumer *loyalty* towards brands of mobile phones. The highest value of the arithmetic mean refers to statements related to communication (4.91) and loyalty (4.83). The lowest value of the arithmetic mean was obtained in the statement that refers to the concept of the consumer's personality, that is, within the dimension of conscientiousness, and that of consumers who are lazy (3.59). By analyzing the value

of the standard deviation, it can be stated that the most homogeneous attitudes of the respondents are in relation to the statement „I would like to share my experience of buying the brand with other people” (standard deviation 0.334), while the greatest heterogeneity of attitudes can be seen in the statement „I am satisfied with this brand and its performance” (standard deviation 1.697).

The initial phase of the statistical analysis is devoted to testing the reliability and

validity of the research model. Tab. 2 shows factor loadings that were calculated to give an indication of how much of the variance in the researched variables can be explained by the factor. The ideal value of the load factor should be greater than 0.7, while an acceptable value is 0.5 (Hair et al., 2006). In this

context, to make sure the research tool is reliable, the internal consistency of the tool was checked using Cronbach's alpha coefficient, followed by an exploratory factor analysis, applied in order to assess the need to assess the conformity and validity of the model. The data is presented in Tab. 3.

Tab. 3: Cronbach's alpha and factor analysis results

Dimensions	Cronbach's alpha	No. of items	KMO and Bartlett's test	Sig.	Total variance explained
<i>Big Five</i>	0.961	14	0.924	<0.000	62.04
<i>Extroversion</i>	0.576	3	0.514	<0.000	56.03
<i>Acceptability</i>	0.015	2	0.500	0.874	50.45
<i>Conscientiousness</i>	0.950	3	0.500	<0.000	50.04
<i>Neuroticism</i>	0.856	3	0.583	<0.000	46.52
<i>Openness</i>	0.818	3	0.716	<0.000	74.93
<i>WOM</i>	0.919	2	0.500	<0.000	63.39
<i>Satisfaction</i>	0.668	2	0.500	<0.000	75.79
<i>Loyalty</i>	0.776	4	0.663	<0.000	60.54

Source: own

The results indicate that appropriate values of Cronbach's alpha coefficient were recorded. These values are higher than the threshold of 0.7, with the range between 0.5 and 0.7 showing moderate reliability, and results below 0.5 showing low reliability (Hinton et al., 2004), as exhibited by this value for the variable *extroversion* (0.576), the variable *satisfaction* (0.668), and the variable *acceptability*, which is at the minimum level. Thus, it can be concluded that each latent variable of the model, except for the variable *acceptability*, has an adequate level of reliability, i.e., that it is measured through internally consistent findings. The results of the exploratory factor analysis show that the *acceptability* variable achieved a KMO test value at the value threshold accepted for further analysis, i.e., 0.5. However, the values of the same latent variable do not show a statistically significant value, which should be below 0.05. Therefore, the *acceptability* variable is excluded from further analysis. The *loyalty* variable, which includes 4 statements, showed a KMO test value of 0.663 and a statistically significant *p*-value of 0.000. However, all statements within the variable should

achieve a threshold value above 0.4. This is not the case with the first statement: "Whenever possible I choose my favorite brand, the price difference between individual brands affects my intention to buy my favorite brand," which achieved a value of 0.336 and is therefore excluded from further analysis. All other variables achieved a KMO test value above the value threshold of 0.5, and achieved a statistically significant *p*-value (Sig.) below 0.05. All analyzed variables are explained by one factor, which means that all statements within the variables are compatible, and the percentage of explained factors is shown in the Total variance explained column (Tab. 3). The results of further analysis are better if the percentage of explanatory factors is higher.

3.2 Measurement model evaluation

The research model includes all the variables and relations of the given concepts in order to test the hypotheses. The paper started by considering the original Big Five model, and four dimensions were kept after the reliability analysis (*acceptability* was eliminated), resulting in an adapted Big Five model shown in Fig. 2.

