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ЕКОНОМИКА

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МЕЂУНАРОДНИ ЧАСОПИС
ЗА ЕКОНОМСКУ ТЕОРИЈУ И ПРАКСУ И ДРУШТВЕНА ПИТАЊА

ЕКОНОМИКА

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1. Часопис “Економика” покренут је јула 1954. године и под називом “ Нишки привредни гласник” излазио је до јуна 1957. године, а као “Привредни гласник” до краја 1969. године. Назив “Наука и пракса” носио је закључно са бројем 1/1973. год. када добија назив “Економика” који и данас има.

2. Часопис су покренули Друштво економиста Ниша и Друштво инжињера и техничара Ниша (остало као издавач до краја 1964. године). Удружење књиговођа постаје издавач почев од броја 6-7/1958. године. Економски факултет у Нишу на основу своје одлуке броја 04-2021 од 26.12.1991. године постао је суиздавач “Економике”. Такође и Економски факултет у ПриШтини постао је суиздавач од 1992. године. Почев од 1992. године суиздавач “Економике”

је и Друштво за маркетинг региона Ниш. Као суиздавач "Економике" фигурирали су у току 1990-1996. године и Фонд за научни рад општине Ниш, Завод за просторно и урбанистичко планирање Ниш и Корпорација Винер Брокер Ниш.

3. Републички секретаријат за информације СР Србије својим Решењем бр. 651-126/73-02 од 27. новембра 1974. године усвојио је захтев "Економике" за упис у Регистар новина. Скупштина Друштва економиста Ниша на седници од 24. априла 1990. године статутарном одлуком потврдила је да "Економика" има статус правног лица. На седници Скупштине Друштва економиста Ниш од 11. новембра 1999. године донета је одлука да "Економика" отвори посебан жиро-рачун.

4. Према Мишљењу Републичког секретаријата за културу СР Србије бр. 413-516/73-02 од 10. јула 1973. године и Министарства за науку и технологију Републике Србије бр. 541-03-363/94-02 од 30. јуна 1994. године "Економика" има статус научног и ранг националног часописа "Економика" је почев од 1995. добила статус међународног економског часописа.

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2. The Journal was initiated by the Society of Economists of Nis and the Society of Engineers and Technicians of Nis (the latter remaind as the publisher till the end of 1964). The Society of Accountants became its publisher starting from the issue no. 6-7/1958. The Faculty of Economics, Nis, on the basis of its Resolution No. 04-2021 from December 26, 1991, became the co-publisher of EKONOMIKA. Likewise, the Faculty of Economics of Pristina became the co-publisher since in 1992. Starting from 1992, the co-publisher of EKONOMIKA has been the Society for Marketing of the Region of Nis. Other co-publishers of EKONOMIKA included, in the period 1990-1996, the Foundation for Scientific Work of the Municipality of Nis, the Institute for Spatial and Urban Planning of Nis and the Corporation Winner Broker, Nis.

3. The Republic Secretariat for Information of the Socialist Republic of Serbia, by its Resolution No. 651-126/73-02 from November, 27, 1974, approved of EKONOMIKA's requirement to be introduced into the Press Register. The Assembly of the Society of Economists of Nis, at its session on April 24, 1990, by its statutory resolution, confrmed the legal status of EKONOMIKA. At the session of the Assembly of the Society of Economists, Nis, on November 11, 1999, the resolution was adopted the EKONOMIKA was to open its own bank account.

4. According to the Opinion of the Republic Secretariat for Culture of the Socialist Republic of Serbia No. 413-516/73-02 from July 10, 1973 and the Ministry for Science and Technology of the Republic of Serbia No. 541-03-363/94-02 from June 30, 1994, EKONOMIKA has the status of a scientific and national journal. Starting from 1995, EKONOMIKA has been having the status of international economic journal.

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THE INFLUENCE OF THE QUALITY OF POLITICAL INSTITUTIONS ON THE LEVEL OF FINANCIAL DEVELOPMENT: A PANEL ANALYSIS OF THE BALKAN COUNTRIES

Abstract

Through the allocation of scarce financial resources and the selection of investment projects, the financial system plays a major role in the economic growth of the country. Modern economic science, on the other hand, recently recognized the importance of institutional factors in shaping economic dynamics. The question arises whether there is and what is the influence of political institutions on the level of financial development of the country. Although there is an extensive literature in this area, there is a lack of research that deals only with the Balkan countries. Due to their specific historical heritage, most of these countries started developing a market-based financial system only in the last decade of the 20th century. The aim of the paper is to examine the influence of the quality of institutions measured by World Governance Indicators (WGI) on the level of financial development expressed by the share of domestic loans to the private sector in GDP.

Key words: *financial development, financial system, Balkan countries, institutions, WGI, panel data*

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УТИЦАЈ КВАЛИТЕТА ПОЛИТИЧКИХ ИНСТИТУЦИЈА НА НИВО ФИНАНСИЈСКОГ РАЗВОЈА: ПАНЕЛ АНАЛИЗА БАЛКАНСКИХ ЗЕМАЉА

Апстракт

Кроз алокацију оскудних финансијских средстава и селекционисање инвестиционих пројеката финансијски систем игра велику улогу у привредног расту земље. Модерна економска наука је, са друге стране, релативно скоро препознала значај институционалних фактора у обликовању економске динамике. Поставља се питање да ли постоји и какав је утицај политичких институција на ниво финансијске развијености земље. Иако постоји обимна литература у овој области, примећен је недостатак истраживања које се

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бави само балканским земљама. Због свог специфичног историјског наслеђа већина ових земаља је са развојем финансијског система на тржишним основама кренула тек у последњој деценији 20. века. Циљ рада је да испита какав је утицај квалитета институција мерених WG индикаторима на ниво финансијске развијености изражен уделом домаћих кредита приватном сектору у БДП-у.

Кључне речи: *финансијска развијеност, финансијски систем, Балканске земље, институције, WGI, панел подаци*

Introduction

At the beginning of the last century, Schumpeter pointed out the importance of the financial system for the economic growth of the country, because it provides entrepreneurs with the necessary financial resources for the realization of investment projects, which have an expansive effect on the dynamics of the capitalist economy. Through the allocative function, the financial system ensures that scarce funds are allocated to exactly those projects that have the highest return and give the greatest impetus to economic growth. Hicks (1969) emphasized the importance of the financial system for starting the industrial revolution in England. The development of statistical instruments made it possible to confirm the positive relationship empirically (Levin, 1997). By reducing the costs of external financing for companies, the developed financial system becomes an important factor in economic growth (Rajan & Zingales, 1998). In addition, the modern financial system promotes investments by identifying and financing attractive projects, mobilizing savings, controlling the performance of managers, enabling trade, hedging and risk diversification (Bekana, 2023).

On the other hand, only at the end of the 20th century, after several decades of dominance of the neoclassical approach, economic science started recognizing the fact that economic activity does not take place in a kind of vacuum, but that it is the result of numerous and complex processes and flows that have an institutional character. North (1991) defines institutions as rules created by men, which shape political, economic and social interactions. They are reflected through formal and informal systems of rules and customs that represent a landmark for human action. Acemoglu et al. (2001) point out that institutions are one of the main determinants of long-term economic growth. Institutions create an environment that can both stimulate and disincentivize economic and social activities (Frunza, 2011).

Based on that, the question arises as to what is the influence of socio-political institutions on the level of financial development of the country? De Soto (2000) points out that the lack of property rights represents a significant obstacle to the financial development of the country. The capital market requires the existence of protection of property rights over time and the absence of the ability of the government to seize one's property or change its value (North, 1991). If economic subjects do not have legal certainty regarding the realization of rights as creditors, they will avoid entering into such transactions (Fergusson, 2006). The importance of institutional factors and compliance

with the law for the development of financial markets stems from the nature of the business that is performed there. Namely, the conditioning of the operation of the entire financial system by trust between two parties is constantly burdened by the impossibility of the one who is in the role of creditor to know the intentions and monitor the behavior of the borrower. The consequence is that in financial markets information asymmetry and distribution of information has greater implications for resource allocation compared to other markets (Capasso, 2004). Also, Roe and Siegel (2011) emphasize the importance of democracy and political stability on the development of the financial sector, because they can also shape political institutions.

The influence of institutions is not limited only to the size measured by the volume of transactions, but also to the structure of the financial system. Depending on the method, i.e. channels through which economic subjects acquire missing financial resources, the financial system can be classified as dominantly market-oriented or bank-oriented. The profiling of these systems in one direction or another is often conditioned by centuries of exposure to the system of rules and laws in the country, primarily those that concern the protection of investors' property. The development of a market-oriented system, as in Great Britain and the USA, is linked to the application of common law, while the civil law in the continental part of Europe favored financing through banks (La Porta et al, 1997). Namely, the civil code gives investors fewer rights compared to the common law system, regardless of the level of economic development, which is why financing through banks is more frequent and common (La Porta et al, 1998). In addition, the positive impact of customary law can be linked to greater adaptability of this system to the real circumstances and needs of economic agents (Back & Levine, 2003).

Confirmation of the previous statements can be found by analyzing the historical development of the financial systems of developed Western countries. North and Weingast (1989) in a study of the achievements of the Glorious Revolution from the 17th century state that institutional changes aimed at protecting the property rights of the people and preventing the arbitrariness of the crown provided the basis for the development of the private capital market. The certainty and security of creditors made it possible to multiply the mobilization function of the state for the necessary financial resources, which in turn encouraged the development of private markets. Under different socio-historical circumstances, different legal systems were created (Common Law, French, German and Scandinavian civil code systems), with different impacts on the general economic and financial system performance (La Porta et al, 1997; 1998; Back & Levine, 2003). According to Acemoglu et al. (2001), the quality and character of institutions in developing countries is a function of their colonial past. By building institutions, including those that regulate the financial system, the colonizers tried to maintain the extractive nature of those economies, and prevent the development of modern states that could compete with them on the international level at a certain moment, which resulted in the general underdevelopment of these countries even today.

The modern approach in development economics highlights the benefits and necessity of liberalizing economic flows for the sake of greater development performance, which also applies to the financial sector. However, there are empirical confirmations that good institutions and public management are a prerequisite for the positive effects of financial liberalization on the development of the financial sector to manifest (Karikari, 2010; Chin & Ito, 2002). Liberalization in the conditions of a system in which there is

no sufficient articulation of the protection of property rights, and the security of creditors will not result in the desired effects. Also, the influence of financial development on economic growth can depend on the quality of institutions in the country (Law et al, 2018). The influence of the financial system on economic growth is most pronounced in medium-developed countries with quality institutions, while in low-income countries without good institutions, financial development may not ensure long-term economic growth (Demetriades & Law, 2006).

The aim of this paper is to examine the nature and character of the influence of institutional factors on the level of development of the financial system of the Balkan countries in the period 2000-2023. The World Governance Indicators (WGI) were used as an indicator of institutions, while the level of financial development was shown through the share of domestic loans to the private sector as a share of GDP. In the first part of the paper, a review of the existing literature was carried out, where the focus was on research that used the same indicators. In the second part of the paper, descriptive statistics of the data used are given, while the research with the conclusion is in the third part of the paper.

Review of Existing Literature

There is extensive literature on the relationship between the institutional environment and the level of financial development of the country. The authors used various statistical models such as random and fixed effects to more demanding ones such as GMM and ARDL. Samples range from large groups of more than a hundred countries to time series analysis of single country data. However, the absence of research dealing with this issue on the sample of Balkan countries was noticed, which represents the main scientific novelty of this paper.