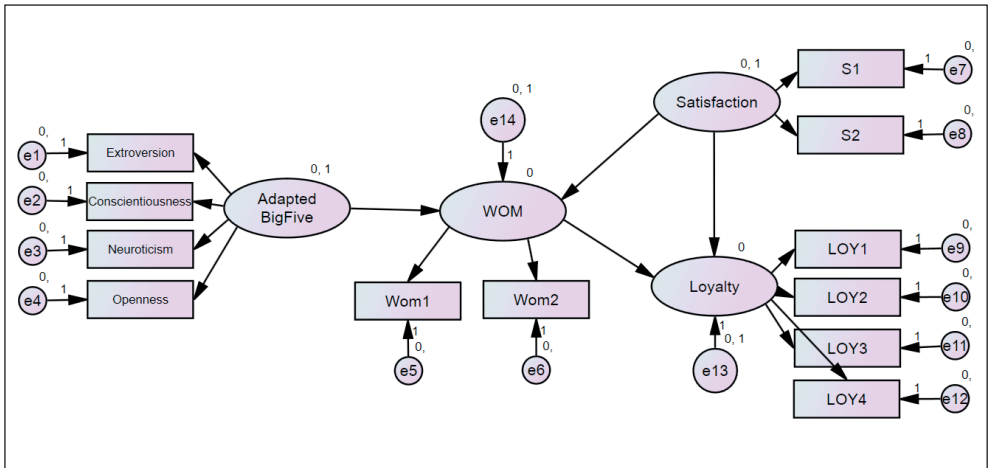


Fig. 2: Research model

Note: Wom1, Wom2, S1, S2, LOY1, LOY2, LOY3, LOY4 are items shown in Tab. 2

Source: own

The outputs of this part of the analysis indicate the degree of suitability of the methods for the evaluation of the structural model. Although the value of the χ^2 statistic should not be statistically significant for the validity of the model, the value of this indicator is statistically significant in the given research model – at $p < 0.001$ level. Namely, this result could be justified by the fact that the sample includes a larger number of respondents than the number of variables used, as well as by the fact that the χ^2 test largely depends on the complexity of the research model itself. For this reason, the ratio χ^2/df , which is within the recommended

value, provides a better estimate of the validity of the model. The closer the value of the CFI indicator is to the value of 1, the better the validity of the model. Also, the value of the RMSEA indicator is lower than 0.1, which is in accordance with the recommended value. Therefore, based on the given parameters, as well as all of the aforementioned, whose values are within those previously identified as reference, it can be confirmed that the designed model showed an acceptable level of compliance. Given that the p -value is lower than 0.05, we evaluate the model as statistically significant.

Tab. 4: Model validity indicators

Indicators	Research model	Recommended value
χ^2/df	3.545	<5.0
GFI	0.987	>0.9
IFI	0.956	>0.9
TLI	0.934	>0.9
CFI	0.956	>0.9
RMSEA	0.093	<0.1

Source: own

3.3 Evaluation of the structural model

After the confirmatory factor analysis was conducted to identify the connection between the variables and test the hypotheses, the structural equation model was applied. The results of the tested connections between the variables in relation to the analysis of the hypotheses set in the paper are shown in Tab. 5. By analyzing the indicators in the structural equation model, the following conclusions are reached. When it comes to the dimensions of consumer personality and communication with consumers, it

is concluded that the dimensions of consumer personality have a statistically significant but negative influence on communication with consumers ($B = -0.086, p < 0.001$). Conversely, consumer *satisfaction* has a statistically significant and positive impact on communication with consumers ($B = 0.231, p < 0.001$). Finally, analyzing the relationship between the *WOM* variable and consumer *loyalty* ($B = 1.403, p = 0.003$), as well as between *satisfaction* and consumer loyalty ($B = 0.399, p < 0.001$), we can conclude that there is a statistically significant and positive influence.

Tab. 5: Testing the relationships between SEM variables

Researched relationship	Estimate	Statistical significance (p)	Result
<i>Adapted Big Five</i> → <i>WOM</i>	-0.086	0.000	Accepted
<i>Satisfaction</i> → <i>WOM</i>	0.231	0.000	Accepted
<i>WOM</i> → <i>loyalty</i>	1.403	0.003	Accepted
<i>Satisfaction</i> → <i>loyalty</i>	0.399	0.000	Accepted

Source: own

Based on the previous analysis, we can conclude that all of the proposed hypotheses have been confirmed. Namely, by testing the first defined hypothesis, related to the dimensions of consumer personality and *WOM* communication, it can be concluded that increasing the adapted Big Five dimensions by one unit decreases *WOM* communication by 0.086 units, while all other conditions remain unchanged ($B = -0.086, p < 0.001$). Then, if *satisfaction* increases by one unit, *WOM* communication increases by 0.231 units, with all other conditions remaining unchanged ($B = 0.231, p < 0.001$). Furthermore, if *WOM* communication increases by one unit, *loyalty* will increase by 1.403 units, with all other conditions remaining unchanged ($B = 1.403, p < 0.001$). Finally, if *satisfaction* increases by one unit, loyalty will increase by 0.399, while all other conditions remain unchanged ($B = 0.399, p < 0.001$).