In a panel of 189 countries in the period 2002-2017, using OLS, random and fixed effects, but also the dynamic GMM model, the influence of institutional quality on financial development was examined (Khan et al., 2020). The variable *domestic credits to private sector by bank (% of GDP)* was used as an indicator of financial development, while WGI were used for the quality of institutions. Of the six indicators, *Political stability*, *Control of corruption* and *Regulatory quality* had a positive, and *Rule of law* had a statistically negative impact on financial development.

Dividing the group of 131 countries into developed and developing countries, Lisbinski and Burnquist (2024) applied GMM to examine the influence of institutions on the level of financial development expressed through the share of domestic loans to the private sector in GDP. On the other side, WGI and the index of economic freedom were used. In the group with developed countries, institutional factors were not statistically significant, while in the other group they were. Due to the already high level of institutional development in developed countries, there is insufficient variation in these factors, so other factors such as technological innovation and human capital gain importance (Lisbinski & Burnquist, 2024).

Law and Azman-Saini (2012) recognized the fact that the financial system can be market- and bank-oriented, and therefore used separately *credits to private sector by bank (% of GDP)* as an indicator of the development of the banking system and *stock*

market capitalization as an indicator of the development of the financial market. In order to check the robustness of the research, the authors also used alternative indicators of the quality of institutions and public management from the WGI and ICRG[4] (International Country Risk Guide). The positive influence of the quality of institutions on the banking sector has been confirmed, while the relationship between institutions and the capital market is in the form of the Latin letter U, i.e. up to a certain level, the quality of institutions has a negative effect, and only at higher levels it has a positive effect on the growth of the capital market.

On a sample of 120 countries, where 32 are high-income and 88 are low-income, Ondoa and Seabrook (2020) used the CCEMG method to examine the relationship between the WGI and the level of financial development in the period 2002-2017. The depth of financial institutions was used as the main indicator of financial development (Svirydzenka, 2016), while an additional check was made by the share of loans to the private sector in GDP. The variables *political stability* and *regulatory quality* had a positive impact, while *voice and accountability* and *government effectiveness* had a negative impact. The choice between alternative dependent variables was not associated with significant differences in results.

In addition to research with a very broad, even global sample, there are also studies that deal with the relationship between institutions and financial development at the regional level. Feng and Yu (2020) examined the role of institutions on the financial development of 11 East Asian countries in the period 1996-2017 using panel and data for each individual country. The impact of the six subcomponents of the IEF (Index of Economic Freedom) published by the Heritage Foundation and the six WGI were separately considered, with the former representing the quality of economic institutions and the latter the quality of legal and political institutions. Different institutions had different roles in different countries; however, the influence of legal-political ones was more pronounced because five out of six were statistically significant, compared to three for economic ones.

Bekana (2023), on an example of 45 African countries, in the period 1996-2018. examined how the quality of institutions affects the development of the financial sector at different levels of financial development using the quantile regression method. Based on six WGI, a composite indicator of the quality of institutions was created, while the share of domestic loans to the private sector in GDP was used as the dependent variable. The research confirmed the positive influence of institutions on the dependent variable, where it was shown that at higher observed quantiles, i.e. at higher levels of financial development, the influence of institutions becomes more pronounced.

On the other hand, there are studies in which the influence of institutions on financial development has not been confirmed (Fagbemi & Ajibike, 2018). Using the ARDL and bound test, the authors examined the influence of institutions, trade openness and the level of economic development on the size of the financial sector expressed by the share of loans to the private sector in GDP and the share of money supply M2 in GDP on the example of Nigeria in the period 1984-2015. The control variables were statistically significant, while the quality of institutions was not statistically significant either in the short or long term. This is

[4] In the model using WGI, the number of observed countries is 63 and the time period is 1996–2004, while in the model using ICRG, 51 countries are included and the period is 1984–2004.

explained by the fact that the quality of institutions in Nigeria in the observed period was at a very low level, as a result of which it could not achieve a positive effect.

Also, Cherif and Gazdar (2010) observed 14 MENA (The Middle East and North Africa) countries in the period 1990-2007 ICRG indicators (International Country Risk Guide) were used as indicators of institutions, while the level of capital market development as a share of market capitalization in GDP is an independent variable. The research did not confirm the statistically significant influence of institutions on the development of the capital market.

Overview of Used Variables and Descriptive Statistics

The paper used panel data, which actually represent a combination of cross-sectoral and temporal data. Hsao (2003) and Klevmarken (1989) state a number of reasons why panel data should be used in econometric research, such as control of individual heterogeneity, greater information content, the possibility of testing more complex models, etc. The research covers a group of ten Balkan countries in the period 2000-2023. All data are taken from the WDI (World Development Indicators) and WGI databases of the World Bank. An overview of the variables used is given below in Table 1.

Table 1. Overview of used variables

Variable	Source	Description
Domestic credits to private sector (% GDP)	WDI	The amount of financial resources provided to the private sector by financial corporations in the form of loans, bond purchases, trade credits, etc., expressed as a share of GDP. Financial corporations include the monetary authority, depository credit banks, but also other organizations such as leasing corporations, insurance institutions, pension funds, etc...
Rule of Law	WGI	It represents the perception of public trust and the extent to which agents obey the rules of society. Enforcement of contractual obligations, protection of property rights, independence of judiciary and police...
Government Effectiveness	WGI	It measures the perception of the quality of public goods, public service services, the degree of its independence from political pressures, the quality of public policies and the government's consistency in their implementation.
Regulatory Quality	WGI	It represents the public's perception of the government's ability to formulate and implement sound policies and create regulations that promote private sector growth.
Control of Corruption	WGI	The perception of the extent to which public position is used for personal gain, including grand and petty corruption, as well as the degree to which the state is captured by elites and private interests.

Voice and Accountability	WGI	The perception of the degree to which the citizens of a country are able to participate in the election of the government, the degree of freedom of expression, association and freedom of the media.
Political Stability and Absence of Violence/ Terrorism	WGI	It measures the perception of the likelihood of political instability and/or politically motivated violence, including terrorism.
Trade (% of GDP)	WDI	The sum of exports and imports of goods and services expressed as a share of GDP.
GDP per capita (constant 2015 dolars)	WDI	The total value of goods produced on the territory of one country within one year.

Source: created by the authors based on data from the World Bank website

There are different ways to measure the level of financial development; however, the volume of loans and the size of the capital market are most often used in the literature (Rajan & Zingales, 1998). Considering the general underdevelopment of the capital market in the Balkans, the authors' decision is to use the variable *Domestic credits to private sector (% GDP)*, while WGI was used as indicators of the quality of institutions.

The level of economic development in the form of GDP per capita and the country's trade openness shown as a share of the country's total imports and exports in GDP were used as control variables. A higher level of development of the country and greater freedom of exchange with foreign countries implies a larger volume of financial transactions, and in this case, it can also mean a larger volume of loans. Regarding the country's trade openness, Ryan and Zingales (1998) provide a seductive explanation, according to which certain interest groups deliberately inhibit the development of the financial system, because it facilitates the emergence and development of competition that can threaten their position and the rent they earn. Opportunities for such activities are more difficult if there are trade and financial openness of the country.

Probably the most frequently used indicators of the quality of institutions and public management are the WGI. These indicators cannot be considered completely independent of each other (Kaufmann et al., 2010). Namely, in a country where there is a strong rule of law, it will be more difficult to carry out corrupt activities, thus the level of corruption itself will be low. An effective government capable of creating and implementing effective policies will ensure that legislation is good. Lack of transparency will favor the spread of corruption, which can cause political instability, etc. Considering the strong correlation that exists between these indicators, the recommendation of their creators is to use them individually in research (Kaufmann et al., 2010). Accordingly, the paper will use the average value of these indicators, as a summary expression of the quality of institutions (Karikari, 2010).

Table 2. Descriptive statistics of the data used

Variables	Arithmetic mean	Std. dev	Min	Max
Credits to private sector	49.98	22.083	7.125	120.147
Gdpvpervcapita	9292.5	6301.42	1991.91	25708.87
Trade openness	93.178	27.403	21.109	186.22
Institutions	51.96	16.981	0	82.192
Government effectiveness	54.38	15.94	11.89	84.76
Political stability	51.02	16.94	7.93	93.65
Regulatory quality	60.78	11.92	19.02	79.04
Rule of Law	53.06	14.26	10.44	84.28
Voice and accountability	58.99	12.41	30.34	87.02
Control of corruption	50.17	13.93	9.04	83.25

Source: created by the authors

Table 3. Overview of average values by country

Country	Domestic credits	GDP per capita (dollars)	Institutions	Trade openness
Greece	85.6	19991	65.3	64.1
Croatia	58.24	12542.5	63.51	87.45
Slovenia	57.5	20834.4	79.27	137.8
B&H	57.5	4281.8	36.5	87.9
N. Macedonia	51.3	4715.5	46.3	108.9
Montenegro	48.3	6115.2	46.8	105.5
Bulgaria	47.9	6710.4	57.02	111.8
Albania	36.7	3625.5	44.02	72.9
Serbia	35.03	5716.8	41.94	82.9
Romania	25.8	8391.6	55.9	72.3

Source: created by the authors

Table 2 shows the descriptive statistics of the data used, and Table 3 shows the average value for the observed countries. The average value of the share of domestic loans to the private sector in the observed period was 49.98% of GDP, with the highest average value in Greece 85.6, and the lowest in Romania 25.8. The average value of GDP per capita was 9293.5 USD. The most economically developed country is Slovenia with an average value of GDP per capita of 20,834.4 USD, ahead of Greece, which has 19,991 USD. Albania was the least developed with an average value of GDP per capita of only 3625.5 USD. Slovenia has the highest average score of the WGI in the observed period, 79.27, while B&H has the lowest score in the group, 36.5. Slovenia also achieved the largest relative volume of foreign trade, i.e. has the highest trade openness, averaging as much as 137% of GDP, while Greece achieved the lowest, only 64.1% on average.

Research

Although the application of GMM represents a recent trend in the literature, the sample size does not allow the application of this method, which is why the static linear regression model was used. In accordance with the set goal of the research to examine the existence and nature of the influence of the institutional environment and the quality of public management on the level of financial development of the Balkan countries, the specification of the used linear regression model was set. Variables are logarithmized to control for heteroskedasticity and autocorrelation, and the specification is given in terms of Green (2002).

$$logFD = \beta_1 + \beta_2 INS + \beta_3 loggdppercapita + \beta_4 logTRADE + \varepsilon$$

The data was first checked for the existence of a unit root, i.e. whether all observed variables are stationary. According to the theory, a variable can be considered stationary if its probability distribution does not change over time (Wooldridge, 2013). The Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003) test was used in the study, and the used decision criterion was α=0.05. The null hypothesis (H0) of the tests used assumes that the observed variable is not stationary, i.e. to have a unit root.

Table 4. Summary of values of LLC and IPS unit root tests

Variable	LLC test		IPS test	
	t-stat	p-value	t-stat	p-value
logFD	-	-	-2.98	0.000
logINS	-6.884	0.000	-2.265	0.010
loggdppercapita	-3.76	0.0036	-2.048	0.025
logTRADE	-4.692	0.0469	-4.138	0.000

Source: created by the authors

The obtained values are shown above in Table 4. Since all values are less than the decision criteria, it can be concluded that all variables are stationary at level I(0), that they are of the same order of integration, and that the regression analysis can be continued on that basis.

Checking the existence of multicollinearity was performed by calculating Pearson's correlation coefficients. If the correlation coefficient of the observed variables has a value greater than 0.8 or 0.9, it is considered that there is a problem of multicollinearity (Senaviratna & Cooray, 2019). The results obtained are shown below in Table 5.

Table 5. Overview of Pearson's correlation coefficient values

	logcredits	loginstitutions	loggdp	logtrade
logcredits	1.00	-	-	-
loginstitutions	0.39	1.00	-	-
loggdp	0.44	0.76	1.00	
logtrade	0.16	0.31	0.15	1.00

Source: created by the authors

Within the obtained matrix of correlation coefficients, no value indicates the presence of multicollinearity between the variables. The highest value between the independent variables *loginstitutions* and *loggdp* is 0.76, which confirms the assumption that there is a better institutional environment in more developed countries.

After the initial checks, the regression analysis was started. Below in Table 6 are the values obtained by applying the pooled model and regression with fixed effects.

Table 6. Overview of values using pooled and fixed effects

Variable	Pooled	Fixed effects
loginstitutions	0.888***	0.986***
	(0.174)	(0.173)
logtrade	-0.045	-0.212
	(0.135)	(0.153)
loggdppercapita	0.334***	0.565***
	(0125)	(0.158)
R-squared	0.275	

Note:***α=0.01;**α=0.05; *α=0.01

Source: created by the authors

The variables that represent the quality of political institutions *loginstitutions* and the level of economic development of the country *loggdppercapita* are statistically significant at the statistical significance level of 1%. The country's trade openness *logtrade* in the model is not statistically significant. In both models, the quality of institutions has a greater influence on the level of financial development than the level of economic development. In the model with group effects, the coefficient values are 0.888 and 0.334, which indicates that institutions have almost two and a half times greater influence than the level of GDP per capita. The difference decreases in the model with fixed effects, in which the coefficients are 0.986 and 0.565. This implies that a 1% improvement in political institutions, as measured by the WGI, will result in a 0.986% increase in domestic credit to the private sector, while a 1% increase in economic growth will lead to a 0.565% rise in the dependent variable.

In order to verify the correctness of the obtained values, the research follows the assumptions of linear regression, namely the homoscedasticity of the data and the absence of autocorrelation (Greene, 2002). Homoscedasticity of the data means that the variance of the random error in the model is constant, while failure to respect this assumption may lead to an unreliable estimate (Gujarati, 2003). The check was performed using the Wald heteroskedasticity test, and the obtained values are shown below in Table 7.

Table 7. Wald test values

Chi2	9932.25
Prob>Chi2	0.000

Source: created by the authors

According to the H0 test hypothesis, the variance of the random error is constant for each value of the independent variable. The obtained *p* value is less than the critical value of the test α=0.05, which is why the H0 hypothesis is rejected, and it is concluded that there is a problem of heteroskedasticity in the model.

The next check concerns the existence of autocorrelation through the Wooldridge test (2002). Ignoring the autocorrelation problem will still result in consistent but inefficient coefficient estimates and biased standard errors (Baltagi, 2005). An overview of the obtained values is given below in Table 8.

Table 8. Wooldridge test values

F(1,9)	1013.76
Prob>F	0.000

Source: created by the authors

In the used Wooldridge test, the *H0* hypothesis is that there is no autocorrelation, and the alternative *Ha* hypothesis is that there is. Given that the obtained *p* value (0.000) is less than α=0.05, the H0 hypothesis is rejected and *Ha* is accepted.

Through the Pesaran test (2004), the existence of cross-sector data independence was examined. The obtained test value is 0.000, which is also less than the decision criterion α=0.05. Therefore, it is concluded that there is a problem of cross-sectoral correlation in the model.

Due to the shortcomings, the results shown in Table 6 cannot be accepted, and a more adequate statistical model should be used. The STATA program allows calculating the standard error robust to the problems of autocorrelation, heteroskedasticity and cross-sectoral correlation through the option *xtsccza* coefficients (Hoechle, 2007). The module is based on the calculation of Driscoll and Kraay (1998) standard error. The results obtained by this model are shown below in Table 9.

Table 9. Overview of model values with Driscoll and Kraay standard error

Variable	**I**	**II**
loginstitutions	0.986*** (0.297)	-
logtrade	-0.212 (0.286)	-0.01 (0.241)
loggdppercapita	0.565 (0.498)	0.826* (0.449)
R-squared	0.27	0.186

Source: created by the authors

The quality of institutions *(loginstitutions*) proved to be robust to the correction of autocorrelation, heteroscedasticity and cross-sector correlation problems, and preserved

the level of statistical significance of 1%, but the level of economic development (*loggdppercapita*) is no longer statistically significant. However, this should not be understood as an assertion that it has no influence on the level of financial development, because if we exclude institutions from the model (see column II), the variable becomes statistically significant again, at the 10% level. Institutions are of greater importance than the mere expansion of material production. If economic growth is achieved without corresponding progress in this area, the financial development of the country will be hindered.

Examining the Influence of Individual Indicators

After the positive influence of institutions on the financial development of the country was confirmed in the previous part of the paper, there was a need to examine the separate influence of each of the six WGI and determine which aspect of the institutional environment has the greatest influence. In view of the mentioned problems of multicollinearity between WGI, six separate models were created, in each of which only one indicator was taken as a dependent variable. The results are shown below in Table 10.

Table 10. Overview of values of individual WGI

Variable	I	II	III	IV	V	VI
logcorruption	0.195 (0.126)	-	-	-	-	-
loggovernment	-	0.061 (0.101)	-	-	-	-
logruleoflaw	-	-	0.574** (0.211)	-	-	-
logregulatory	-	-	-	0.722*** (0.164)	-	-
logpolitical	-	-	-	-	0.078 (0.08)	-
logvoice	-	-	-	-	-	-0.024 (0.226)

Note:***α =1%; ** α = 5;* α = 10%

Source: calculated by the authors

Of all the variables, only the rule of law (*logruleoflaw*) and quality of regulation (*logregulatoryquality*) proved to be statistically significant at the level of 5 and 10% respectively. The quality of regulation with a coefficient value of 0.722 has a greater influence than the rule of law with 0.574. Compliance with laws and regulations that protect private property and enable its efficient utilization is more conducive to financial development. The security and certainty associated with contract enforcement enjoyed by financial market participants outweigh the importance of political stability, freedom of expression, the government's capacity to design and implement effective policies, and even the level of corruption.

Conclusion

The main novelty of this research comes down to the selection of the observed sample - the Balkan countries. There is extensive literature that deals with the study of the relationship between institutions and the level of financial development, but the Balkan region has not been the subject of separate consideration until now. The results obtained are in accordance with what the theory dictates, which was also achieved in another research. The positive influence of the quality of the institutional environment on the level of financial development of the country was confirmed, and it proved to be more important than the level of economic development itself. Among all institutional aspects, only the quality of legislation and the rule of law have a statistically significant impact. Legal certainty and adaptation of the law to the real needs of economic actors are important determinants of the size of the country's financial system. Nevertheless, it is difficult to imagine that progress can be achieved in only one area, as institutional advancement is generally realized simultaneously across all institutional dimensions. Although the World Bank publishes them as separate indices, these dimensions are closely related and deeply interconnected.

As a recommendation for future research, the inclusion of additional control variables, such as quality of life, the level of human capital, inflows of foreign direct investment, and the effects of crisis-related events, appears warranted. Furthermore, the application of more advanced cointegration techniques could enable the distinction between short-run and long-run effects, as well as the examination of bidirectional causal relationships between the variables.

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SOCIO-ECONOMIC EVALUATION OF FOOD LOSS AND WASTE INTERVENTIONS: A STRUCTURED METHODOLOGICAL FRAMEWORK

Abstract

Food loss and waste (FLW) represent a major socio-economic and environmental challenge, generating significant economic losses, environmental externalities, and social inefficiencies across food systems. While numerous interventions targeting FLW prevention and valorisation have been implemented, their socio-economic impacts are assessed using heterogeneous methodological approaches, limiting comparability and policy relevance. This paper provides a structured overview and comparative assessment of socio-economic evaluation methods applied to FLW interventions. The analysis reviews cost-benefit analysis, full-cost accounting, life-cycle costing, input-output and economy-wide models, as well as hybrid and multi-criteria frameworks. For each method, the paper discusses analytical scope, data requirements, strengths and limitations, and suitability for different intervention types. The findings underline that no single method adequately captures the multidimensional impacts of FLW reduction, highlighting the need for integrated and context-sensitive evaluation frameworks. The paper concludes with methodological guidance for researchers and policymakers aimed at supporting evidence-based decision-making aligned with circular economy and sustainable development objectives.

Key words: *food loss and waste (FLW), socio-economic evaluation, cost-benefit analysis, sustainability assessment, policy analysis, circular economy*

JEL classification: *Q18, D61, Q53*

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СОЦИО-ЕКОНОМСКА ЕВАЛУАЦИЈА ИНТЕРВЕНЦИЈА ЗА СМАЊЕЊЕ ГУБИТАКА И ОТПАДА ОД ХРАНЕ: СТРУКТУРИСАНИ МЕТОДОЛОШКИ ОКВИР

Апстракт

Губици и отпад од хране (FLW) представљају један од кључних социо-економских и еколошких изазова савремених прехрамбених система, који генеришу значајне економске губитке, еколошке екстерналије и друштвене неефикасности дуж читавог ланца снабдевања храном. Иако су развијене и примењене бројне интервенције усмерене на превенцију и валоризацију FLW, њихови социо-економски ефекти се процењују применом хетерогених методолошких приступа, што ограничава упоредивост резултата и њихову релевантност за креирање јавних политика. Овај рад пружа структурирани преглед и компаративну анализу метода социо-економске евалуације примењених у процени FLW интервенција. Анализа обухвата анализу трошкова и користи, рачуноводство пуних трошкова, обрачун трошкова животног циклуса, инпут-аутпут моделе и моделе на нивоу привреде, као и хибридне и вишекритеријумске оквире. За сваку методу разматрају се аналитички обухват, захтеви у погледу података, предности и ограничења, као и погодност за различите типове интервенција. Резултати указују да ниједна појединачна метода не обухвата у потпуности мултидимензионалне ефекте смањења FLW, што наглашава потребу за интегрисаним и контекстуално прилагођеним евалуационим оквирима. Рад се завршава методолошким препорукама намењеним истраживачима и доносиоцима одлука, са циљем подршке доношењу одлука заснованих на доказима, у складу са принципима циркуларне економије и одрживог развоја.

Кључне речи: *губици и отпад од хране (FLW), социо-економска евалуација, анализа трошкова и користи, процена одрживости, анализа јавних политика, циркуларна економија*

Introduction

Food loss and waste (FLW) is a pressing global issue with profound economic, environmental, and social implications. Approximately one-third of all food produced for human consumption is lost or wasted worldwide, costing the global economy around $940 billion annually and contributing roughly 8% of greenhouse gas emissions (Champions 12.3, 2017). In the European Union (EU) alone, an estimated 59 million tonnes of food are wasted each year, representing an economic loss of about €143 billion (in product value and waste-management costs) (Eurostat, 2022). These losses exacerbate food insecurity and environmental degradation while indicating systemic inefficiencies in the food supply chain (e.g. unnecessary resource use and pollution) (Kitanovski et al., 2025). Reducing FLW is therefore recognized as a key strategy for improving food system sustainability and is reflected in policy goals such as United Nations SDG 12.3, which calls for halving per capita food waste by 2030, and the EU's Circular Economy Action Plan (De Laurentiis et al., 2020). Achieving these targets will

require not only effective interventions across the food supply chain, but also robust methods to evaluate the socio-economic outcomes of these interventions. Policymakers and stakeholders need evidence on the costs, benefits, and broader impacts of FLW prevention and valorisation initiatives in order to prioritize strategies and justify investments (De Laurentiis et al., 2020).