4. Discussion

The research observed in the paper is focused on recognizing key variables (Big Five concept, *WOM* communication, *satisfaction*) that influence consumer loyalty on the mobile phone

market in the Republic of Serbia. That is, it began with a descriptive analysis (arithmetic mean and standard deviation) with the aim of determining the average value of each examined statement within the set variables, along with determining the homogeneity/heterogeneity of the sample. Then, an analysis of the reliability of the Big Five, *WOM* communication, *satisfaction* and brand loyalty, and correlation analysis between dimensions was performed as a significant requirement for further analysis and the interpretation of conclusions. Finally, the connection between the variables was established, and further guidelines for improving operations in the mentioned markets were formulated based on the defined hypotheses. Overall, the personal characteristics of consumers are an important predictor of *WOM* communication in our research. Of the five analyzed personal characteristics, only one did not show a statistically significant influence on *WOM* communication (acceptability). The indirect impact of *WOM* communication is reflected in the established relationship between *satisfaction* and consumer loyalty. Consumers who are satisfied will be more inclined

to communicate and make recommendations, which further has a positive effect on loyalty. This implies that a positive direct relationship has been established between satisfaction and WOM communication, as well as between satisfaction and consumer loyalty.

The purpose of the first hypothesis was to indicate the influence of consumer personality dimensions on the tendency towards WOM communication between consumers. The results of the research indicate that a positive relationship has been formed in the mobile phone market, that is, that there is a significant relationship between the dimensions of the adapted Big Five (extroversion, conscientiousness, neuroticism, openness) and WOM communication. This further affects the positive relationship towards consumer loyalty in the mobile phone market, which was also confirmed by the third hypothesis. The results obtained in this way are consistent with existing research (Huang et al., 2012; Šeimienė, 2015). Research on the mobile phone market has shown that consumer characteristics have a positive effect on emotional loyalty towards the Apple and Samsung brands. Namely, according to the authors Teimouri et al. (2016), brand personality is proportional to each customer having an extroverted and congruent personality. Therefore, Samsung should highlight its genuine personality and create value for customers by creating a fit between consumer personality and brand personality that ultimately leads to customer loyalty. The authors' proposal is that the Samsung company stimulates the loyalty of its customers by taking into account the personality of its different consumer groups via a distinct brand personality. Research conducted by Letukytė and Urbonavičius (2022) indicates that the concept of consumer personality has a positive effect on the emotional loyalty of consumers in the mobile phone market. By observing the constituent dimensions of the consumers' personalities within the scope of research in this paper, it can be concluded that the acceptability dimension is excluded from further research, i.e., that consumers who are soft-hearted, who assess the quality of interpersonal orientation, and who are good-natured, and trustworthy were not taken into further consideration and analysis in the paper. The reasons for this are the low level of reliability and internally inconsistent findings. Accordingly, the concept of consumer

personality was considered through the remaining four dimensions, which showed a positive relationship with consumer loyalty. This indicates that there is room for business improvement in the mobile phone market in the sense that the marketing activities of the company should be aimed at those consumers who are described through the acceptability dimension.

Regarding the second defined hypothesis, the research results show a positive influence of consumer satisfaction on the tendency towards WOM communication, given that a statistically significant value was obtained (Sig. < 0.000). The results obtained in this way are in accordance with previous scientific research (Popp & Woratschek, 2017; Prayag et al., 2017; Yacouel & Fleischer, 2012). Despite such empirical results, companies should be marketing-oriented, in the sense that they continuously create superior value for consumers in order to achieve total satisfaction. Creating total customer satisfaction increases the possibility of generating new customers via positive WOM communication. The propensity of consumers to communicate their positive experiences about a product/service or company can be analyzed through various factors that motivate them to such activities. Accordingly, this research is in agreement with the authors Hennig-Thurau et al. (2004), who proved that satisfied consumers more often transfer knowledge and positive feelings, give advice to others, and receive advice from others.

The third defined hypothesis aimed to examine the relationship between WOM communication and consumer loyalty in the mobile phone market in the Republic of Serbia. The research results show the impact of WOM communication on consumer loyalty, given that a statistically significant value was obtained (significant 0.003). The results obtained in this way agree with previous scientific research (Skackauskiene et al., 2016; Wang et al., 2010). Long-term customer loyalty is the focus of a marketing-oriented company. However, the difficulties in securing long-term consumer loyalty require companies to constantly investigate the factors that drive loyalty and the factors that demotivate consumers from long-term commitment to the company/brand (Evanschitzky et al., 2011). Relevant information can also be obtained on the basis of continuous communication with consumers who convey their experiences to other consumers

and to the company. In our research, this connection was proven, that is, it was proven that WOM communication contributes to consumer loyalty. In this sense, loyal consumers represent a free source of promotion for the company, which positively affects the reputation of the brand and the company. Also, the implementation of attractive loyalty programs results in customer satisfaction and retention, which provides the opportunity to spread positive WOM communication to other consumers.