However, evaluating FLW interventions is challenging due to the diverse methodological approaches used in research and policy assessments. Studies have applied everything from basic financial cost-benefit analyses to complex systems models, each capturing different dimensions of impact. This variability makes it difficult to compare results across projects or to generalize best practices. Recent reviews highlight a lack of standardized frameworks: many interventions report on physical waste reductions, but few quantify broader economic, environmental, or social effects, limiting the ability to identify which measures truly offer the best value or overall benefit (De Laurentiis et al., 2020). For instance, Goossens et al. (2019) found that relatively few published studies on food waste initiatives evaluated outcomes like cost savings or social impacts, and that methodologies differed widely among those that did (Goossens et al., 2019). Stöckli et al. (2018) likewise called for more systematic and comparable evaluation of consumer-focused food waste interventions, noting inconsistent metrics and a need for common definitions and methods. Recognizing these gaps, the European Commission's Joint Research Centre (JRC) developed an evaluation framework and Food Waste Prevention Calculator to consistently assess both the environmental and economic performance of FLW prevention actions (De Laurentiis et al., 2020). This reflects a broader trend in the EU toward evidence-based policy: under the Better Regulation guidelines (European Commission, 2017), major policy proposals (including those on food waste) undergo impact assessments that examine expected economic, social, and environmental effects in tandem (De Laurentiis et al., 2020).

In this context, the present paper provides a structured overview of the main socio-economic evaluation methods used for FLW prevention and valorisation initiatives. It describes key methodologies, discusses how each has been applied (with examples from literature and policy), and compares their applicability, data requirements, strengths and limitations for different types of FLW interventions. The methods covered include: Cost-Benefit Analysis (CBA), Full-Cost Accounting (including environmental externalities), Input-Output (IO) and Economy-Wide (EW) Models, Life-Cycle Costing (LCC), and Hybrid frameworks that integrate economic, environmental, and social assessment. A comparative table is presented to summarize these approaches. Our aim is to guide researchers, practitioners, and decision-makers in selecting appropriate evaluation tools for various FLW strategies, and to highlight methodological and institutional gaps that must be addressed to improve the evidence base. Ultimately, more robust and comprehensive evaluations will help ensure that resources are directed to the most cost-effective and impactful FLW reduction measures, aligning with both economic incentives and broader sustainability goals (De Laurentiis et al., 2020).

Socio-Economic Assessment Methods for FLW Initiatives

Cost-Benefit Analysis (CBA)

Overview: Cost-Benefit Analysis is a well-established economic evaluation method that compares the monetary costs of an intervention to its monetary benefits

over time. A CBA yields metrics such as a benefit-cost ratio (BCR) or net present value (NPV), indicating whether the benefits of an action outweigh its costs. In the context of food waste, CBA typically counts direct financial costs (e.g. implementation expenses, operating costs) against direct financial benefits (e.g. reduced waste disposal fees, savings from purchasing less food, revenues from by-product sales). CBA appeals to both policymakers and businesses because it translates outcomes into the common language of money, facilitating comparisons and investment decisions (ReFED, 2016). However, conventional CBA often struggles to incorporate intangible or non-market impacts (like environmental improvements or social benefits) unless these are monetized. Thus, while CBA is excellent for evaluating private profitability or budgetary impacts of FLW interventions, it may undervalue external benefits unless adjusted (see *Full-Cost Accounting* below for approaches to address this).

Applications in FLW interventions: CBA has been widely used to demonstrate the economic rationale for reducing food waste. A landmark example is the report *"The Business Case for Reducing Food Loss and Waste"* by Champions 12.3, which analysed historical data from multiple countries, cities, and companies (Champions 12.3, 2017). Hanson and Mitchell (2017) found that the financial benefits of food waste reduction efforts often far exceed the costs: on average, companies achieved a 14:1 return on investment, and a UK nationwide campaign reduced household food waste by 21% with a benefit-cost ratio over 250:1 (Champions 12.3, 2017). These striking BCRs (e.g. £250 saved per £1 invested in the UK case) strengthen the argument that FLW reduction makes economic sense for both governments and businesses (Champions 12.3, 2017). Another influential analysis by ReFED (2016) evaluated 27 food waste solutions in the United States, ranking them by societal net economic value per ton of waste reduced. The ReFED Roadmap calculated how much each intervention would cost to implement versus the financial savings and revenues it would generate, using a 10-year NPV framework. This CBA-driven approach identified priorities like consumer education campaigns and packaging improvements as "low-hanging fruits" with high net benefits, while also highlighting interventions (e.g. certain recycling technologies) that might not pay off without policy support (ReFED, 2016). Both the Champions 12.3 and ReFED studies communicated results in clear economic terms that resonated with decision-makers, thereby spurring action.

Strengths: CBA's main strength is its clarity and decision-orientation. By summarising outcomes to a single monetary metric or ratio, CBA allows straightforward comparison of options: if an FLW project has a BCR > 1 (benefits greater than costs), it is economically justified. This makes CBA a powerful tool for advocacy and policy justification (Champions 12.3, 2017). It is also relatively intuitive and uses data (prices, quantities) that are familiar to businesses and governments. CBA works best for interventions with easily quantifiable direct impacts – for example, a change in packaging that costs *X* but reduces food spoilage by *Y* amount, saving *Z* euros. Indeed, many food waste reduction measures yield direct cost savings (less waste to haul, less purchasing of surplus food) that can be readily monetized (Kitanovski et al., 2025). CBA is thus well suited to assessing efficiency improvements or technologies from the standpoint of the investor or implementing entity (e.g. a company evaluating if a waste tracking system will pay off).

Limitations: The simplicity of CBA can also be a weakness. By focusing on monetized costs and benefits, a standard CBA may omit broader societal impacts that

are harder to price, such as reduced greenhouse gas emissions (GHG), improved food security, or job creation in redistribution programs. For example, the benefit of averting a tonne of CO_2 from avoided food production can be included if one applies a carbon price, but the choice of price (social cost of carbon, market price, etc.) significantly influences results (Hanes, 2014; Research Institute of Organic Agriculture, 2014). Social benefits like increased awareness or changes in consumer behaviour are even more difficult to monetize credibly. Therefore, a narrowly financial CBA might undervalue interventions that have big environmental or social paybacks but modest immediate financial returns. Another challenge is data availability, as performing a robust CBA for FLW initiatives requires data on costs (which may be dispersed across stakeholders) and on the economic value of food waste avoided. While direct cost data are often obtainable, estimating the monetary benefit of "a tonne of food waste prevented" can be complex since it involves upstream embedded costs (production, processing, etc.) and downstream waste management costs. Some studies address this by using average food prices for the edible portion and typical disposal costs per tonne (De Laurentiis et al., 2020). Nonetheless, uncertainties remain, and sensitivity analysis is important to test key assumptions (e.g. the longevity of an intervention's effects, discount rates, or future price changes).

Examples: Despite these limitations, CBA continues to be a foundational tool in FLW policy analysis. The European Commission often employs cost-benefit thinking in its impact assessments for waste legislation, weighing implementation costs against expected savings for consumers and businesses. For instance, the Impact Assessment accompanying the EU's proposed food waste reduction targets estimated both compliance costs (~€2 billion across the food chain) and the economic value of food saved (European Commission, 2023a). Even at the local level, municipalities have used CBA to decide on waste prevention programs, comparing the expense of running education campaigns to the avoided landfill costs and potential savings for households.

In sum, CBA provides an outcome-focused evaluation of FLW interventions in monetary terms. It excels at answering the question "Is this intervention worth it financially?" but may need to be complemented by other methods to capture the full spectrum of benefits and trade-offs. This sets the stage for more comprehensive approaches like full-cost accounting and integrated assessments presented below.

Full-Cost Accounting (FCA) and True Cost of Food Waste

Overview: Full-Cost Accounting extends traditional cost analysis by including externalities and hidden costs associated with an intervention or activity. In the context of food waste, FCA attempts to account for all costs and benefits to society, not just those that directly accrue to the implementer. This means assigning monetary values to environmental impacts (e.g. GHG, water use, biodiversity loss) and social impacts (e.g. health or employment effects) so that they can be considered alongside direct financial costs (Hanes, 2014; Research Institute of Organic Agriculture, 2014). FCA is sometimes termed "true cost accounting" when used to reveal the true societal cost of food waste itself. A seminal study by the FAO (2014) applied FCA to global food wastage: it estimated not only the market value of lost food (~$1 trillion) but also the hidden environmental costs (~$700 billion, from emissions, water, land degradation) and social costs (~$900 billion,

from livelihood impacts, hunger, etc.) of food waste. The conclusion was that food waste's *total* cost to society was about $2.6 trillion annually, far higher than the direct economic value of the wasted food (FAO, 2014). This kind of analysis underscores that decisions solely based on private costs (e.g. the grocery store's loss or disposal fee) vastly understate the harm of food waste when externalities are ignored (Schuler, 2017).

In evaluating FLW interventions, an FCA approach would incorporate both the standard financial results (like a CBA would) *and* the monetized value of external impacts. For example, consider an initiative to divert surplus food to bioenergy rather than landfilling it. Beyond the operational costs and revenue from energy, an FCA might include the climate benefit of methane emissions avoided at landfills and the societal value of energy generated. Similarly, a household food waste reduction program's full benefits would include not just household savings, but also the upstream resource savings (land, water, fuel) from producing less food, monetized via environmental economic estimates. The goal is to inform decision-makers of the comprehensive return on investment from society's perspective (Hanes, 2014). FCA is closely aligned with the "polluter pays" principle and is useful for policy design (e.g. setting the level of incentives or penalties that reflect true costs).

Applications in FLW interventions: At a macro level, the FAO's Food Wastage Footprint: Full-Cost Accounting project (2014) remains a touchstone, illustrating how to layer environmental and social cost factors onto food waste tonnages by region and commodity (TMG & WWF, 2021). On a project scale, FCA techniques have been employed in some municipal waste management analyses and corporate sustainability assessments. For instance, the U.S. EPA and various municipalities produced guides on FCA for solid waste in the 1990s, encouraging local governments to calculate the real cost of waste services by including capital depreciation, environmental compliance, etc., a concept now extending to food waste programs. In the FLW context, De Menna et al. (2018) conducted a review of life-cycle costing (LCC) approaches for food waste, which essentially falls under FCA when environmental costs are internalized. They note that methods range from simple add-on cost estimates (e.g. multiplying emissions by a carbon price) to more elaborate hybrid LCA-LCC models that integrate life-cycle environmental impacts with economic costing. An example from their review is a study where the "cost" of a food waste prevention measure included not only the program's expenses but also the social cost of carbon saved by avoiding waste, thus altering which option appeared most attractive when ranked by true cost (De Menna et al., 2018). Another example is the UK's Waste & Resources Action Programme (WRAP), which has at times highlighted the "true cost" of household food waste by factoring in the retail price of food wasted (£14 billion/year in the UK) plus disposal costs and environmental costs – framing FLW reduction as a win-win for consumers and the planet (WRAP, 2016).

Strengths: FCA provides a holistic evaluation, aligning financial analysis with sustainability goals. It helps capture the rationale for interventions that might be overlooked if only direct profits are considered. For policymakers, FCA can justify supportive measures (subsidies, regulations) for FLW reduction: if an intervention's private BCR is <1 but the societal BCR (including external benefits) is $\gg 1$, public intervention may be warranted to bridge that gap (U.S. Environmental Protection Agency, 2025a). FCA also aids in prioritizing actions by true effectiveness, for instance, it might show that preventing a tonne of food waste at the consumer level yields greater net social benefit than recycling two tonnes via composting, when all factors are weighed. By making

external costs explicit, FCA pushes stakeholders to recognize otherwise "invisible" savings like GHG reductions or reduced water pollution. It aligns with concepts like the food waste hierarchy by giving prevention a higher value (due to larger avoided externalities) than end-of-pipe solutions. In summary, FCA translates sustainability into the language of finance, broadening the scope of CBA to encompass public goods.

Limitations: The challenge, of course, lies in monetizing externalities credibly. Estimates of environmental costs can vary widely depending on methodologies (e.g. different carbon prices can dramatically change the valuation of emissions saved). There is also the ethical debate of putting a price label on certain social impacts (what is the monetary value of reducing hunger by redistributing food surplus, for example?). FCA results may be sensitive to contested assumptions, and presenting highly aggregated "single figure" outcomes (like € saved when including nature) can invite scrutiny. To mitigate this, analysts often present ranges or conduct sensitivity tests. Another limitation is data and complexity, as performing a rigorous FCA often requires life-cycle assessment data, environmental economic data (for damage costs), and socio-economic data, which can make it resource-intensive. Despite these hurdles, the trend is towards improving these valuations. For instance, the European Commission has developed methods like the Environmental Footprint 4.0, which quantifies several environmental impacts of products and can be linked to cost factors (Kitanovski et al., 2025). Indeed, the JRC Food Waste Prevention Calculator mentioned earlier incorporates default environmental coefficients to estimate CO_2 savings and other impacts for prevention actions (De Laurentiis et al., 2020), effectively building a simplified FCA into a user-friendly tool.

Examples: An illustration of FCA in practice is a city evaluating an organic waste prevention program versus building a new anaerobic digester. A pure financial analysis might favour the digester (if it generates revenue from energy and compost). But an FCA could reveal that the prevention program yields greater net benefit once the *social value* of food saved (e.g. if redistributed) and the *environmental value* of avoided emissions are counted, whereas the digester still results in some emissions and only addresses waste after it is created. Such insights guide more sustainable choices.

In conclusion, FCA complements traditional CBA by illuminating the *total* costs and benefits of FLW interventions. It provides a strong argument for preventative measures and can help align business cases with societal welfare. Many European policy analyses now embrace this approach, ensuring that evidence-based decisions on food waste are informed by the true costs and savings at stake (Eosta et al., 2017).

Input-Output Models and Economy-Wide Impact Assessment

Overview: Input-Output (IO) models and related economy-wide models (such as Social Accounting Matrices (SAM) or Computable General Equilibrium (CGE) models) are used to assess the broader macroeconomic and sectoral impacts of changes in the food system, including those from FLW reductions. Unlike project-level evaluations, IO models consider how an intervention's effects ripple through the economy, capturing indirect and induced impacts on output, employment, income, and even trade. For example, reducing food waste might lower demand for food production (affecting the agriculture and food manufacturing sectors), but increase economic activity elsewhere (as households spend

their saved money on other goods, or waste management companies see reduced business) (Lekavičius et al., 2023). IO analysis uses large tables of inter-industry transactions to estimate these cross-sector effects. In the context of FLW, IO and SAM models can help answer questions like: *What is the net effect on GDP and jobs if we halve food waste?* or *How do food waste reductions in households versus farms differ in their economic outcomes?* These models can also integrate environmental extensions, producing results on how economy-wide resource use or emissions change under different scenarios.

Applications in FLW research: A recent study by Lekavičius et al. (2023) provides a prime example of using an economy-wide model for FLW reduction analysis. They applied a SAM-based model (SAMmodEU) to simulate various food waste reduction scenarios across the EU supply chain, analysing impacts on GDP, employment, and pollution. The results showed that most scenarios led to slight increases in GDP and employment, essentially, a net positive socio-economic effect, though outcomes varied by sector (Lekavičius et al., 2023). Interestingly, the multicriteria analysis in this study identified reducing waste in food services (restaurants, catering) as yielding the best overall performance when considering both economic and environmental criteria (Lekavičius et al., 2023). Another important insight from economy-wide modelling is the identification of potential trade-offs: for instance, some general equilibrium analyses (such as those using the MAGNET model) have found that if household food waste is sharply reduced, the food production sector might contract, potentially affecting farmer incomes, a reminder that waste reduction, while socially beneficial, can redistribute economic activity (Philippidis et al., 2019). Such models underscore the importance of complementary measures (like redirecting surplus to bioeconomy uses) to mitigate any negative economic side-effects.

Beyond academic studies, IO approaches are also employed in policy. The European Commission's Impact Assessment for food waste targets considered indirect economic effects on upstream and downstream industries, using multiplier estimates (European Commission, 2023a). National and regional governments have commissioned IO-based analyses as well. For example, a Massachusetts (USA) study used an IMPLAN IO model to estimate the economic impact of a commercial food waste landfill ban – finding it would create jobs in recycling and composting sectors while minimally affecting the food industry overall (ICF, 2016; BioCycle, 2025). Similarly, a European study used a multi-regional IO scenario to evaluate energy and environmental savings if Europe meets SDG 12.3, highlighting significant reductions in energy use and GHG emissions at the continental scale (Osei-Owusu et al., 2023). These approaches help elevate the discussion from individual projects to the system-wide implications of tackling food waste.

Strengths: The chief strength of IO and SAM models is their comprehensiveness in scope. They capture the interconnected nature of the food system and economy, acknowledging, for example, that cutting food waste can free up resources (land, labour, capital) which then get used elsewhere, rather than simply "disappearing" from economic consideration. This allows for a balanced view of winners and losers. Policymakers gain insight into which sectors may need support (if demand for their output falls) and where new opportunities arise (e.g. in redistribution networks or valorisation industries) (Lekavičius et al., 2023). IO models are also particularly good at estimating employment impacts, which are a key policy concern. Reducing FLW might slightly reduce jobs in food production, but could create jobs in logistics, recycling, or IT (for waste tracking

apps), and IO analysis quantifies these net changes. Moreover, by adding environmental extensions (so-called EEIO models), analysts can link economic changes to changes in environmental outcomes (like carbon footprint or water footprint) on a broad scale (U.S. Environmental Protection Agency, 2025b). This is valuable for evaluating FLW strategies in terms of decoupling economic growth from environmental harm.

Limitations: One limitation is that IO models are typically linear and static, based on fixed coefficients of production and consumption. They generally do not account for price changes or behavioural responses (that is the realm of CGE models). Thus, an IO-based scenario might overestimate benefits by not considering, for example, that reduced food demand could lower food prices and induce some rebound consumption. More sophisticated CGE models can handle such market-mediated effects, but at the cost of greater complexity and data requirements. Another limitation is that IO models tend to work at an aggregate sector level. Food waste is not a single sector, it occurs in agriculture, manufacturing, retail, food service, households, hence analysts must introduce scenarios or shocks into multiple sectors. The resolution of what constitutes "food waste reduction" in IO terms can be tricky. For example, if households waste less, does the model reduce overall household expenditure on food? If so, the model reallocates that spending to other goods (perhaps increasing activity in other sectors). The assumptions behind these reallocations can influence results, and they should be made explicit (Lekavičius et al. (2023), for instance, assumed savings are spent on general goods, leading to modest positive GDP effects). Furthermore, IO models rely on accurate baseline data, which, for food waste flows specifically, is still improving in accuracy. As the EU and countries gather better FLW statistics (e.g. via Eurostat's new reporting), these models will become more reliable.

When to use: Economy-wide modelling is most useful for high-level policy analysis and for interventions expected to have significant upstream or macroeconomic impacts. For example, a national strategy to halve food waste will affect many sectors and stakeholders; an IO/CGE approach is warranted to capture all implications. On the other hand, a small-scale pilot at a single company would not need this treatment. In EU policy circles, these models complement micro-level CBAs: the micro analysis might show, for instance, a €1 investment yields €10 savings in a supermarket (private view), while the macro analysis shows negligible GDP impact but a potential small increase in employment (societal view). Both perspectives together provide a richer understanding. In summary, IO and related models broaden the lens of evaluation to include indirect economic effects and system dynamics. They remind us that FLW reduction is not just an environmental or ethical issue, but also an economic transition, one that can be managed to maximize co-benefits (like green jobs) and minimize disruptions if we plan using sound evidence.

Life-Cycle Costing (LCC) and Life-Cycle Assessment (LCA) Integration

Overview: Life-Cycle Costing (LCC) is an evaluation method that counts all costs associated with a product, service, or intervention over its entire life cycle. It is often used alongside Life-Cycle Assessment (LCA), which assesses environmental impacts over the life cycle. In the context of FLW interventions, LCC asks: *What are the costs incurred*

at each stage from implementation through end-of-life? and *How do they compare to the baseline scenario costs?* Unlike a basic CBA, which might focus on net benefits to one actor, LCC can be structured to include costs borne by different actors across the supply chain or lifecycle (it can even be expanded to societal LCC, including externalities in monetary terms, which overlaps with FCA). For example, consider an intervention like improved inventory management to reduce decomposition at a retailer. An LCC would include the retailer's upfront system costs, training costs, ongoing operational costs, and any cost shifts upstream (perhaps suppliers face different order patterns) and downstream (less waste disposal cost). If combined with LCA, one could also measure how environmental impacts (carbon, water, etc.) per functional unit change, providing a full sustainability profile. Essentially, LCC is a way to systematically account for costs across the same system boundaries that an LCA would use for impacts (Albizzati et al., 2021).

Applications: LCC has been applied to various food waste management and prevention options, frequently in research that aims to identify the optimal waste handling strategy. For instance, a study by Albizzati et al. (2021) performed a quantitative sustainability assessment of different food waste pathways in the EU, using a combination of LCA and societal LCC (SLCC). They evaluated 21 scenarios ranging from prevention and redistribution to composting and bioenergy, calculating environmental impacts and life-cycle costs (including external costs) for each. Their findings reinforced the waste hierarchy: prevention yielded the highest sustainability benefits, and after prevention, reuse (for human or animal feed) was the next best option, whereas some valorisation routes like biochemical production were less favourable when all impacts and costs were considered. Life-cycle costing in this study captured not only direct financial costs but also things like indirect subsidy costs or societal costs of emissions (hence "SLCC") (Albizzati et al., 2021). De Menna et al. (2018)'s review of LCC methods highlighted case studies where LCC was used to compare, say, the cost per tonne of food waste managed via anaerobic digestion vs. composting vs. landfill, often revealing that prevention has a much lower cost per tonne avoided when the avoided production costs are accounted for. Another example: a municipality might use LCC to justify investing in food waste prevention campaigns by showing that, over a 5-year period, the avoided collection and disposal costs (savings) exceed the program costs, even if the program itself does not generate revenue.

When integrated with LCA, this becomes a form of Life-Cycle Sustainability Assessment (LCSA), covering the triple bottom line. For example, the JRC's Food Waste Prevention Calculator effectively implements a simplified LCA+LCC: it asks users for inputs like the amount of food saved (so environmental savings can be calculated via LCA data) and the cost of implementing the action, then outputs both net environmental savings and net economic benefits (De Laurentiis et al., 2020). Such tools illustrate the practical use of life-cycle thinking in everyday decision-making, for example, a project manager can see if an initiative is not only reducing emissions but also saving money over its life cycle, or if there are trade-offs (e.g. an action might reduce waste but require a lot of energy, leading to costs or emissions that offset some benefits).