Finally, the fourth defined hypothesis was examined within the framework of the empirical research, namely the relationship between consumer satisfaction and consumer loyalty in the mobile phone market in the Republic of Serbia. The results of the research show the impact of consumer satisfaction on consumer loyalty, considering that a statistically significant value was obtained (significant 0.003). The results obtained in this way are in accordance with previous scientific research (Kazemi et al., 2013; Rahi & Ishaq, 2020; Samar & Mazuri, 2019). Customer loyalty management is a process that includes a set of activities aimed at identifying high-value customers and creating value for them. Such consumers generate company profits, convey positive attitudes to other consumers, and attract new consumers. This further means that companies should continue to nurture relationships with loyal consumers by listening to their new needs and satisfying them, because loyal consumers are less sensitive to changes in the company's operations, and they influence the company's business performance and represent a free source of company promotion.

Conclusions

Analyzing the concepts of consumer personality (Big Five), WOM communication, and consumer satisfaction and loyalty, as well as testing the causal relationships of the given variables, are important business activities of market-oriented companies. This means that companies follow the changes in the market in their operations in order to listen to the voice of consumers and define a marketing strategy in accordance with their needs and wishes. That is why it is important to analyze the concept of consumer personality, which indicates the characteristics of the target group of consumers. Creating and delivering superior customer value indicates customer satisfaction over a longer period of time, which further

implies long-term loyalty. Consumer loyalty is the ultimate effect of all marketing activities, given that consumers are attached to the company, show a high degree of repeat purchase frequency, spread positive information about the company, and find new ways to increase the value of the company, which makes them co-creators of value.

The research carried out in the Republic of Serbia showed that all the researched variables in the paper (consumer personality concept, WOM communication, satisfaction) significantly influence consumer loyalty on the mobile phone market in the Republic of Serbia. It could be concluded that this study supports the existing trait theory of personality which explains that consumer buying behavior is closely related to personality traits, and that consumers choose those products that best reflect their personality. Given that Serbia is a developing country with numerous cultural differences, the contribution of this research is reflected in the relationship between WOM communication and the Big Five model on a multicultural basis. Also, based on our research, it can be concluded that people in Serbia are open to communication, provide advice on products/services, and are prone to recommendations. When consumers are prone to recommendations, they are typically satisfied and can be loyal consumers. However, despite the results obtained in this way, companies that want to be market leaders must permanently work on building a modern and reliable brand, given that it is a technology and innovation market. Furthermore, a reliable brand leads to consumer satisfaction, which should be maintained in the long term by creating attractive loyalty programs for consumers through gamification, which results in total consumer satisfaction. In this way, we create consumer advocates who will spread a positive experience about the company, product, or service to other consumers, which increases the probability of attracting new consumers. This study also gives certain guidelines to managers in business, which are primarily reflected in the establishment of a connection between the consumer's personality and WOM communication, and points out the way in which information on psychographic segmentation should be connected with WOM communication. The relationship thus established further affects consumer loyalty. Also, marketing activities should be aimed at retaining the existing group

of consumers based on the favorable dimensions of the consumer's personality. However, an attempt should also be made to understand other consumers through influence on the acceptability dimension and the use of other variables. In addition, this paper utilizes a different approach, i.e., the application of a methodology that is not usual for this field of research, such as structural equation modeling (SEM), which enables the creation of structural models aimed at understanding the relationship and influence between variables.

This study has a few limitations that should be acknowledged, the most important of which are the size and type of sample and the incorporation of additional factors in the analysis. Although numerous studies clearly show that some people have a greater tendency than others to talk about products and brands, determined by their personal characteristics, future research can be based on the relationship between the respondents' personality traits and their particular motivations for generating word of mouth. Different individuals are expected to have different primary reasons for generating word of mouth about products and brands. A demographically balanced proportion within the sample could be helpful in further research, as could cross-cultural analysis. Consumers with different cultural customs have different personality traits and different perception of the brand. In other words, this analysis should have components such as the trust consumers have in the brand, their awareness of the brand, and the concept of brand personality, because these elements show the real picture of consumer loyalty and provide us with the clear picture of all the components that affect the relationship between the brand, consumers and their loyalty. Also, future research can be focused on the analysis of consumer loyalty towards a specific brand. Additionally, future research can deal with electronic word of mouth (eWOM) communication as a global phenomenon in different countries and cultures.

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