Strengths: Life-cycle approaches are excellent for avoiding the drawback of problem shifting. By looking at the whole system, LCC/LCA ensures an intervention is not simply pushing costs or impacts to another stage or stakeholder. For example, a packaging change might reduce consumer waste but increase production costs and environmental impacts from packaging materials, only a life-cycle approach would catch that and allow a balanced

decision (maybe the net effect is still positive, but it needs to be quantified) (De Laurentiis et al., 2020). LCC also helps in capturing long-term costs: some interventions might have higher upfront costs but lead to significant savings downstream. A straightforward annual budget analysis could miss this, whereas a life-cycle view (often using discounted cash flow) will show the intervention's true cost-effectiveness over time (De Menna et al., 2018). This is particularly relevant for infrastructure or technology investments in FLW reduction (like automated monitoring systems or new processing facilities) that have multi-year lifespans. Additionally, when combined with LCA, it provides a multi-criteria perspective, stakeholders can see both cost and environmental impact per unit of food waste reduced. This supports informed decision-making where trade-offs are explicit. For instance, one option might be cheaper but less climate-friendly, while another is costlier but yields big emissions reductions; decision-makers can then weigh budget vs. climate priorities transparently (Roy et al., 2023).

Limitations: One challenge with LCC is defining the scope and boundaries. If two alternatives have different functionality (e.g. prevention versus recycling yield different co-products or services), making them comparable requires careful functional unit definition. In FLW interventions, the functional unit often chosen is "per tonne of food waste avoided or treated," which works for many cases but can overlook qualitative differences (like nutritional value saved, or whether people were fed). Moreover, LCC results can be sensitive to the assumptions about future costs (energy prices, labour, etc.) and discount rates. A societal perspective might use a low discount rate for long-term effects, while a private company might use a higher rate, thus leading to different views of, for example, the value of future savings from prevention. It is important to clarify the perspective (private vs. public) in any LCC. Data intensity is another issue, as LCC requires cost data across the lifecycle, which might be proprietary or hard to get (e.g. farmers' costs, transport costs, etc., in different scenarios). Often studies have to use proxies or averages, which introduce uncertainty (Kitanovski et al., 2025). Lastly, while LCC captures costs, it does not inherently capture benefits unless those are framed as "negative costs" (savings). It also does not monetize externalities unless one deliberately includes them, which then essentially merges it with FCA. So, LCC by itself is often one component of a larger analysis.

Examples: LCC is particularly useful when evaluating alternative end-of-life or recycling options for food waste, or comparing prevention with downstream solutions. It is been used by city planners and waste companies to determine the cheapest and most sustainable way to handle unavoidable food waste (e.g. compare the LCC of building an anaerobic digester versus expanding composting facilities, including the capital and operating costs and the byproduct revenues) (Roy et al., 2023). It is also used in project proposals for funding, an EU project might be required to present an LCC showing that a new valorisation process for food waste is economically viable over its lifetime, not just environmentally beneficial. By combining LCC and LCA, one can produce a single integrated report that speaks to economists, engineers, and environmental scientists alike. This integration is evident in tools like the REFRESH project's *FORKLIFT* valuation tool, which allowed users to explore environmental and economic outcomes of different valorisation strategies (REFRESH, 2018).

In conclusion, LCC adds a dynamic, temporally and spatially broad viewpoint to socio-economic evaluation. When leveraged together with environmental assessment, it

helps ensure FLW interventions are truly sustainable, delivering net benefits over their full lifespan and avoiding unintended consequences at other stages of the food system.

Hybrid Frameworks and Multi-Criteria Decision Analysis

Many complex decisions on FLW interventions cannot be made on a single metric alone. Hybrid evaluation frameworks combine multiple methods or criteria to provide a more nuanced assessment. This can include Multi-Criteria Decision Analysis (MCDA) where a set of economic, environmental, and social indicators are evaluated together (sometimes with weighting), or adapted frameworks that integrate qualitative and quantitative evaluation. In the European policy context, there has been a move towards such integrated assessments. The EU Platform on Food Losses and Food Waste, for example, developed recommendations for evaluating food waste prevention initiatives that include criteria like effectiveness (amount reduced), efficiency (cost per amount), environmental benefit, social benefit, scalability, and sustainability over time (Caldeira et al., 2019). Garcia-Herrero et al. (2023) proposed a comprehensive framework for consumer food waste intervention evaluation that considers: intervention design quality, effectiveness (waste reduction achieved), efficiency (including cost-effectiveness), wider systemic effects, sustainability over time, and transferability. Such frameworks go beyond pure economics to capture behavioural and institutional factors (e.g. is the intervention easy to replicate elsewhere? Does it have lasting effects or only short-term?). While these criteria are sometimes scored qualitatively, they can incorporate quantitative measures like cost per kg avoided (efficiency) or tons waste reduced (effectiveness) alongside softer measures.

MCDA specifically has been used in FLW strategy selection. For instance, the study by Lekavičius et al. (2023) mentioned earlier not only modelled scenarios but also performed a multicriteria analysis ranking scenarios on both economic (GDP, employment) and environmental outcomes. This showed that reducing waste in food service was most balanced in delivering economic gains and pollution reduction, guiding policymakers to perhaps focus efforts there. Another example of MCDA in practice: A city considering various FLW initiatives (public awareness campaign, food donation program, waste-to-energy facility) might evaluate each against criteria such as cost, waste reduction potential, public acceptance, regulatory feasibility, and environmental impact. Each criterion can be given a weight (reflecting priorities, e.g. perhaps environmental impact and waste reduction are rated highest). The options are then scored and a composite score calculated to identify which option best meets the city's objectives. This approach was reflected in some local waste management plans in Europe, where stakeholders engaged in ranking exercises to decide on interventions with the help of MCDA software.

Hybrid economic-environmental models are another form of integration. One such approach is combining Economic Input-Output models with LCA (EIO-LCA) to estimate upstream environmental impacts of economic changes. While not specific to FLW, an EIO-LCA tool could, for example, estimate how a reduction in food sector output (due to waste cuts) translates into environmental savings economy-wide. Another hybrid is the use of Social Return on Investment (SROI) analysis for food waste projects, which assigns monetary values to social and environmental outcomes (much like FCA) and computes a

ratio of total value to investment. SROI has been applied to food redistribution programs: by monetizing social outcomes (meals for people in need, volunteer skill development) and environmental outcomes (emissions avoided via redistribution), one can claim a societal return like "€X of social value created per €1 spent." This is compelling for charities and funders. For example, an SROI analysis of a UK surplus food redistribution network found a return on investment of approximately 5:1 when considering the social value of nutrition provided and emissions averted (Nicholas et al., 2025). Such analyses, while requiring many assumptions, help communicate the full impact of an intervention to stakeholders who care about more than just financial gains.

Strengths: They provide a balanced evaluation that acknowledges multiple goals. FLW reduction is not purely an economic exercise; it is about environmental sustainability, food security, and social well-being too. Hybrid frameworks ensure that a narrow focus (e.g. cost per ton) does not lead to perverse choices (like ignoring an option that slightly costs more but yields huge social benefits). They are especially useful in participatory decision-making, allowing different stakeholders (government, industry, NGOs, community) to see their concerns addressed in the criteria and to find common ground. Moreover, integrated approaches can identify win-win solutions or acceptable trade-offs. For instance, MCDA might reveal that an option is second-best on both cost and environmental impact, but by far the best on social acceptance, perhaps making it the overall preferred compromise.

Limitations: The more criteria and methods one combines the more complex the analysis and the more expertise and data required. MCDA outcomes can be sensitive to the weighting scheme, which might be subjective, transparency and stakeholder input in setting weights is critical to maintain legitimacy. There is also a risk of information overload, since presenting too many indicators can confuse decision-makers. Thus, often a hybrid framework will convert findings into an easy format (like a dashboard or a single index) at the end, but that in itself requires careful normalization and can obscure detail. Ensuring consistency is another issue, as economic and environmental models might not align perfectly (e.g. system boundaries or assumptions differ). A lot of effort in integrated assessment goes into harmonizing these pieces. The JRC's framework, for example, had to align data collection templates so that reported outcomes from interventions could feed into both cost analysis and environmental analysis uniformly (De Laurentiis et al., 2020). Finally, not all outcomes are quantifiable, some might be qualitative (like "improved stakeholder collaboration" as a systemic effect). These must be evaluated in a narrative or ordinal way, which can feel less rigorous. Nonetheless, including them is important for a full picture.

Examples: Europe has been moving toward such integrated evaluations. The Better Regulation Toolbox explicitly encourages assessments of economic, social, and environmental impacts in unison for any major policy proposal (European Commission, 2023b). In the FLW realm, this means that when the European Commission proposed binding food waste reduction targets in 2023, the impact assessment considered not just compliance costs to businesses but also social impacts (e.g. potential job shifts, effects on food donation) and environmental gains (emissions, water) (European Commission, 2023a). Likewise, national strategies often use a suite of indicators to track progress, economic savings, tonnage reductions, hunger alleviation, etc., reflecting a hybrid mindset.

Comparative Analysis of Evaluation Methods

The summary of comparative insights of the discussed methods is presented in Table 1. Each method offers a distinct lens on FLW interventions, and they are often complementary. Using multiple methods in tandem can yield a robust evaluation: for example, performing a CBA to get financial metrics, an LCA to get environmental metrics, then using MCDA to weigh them along with social considerations. The ultimate aim is to ensure that decisions on how to reduce food waste are evidence-based, context-appropriate, and aligned with broader sustainability values (De Laurentiis et al., 2020). There is no one-size-fits-all method, the choice depends on the question being asked (micro or macro? financial or multi-faceted?) and the audience for the results (investors, policymakers, public). The European research and policy community, through efforts like the REFRESH and FUSIONS projects and the EU FLW Platform, has made significant strides in mapping these methods and developing guidance on their use (REFRESH, 2018; United Nations DESA, 2025). The following table synthesizes key characteristics to aid in method selection for future FLW evaluation needs.

Each method has a distinct focus, from purely financial metrics to integrated sustainability criteria. Often, multiple methods are used in combination – for example, a project might undergo a CBA for financial feasibility, an LCA for environmental impact, and then an MCDA that includes both results plus social considerations. Selecting the right tool (or mix of tools) depends on the decision context, scale of intervention, and stakeholder needs. Policy frameworks increasingly call for combining these approaches to ensure that no important impact is overlooked (De Laurentiis et al., 2020; Garcia-Herrero et al., 2023).

To illustrate conceptually how multiple evaluation methods may be combined in practice, consider a supermarket intervention based on improved inventory management and surplus food redistribution. In a first step, CBA can be used to assess direct financial effects, including implementation costs, savings from reduced disposal, and the value of avoided product losses. In a second step, LCA/LCC may be applied to estimate life-cycle environmental savings and longer-term cost implications, including avoided greenhouse gas emissions, water use, and resource depletion associated with food production that no longer becomes waste. In a third step, MCDA can integrate these economic and environmental results with additional social and operational criteria, such as food donation outcomes, stakeholder acceptability, and implementation feasibility. In this way, the intervention can be assessed not only in terms of private financial efficiency, but also in relation to broader sustainability performance and decision-making relevance.

Table 1. Comparison of Evaluation Methods for FLW Interventions

Method	**Scope & Focus**	**Key Metrics/ Outputs**	**Data Requirements**	**Strengths**	**Limitations**
Cost-Benefit Analysis (CBA)	• Project or program level • Economic (financial) focus • Single-actor perspective (firm or public agency).	• BCR • NPV • Internal Rate of Return (IRR) (monetary terms)	• Costs of intervention • Monetary value of benefits (e.g. waste disposal cost saved, food saved * price) • Discount rate for NPV	• Clear yes/ no financial viability criterion (BCR>1) • Easy to communicate • Widely understood by decision-makers • Uses familiar monetary units, facilitating comparison across different options	• Does not automatically include externalities (unless monetized separately) • Can undervalue interventions with big environmental/ social benefits but modest financial returns. • Results sensitive to assumptions (e.g. benefit valuation, time horizon). • Usually static, and single-figure outcome may mask distributional effects.
Full-Cost Accounting (FCA)	• Broad societal perspective • accounts for external environmental and social costs/ benefits as well as direct financial ones • Can be applied at project or system level.	• "True cost" or net societal benefit in monetary terms (includes e.g. monetized carbon emissions, pollution, health impacts) • Sometimes expressed as expanded BCR including external value	• All data from CBA + estimates of external impacts (emission quantities, environmental damage costs per unit, social impact valuations) • Often requires LCA data and economic valuation coefficients.	• Holistic: captures the full societal value of an intervention, aligning with sustainability goals • Reveals hidden costs of inaction (food waste) or hidden benefits of action, strengthening the case for preventive measures • Can justify policy support if private and social returns diverge	• Monetization of externalities can be controversial or uncertain (results depend on carbon price chosen, etc.) • Data- and analysis-intensive; requires interdisciplinary inputs • May be less intuitive to stakeholders if not familiar with environmental economics • Risk of double-counting or inconsistency if not carefully done (boundary issues)

Input-Output / Economy-Wide Models (e.g. IO, SAM, CGE models)	• Macro or sectoral level • Captures indirect and induced effects across the economy • Looks at inter-sector linkages and possibly price/market adjustments (in CGE) • Can be national or multi-regional.	• Changes in GDP, employment, sector outputs, trade balances, etc. • Possibly changes in aggregate environmental indicators if linked (e.g. total emissions). • Often scenario-based ("with vs without intervention").	• Baseline IO or SAM tables • Data on how the FLW intervention translates into shocks (e.g. reduced final demand for food, increased spending elsewhere). • For CGE: elasticities, behavioural parameters.	• System-wide perspective: identifies economy-wide gains or losses and distribution across sectors • Can uncover trade-offs (e.g. reduced production in one sector vs. growth in another) • Captures employment effects and other policy-relevant macro indicators • With extensions, integrates environmental footprint analysis on a large scale.	• Aggregate: less detail on specific projects, more on overall trends. Not suitable for micro evaluation. • IO assumes fixed coefficients (CGE relaxes this but is complex). • Data may be outdated or coarse (food waste not always explicitly modelled, it is an implicit reduction in demand). • Requires expertise to run and interpret • Results can be abstract for untrained stakeholders.
Life-Cycle Costing (LCC) (often alongside LCA)	• Life-cycle system perspective (cradle-to-grave for a product, or end-to-end for a process) • Focus on costs incurred by all processes/stages in the system, over time • In societal LCC, includes external costs • In conventional LCC, just costs to defined actors	• Total cost over life cycle (often expressed per functional unit, e.g. per tonne of food waste managed or prevented) • Breakdown of costs by life-cycle stage. • If paired with LCA: environmental impact indicators (CO_2 eq, water use, etc.) for the same functional unit.	• Detailed process data: capital costs, operating & maintenance costs at each stage • Depreciation periods • Disposal costs or residual values • If dynamic, need discount rate • LCA data for environmental impacts per stage (if integrated assessment).	• Prevents problem-shifting: ensures an intervention's impacts/ costs aren't simply moved elsewhere unseen • Long-term view: captures full lifespan costs, supporting sustainable financial planning • When combined with LCA, provides a robust multi-dimensional picture (both cost and environmental impact per unit outcome) • Useful for comparing waste management alternatives on equal footing (e.g. cost per tonne for landfill vs. AD vs. composting vs. prevention).	• Data intensive: requires granular data which may be hard to get (especially for new processes or informal processes like donation) • Can be complex to communicate, especially if both cost and multiple impact results are presented • Results may vary with system boundary choices (e.g. whether to credit avoided product production in prevention scenarios) • Does not inherently prioritize, multiple indicators need interpretation (hence often fed into MCDA).

Hybrid / Integrated Frameworks (e.g. MCDA, custom scoring frameworks, SROI)	• Combination of dimensions: economic, environmental, social, technical feasibility, etc. • Can be at project, program, or policy level. • Often involves stakeholder input for criteria weighting.	• Depends on framework: could be a composite index or ranking • In MCDA, a score for each option against each criterion and an overall weighted score. • In SROI, a monetized "social return" ratio (e.g. € value created per € invested). • In qualitative frameworks, narrative evaluations for each criterion.	• Requires a broad set of data: economic (costs, savings), environmental (emissions, etc.), social (e.g. number of people reached or qualitative ratings of acceptance), plus expert/ stakeholder judgments for scoring or weighting. • SROI needs outcomes and proxies to monetize them.	• Comprehensive and flexible: can incorporate any factor of importance, thus reflecting real-world decision criteria (not just financial efficiency) • Encourages stakeholder engagement, making the basis of decisions transparent and inclusive (especially with MCDA workshops) • Can reveal balanced solutions and facilitate trade-off discussions (e.g. option that is moderate on all criteria vs. one great economically but poor socially). • SROI and similar approaches communicate social impact in monetary terms, resonating with funders and policymakers by speaking in ROI language albeit social.	• Subjectivity in weighting and scoring, hence results can be contested if stakeholders disagree on importance of criteria. • Requires careful design to avoid bias (e.g. double-counting a benefit in multiple criteria). • May be complex to execute and interpret if many criteria. • Can lead to oversimplification (index) or overwhelm (too many numbers). • SROI monetization faces similar challenges to FCA (assigning € to volunteer time, carbon, etc.) and can be sensitive to those proxy values.

Source: Authors

Conclusions and Recommendations

The FLW challenge demands not only innovative solutions on the ground, but also rigorous ways to measure and compare the outcomes of those solutions. This paper has surveyed the main socio-economic evaluation methods currently used to assess FLW prevention and valorisation initiatives, highlighting their relevance in research and European policy contexts. A clear finding is that no single method can provide a full picture. Instead, a toolkit of approaches is needed, and their judicious application will yield the most credible and useful insights. Encouragingly, a convergence is observed in recent years: economists, environmental scientists, and social experts are working together more closely to evaluate FLW interventions, resulting in more holistic studies

and policy assessments (De Laurentiis et al., 2020). For example, European projects like REFRESH and national programs in France, Italy, and elsewhere have developed evaluation guidelines that blend cost-effectiveness analysis with environmental assessment and social impact criteria (REFRESH, 2018; Garcia-Herrero et al., 2023). The European Commission's own analyses for new waste legislation exemplify integrated assessment, ensuring that proposed measures (like setting EU-wide food waste reduction targets) are backed by evidence on economic feasibility, social acceptability, and environmental benefit (Lekavičius et al., 2023; United Nations DESA, 2025).

Key recommendations are as follows:

First, match the method to the question. If the primary concern is financial viability for an investor or company, CBA (possibly extended to ROI or payback period calculations) will be the central tool. If the question is societal value, then FCA or SROI frameworks should be applied, to account for external benefits. For policy choices involving trade-offs, MCDA or hybrid scoring can be invaluable. One size does not fit all, thus evaluators should be clear on whose perspective is being analysed (private vs public, micro vs macro) and choose methods accordingly. It is often useful to perform both a private CBA and a societal CBA (i.e. FCA) to highlight differences, as Champions 12.3 (2017) did by noting private ROI alongside broader benefits.

Second, leverage life-cycle and systems thinking. FLW interventions often have cross-cutting impacts (e.g. upstream production resources, downstream waste). LCA and costing approaches should be more widely adopted so that we do not unintentionally shift burdens. For instance, a policy to convert food waste to animal feed might seem great in a simple analysis (divert waste from landfill), but an LCA/LCC might show high energy use or costs in processing that negate some benefits. European research institutions (like JRC) have provided tools and data to facilitate this – the Environmental Footprint method and the Food Waste prevention calculator are readily available resources to incorporate life-cycle data into evaluations (De Laurentiis et al., 2020). Practitioners are encouraged to use these tools, as they simplify complex LCA/LCC calculations into user-friendly formats, ensuring even smaller organizations can do a simple integrated analysis.

Third, improve data and fill methodological gaps. One recurring challenge noted is data quality, especially on the amounts of FLW prevented and the costs associated with interventions (many of which are not published due to commercial sensitivity). Continued efforts to build databases of intervention outcomes (perhaps through the EU FLW Platform or academic repositories) would aid future evaluations. Methodologically, standardizing certain assumptions can improve comparability, for example, having a common assumed social cost of carbon for European analyses, or using a standard set of commodity prices for food waste economic value (as done in some studies using FAO or Eurostat data). The EU FUSIONS project's work in estimating EU food waste levels with a consistent approach (De Laurentiis et al., 2020) and the more recent EU Consumer Food Waste Forum outcomes on evaluation frameworks (Garcia-Herrero et al., 2023) are steps in this direction. Yet, gaps remain, for instance, how to evaluate behavioural interventions that do not lend themselves to simple tonnage or cost metrics. Developing proxies for "behaviour change benefit" or longitudinal study designs to capture lasting impact are areas needing attention (as highlighted by Stöckli et al. (2018), and Reynolds et al. (2019)). Methodological innovation should continue, perhaps learning from public health and education sectors on evaluating awareness campaigns and habit changes.

Fourth, focus on European context and policy integration. For European stakeholders, it is crucial that evaluation methods align with EU policy frameworks. This means incorporating social and environmental dimensions in addition to economics, reflecting EU priorities like the Green Deal and Climate Law. It also means providing evidence in a form useful for Better Regulation processes, i.e. clear, quantified impacts on key indicators. European research can lead by tailoring general methods to food waste specifics: for example, updating input-output models to include a food waste sector or parameter, or enhancing CGE models to simulate food waste reduction explicitly (some CGE models like MAGNET have started exploring this (Garcia-Herrero et al., 2023)). Additionally, the EU and national governments should continue funding studies that demonstrate the co-benefits of FLW reduction (like how it contributes to climate targets, resource efficiency, and even economic resilience, as less waste can mean less dependence on imports, etc.). The systemic nature of FLW means it links to agriculture, environment, social policy, and beyond, so evaluation approaches should ideally capture these linkages to inform cross-cutting policy development.

Although this review is situated primarily within the European policy and research context, the methodological insights are transferable beyond Europe. The core evaluation challenges associated with FLW interventions, including the need to balance financial feasibility, environmental externalities, social outcomes, and system-wide effects, are also highly relevant in low- and middle-income countries as well as in other developed economies. However, transferability requires sensitivity to contextual differences in data availability, institutional capacity, supply-chain structure, informal food distribution systems, and policy priorities. In high-income settings, integrated approaches may be applied through advanced datasets and formal policy appraisal frameworks, whereas in resource-constrained contexts, simplified combinations of CBA, basic environmental indicators, and qualitative multi-criteria assessment may provide a more feasible evaluation pathway. Therefore, the framework proposed in this paper should be understood as adaptable rather than region-specific.

Fifth, communicate findings effectively. Even the best analysis is only as good as how its insights are communicated to decision-makers. The narrative around FLW interventions should emphasize the multiple wins documented by comprehensive evaluation. Namely, investments in food waste prevention programs yield direct savings for businesses and households, avoid tonnes of CO_2 emissions contributing to climate benefits, increase jobs in the local economy, and strengthen food security. The EU statistics on 88 million tonnes waste, which is equal to €143 billion cost, are often cited in policy debates (Champions 12.3, 2017), ensuring these figures are up-to-date and grounded in sound evaluation reinforces the urgency to act and guides where action is most needed.

In conclusion, advancing the fight against FLW will require parallel advances in how we evaluate progress. By using the full arsenal of socio-economic methods, from CBA to LCA to multi-criteria frameworks, a 360-degree view of interventions' impacts can be obtained. This structured, evidence-based approach will help identify the most effective strategies for different contexts (be it a household education campaign in a city or a supply-chain optimization by a major food company) and ensure that resources are directed toward solutions that offer the greatest overall benefit for Europe's economy, society, and environment. The findings of this paper underscore that many FLW initiatives are not just good for the planet, but sound investments with paybacks on multiple levels (Champions

12.3, 2017; ReFED, 2016). As EU member states and businesses rise efforts to meet SDG 12.3 and forthcoming EU targets, rigorous evaluation will be an indispensable tool, one that transforms unreliable success stories into quantifiable, comparable results and thereby accelerates the adoption of best practices across Europe. By institutionalizing the use of these evaluation methods in project and policy cycles, we can move towards a future where preventing food waste is not only seen as the right thing to do, but also the economically and socially prudent thing to do. In sum, better evaluation will enable better decision-making, which in turn will drive better outcomes in our collective efforts to reduce FLW.

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EXPLORING BIRDWATCHING TOURISM IN THE SPECIAL NATURE RESERVE ZASAVICA: INSIGHTS INTO VISITORS' PERCEPTIONS

Abstract

Birdwatching tourism is a rapidly growing segment of nature-based tourism that offers both recreational and educational opportunities while supporting biodiversity conservation. This paper examines the main features, development potential, and economic effects of birdwatching tourism, with a particular focus on lessons from international examples and their applicability to the Special Nature Reserve Zasavica in the Republic of Serbia. Using literature review and case studies from countries such as Colombia, Alaska and Poland, the study highlights how strategic planning, infrastructure development, and community involvement can enhance the success of birdwatching destinations. The analysis emphasizes that economic benefits for local communities and the protection of natural habitats are closely linked, and that the richness of bird species alone is not sufficient for development of birdwatching tourism. Special attention is given to the Special Nature Reserve Zasavica as a model for applying international lessons locally. In addition, the paper presents the results of a survey conducted among visitors to Zasavica in November 2025, aimed at exploring their awareness, experiences, and perceptions of birdwatching tourism development.

Key words: *birdwatching tourism, sustainable tourism, economic development, biodiversity conservation, Zasavica*

JEL classification: *Q26, Q57, L83*

ИСТРАЖИВАЊЕ BIRDWATCHING ТУРИЗМА У СПЕЦИЈАЛНОМ РЕЗЕРВАТУ ПРИРОДЕ ЗАСАВИЦА: УВИД У ПЕРЦЕПЦИЈЕ ПОСЕТИЛАЦА

Апстракт

Birdwatching туризам је сегмент туризма заснованог на природи који брзо расте и пружа како рекреативне, тако и едукативне могућности, исто-

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времено подржавајући очување биодиверзитета. Овај рад проучава главне карактеристике, развојни потенцијал и економске ефекте бирдwатцхинг туризма, са посебним фокусом на лекције из међународних примера и њихову примену Специјални резерват природе Засавица у Републици Србији. Прегледом литературе и студија случаја из земаља као што су Колумбија, Аљаска и Пољска, истраживање истиче како стратешко планирање, развој инфраструктуре и укључивање локалног становништва могу побољшати успех дестинација бирдwатцхинг туризма. Анализа наглашава да су економске користи за локално становништво и заштита природних станишта уско повезани, и да сам број врста птица није довољан за развој бирдwатцхинг туризма. Посебна пажња посвећена је Специјалном резервату природе Засавица као моделу за примену међународних лекција на локалном нивоу. Поред тога, рад приказује резултате истраживања спроведеног међу посетиоцима Засавице у новембру 2025. године, са циљем испитивања њихове информисаности, искустава и перцепција о развоју birdwatching туризма.

Кључне речи: *туризам посматрања птица, одрживи туризам, економски развој, очување биодиверзитета, Засавица*

Introduction

Birds are an important part of biodiversity and the food chain, and because they are sensitive to changes in the environment, they serve as good indicators of ecosystem health. Their visibility and abundance make them useful for tracking ecological changes, even in cities (Zhang et al., 2023). As environmental problems grow, people are increasingly seeking ways to reconnect with nature. Birdwatching is one such activity, helping people understand the connection between humans, animals, and the environment (Just, 2022).

Tourism has expanded to include more nature-based activities, and birdwatching has become one of the most popular. It offers visitors both enjoyment and learning opportunities, while also creating economic benefits for local communities and tourism companies. Birdwatchers are often well-educated and belong to higher-income groups (Schwoerer & Dawson, 2022).

Although birdwatching tourism has been widely studied, there is still a lack of research focusing on visitors' perceptions and their willingness to financially support its development in less explored destinations. In Serbia, and particularly in the Special Nature Reserve Zasavica, this form of tourism has not been sufficiently examined from the perspective of visitors. This creates a gap in understanding how visitors perceive its potential and whether they are willing to contribute to its further development.

This study examines birdwatching tourism, its main features, and development potential, with particular focus on the Special Nature Reserve Zasavica in Serbia. In addition to reviewing international examples and best practices from destinations such as Colombia, Alaska, and Poland, the research includes an empirical component, a survey conducted among visitors to Zasavica. The purpose of the survey was to explore visitors' awareness, experiences, and perceptions of birdwatching tourism, as well as their willingness to financially support its development in Special Nature Reserve Zasavica.

Based on this purpose, the following hypotheses were formulated:

Main hypothesis (H1):

Visitors of the Special Nature Reserve Zasavica recognize its potential for the development of birdwatching tourism and show willingness to financially support such activities.

Supporting hypotheses:

H1a: Most visitors perceive Zasavica as having a high potential for birdwatching tourism development.

H1b: Visitors are willing to spend money on birdwatching-related activities (guided tours, equipment, guides) in Special Nature Reserve Zasavica.

H1c: Visitors believe that birdwatching tourism could contribute to local economic development in Special Nature Reserve Zasavica.

The underlying assumption of this study is that visitors' perceptions, experiences, and willingness to support birdwatching tourism are central to its successful development, alongside natural and infrastructural resources. Research by Callaghan et al. (2022) indicates that birdwatchers' perceptions and motivations strongly influence their choices of destinations at local, national, and international levels. For example, casual and hardcore birdwatchers prioritize different factors, such as the chance to see rare species, well-planned itineraries, or the quality of infrastructure. These findings highlight the importance of tourists' perceptions and preferences in shaping birdwatching tourism, providing a clear rationale for examining visitors' perceptions and willingness to pay in Zasavica.

Theoretical Background

Although birds inhabit nearly every part of the world, providing countless opportunities for observation, there are still differences and overlaps in how the terms birdwatching, ornithological tourism, and avitourism are used. Birdwatching usually refers to the activity of simply observing birds, which can take place anywhere, from urban parks to remote natural areas. Ornithological tourism generally involves traveling to natural habitats to experience both birds and their ecosystems, while avitourism focuses on travel aimed specifically at seeing certain bird species, sometimes in very specific or even urban settings. In both scientific and popular contexts, the term birdwatching is often used broadly, as a synonym for birdwatching tourism (Afanasiev, 2022). According to the UNWTO (2014), birdwatching belongs to the category of wildlife watching tourism, as it is based on the non-consumptive observation of birds in their natural environments.

Birdwatching tourism relies on bird diversity and the quality of their habitats, while requiring minimal physical effort and equipment. Closely connected to sustainability, it is linked with environmental protection, ecotourism, and other forms of nature-based tourism that aim to reduce negative environmental impacts (Padilla-Delgado et al., 2025). As a tourism form, it can be described as travel motivated by the desire to detect, identify, and observe wild, free-living bird species for personal satisfaction or educational purposes (Mohammadi et al., 2024, p. 214). Birdwatching tourism is expanding rapidly worldwide, but its success depends not only on the richness of bird species, but also on factors such as visitor safety, accessibility of sites, appropriate infrastructure, and qualified guides (IDB et al., 2015).

When analyzing birdwatching tourism, it is also important to understand the demand for this form of tourism and the characteristics that shape birdwatchers' choices and experiences. Birdwatchers differ significantly in their motivations, influencing the type and intensity of their activities (Großmann et al., 2025). The choice of destination is mostly determined by natural features, landscapes, and ecosystem diversity. Enthusiastic birders are usually motivated by the opportunity to see many species and enjoy unique landscapes, while less experienced birders tend to consider other aspects, such as additional tourist facilities, accessibility, and the availability of non-birding activities (Padilla-Delgado et al., 2025). Research also shows that birdwatchers prefer tours of medium duration, good interpretive guidance, organized transport, and opportunities to see rare or endemic species. They also value affordable pricing and are willing to pay more for higher-quality and more diverse birdwatching experiences, which underlines the need for well-developed and sustainable ecotourism services (Lee et al., 2010).

Birdwatching as a part of ecotourism programs has become particularly popular in North America and Western Europe, and interest has recently been growing in Russia as well (Afanasiev, 2022). On a global scale, the countries that attract the largest number of birdwatching tourists are those with high bird diversity and good infrastructure, such as Colombia, Costa Rica, Mexico, Peru, Ecuador, Brazil, and Australia. In contrast, some tropical countries with exceptionally rich avifauna, including the Democratic Republic of Congo, Venezuela, Bolivia, Madagascar, and Papua New Guinea, still receive relatively few visitors due to political, infrastructural, or safety-related constraints (Soergel, 2025).

Birdwatching tourism brings significant economic benefits through increased tourist spending, job creation, and overall contribution to local and national economies. It also plays an important role in supporting conservation initiatives and local development (Glowinski, 2008; Maldonado et al., 2018). In the United States, for instance, birdwatching generates approximately $108 billion annually through the purchase of equipment, travel expenses, accommodation, and related services. It supports around 1.4 million jobs and provides about $90 billion in labor income, while contributing $38 billion to various levels of tax revenue. In rural regions, birdwatching can be an important driver of economic activity, as the presence of rare or highly wanted bird species attracts large numbers of visitors and stimulates local businesses (BirdWatching Daily, 2025). Globally, birdwatching tourism is estimated to generate around US$13 billion in revenues that contribute directly to nature conservation efforts (Slater et al., 2019).

However, even though birdwatching is considered a non-consumptive activity, it is not entirely without impact. Birdwatchers, especially photographers, can sometimes disturb birds and cause stress, leading certain species to alter their natural behaviour or exhibit stronger escape reactions (Slater et al., 2019). Moreover, tourism in general, even when not directly related to birdwatching, can pose various risks to bird populations through habitat disturbance, noise, or pollution (Steven & Castley, 2013). Nevertheless, some researchers argue that birdwatching tourism, when properly managed, can play a positive role in protecting species and habitats by increasing awareness and generating financial support for conservation (Puhakka et al., 2011).

In tourism, which is considered an unpredictable environment, tourists often seek assurance that the services provided will meet their needs and expectations (Leković et al., 2025). Visitors' perceptions are a key factor in the development of birdwatching

tourism. Research shows that tourists provide important feedback on the quality and completeness of facilities, infrastructure, information centers, and the equipment used during birdwatching activities (Suyantri et al., 2024). Their opinions help improve the overall experience and ensure that the destination meets visitors' expectations. In addition, successful birdwatching ecotourism requires the involvement of multiple stakeholders, including local communities, tour operators, and conservation organizations, to ensure both positive visitor experiences and the protection of wildlife. For instance, studies at Hornøya, a protected bird cliff in Northern Norway, show that inadequate visitor management and limited presence of guides or enforcement personnel can lead to behaviours that disturb birds, highlighting the need for coordinated stakeholder involvement in ecotourism management (Aas et al., 2023). Considering visitors' perceptions and preferences in planning not only enhances satisfaction but also supports conservation efforts and sustainable development of the site. These insights underline the importance of examining visitors' perceptions and willingness to financially support birdwatching tourism.

International Case Studies of Birdwatching Tourism Development

Colombia is home to more than 1,900 bird species, accounting for almost 20% of all bird species worldwide. The country holds the world record for the highest number of bird species (Colombia Travel, 2025). Among them are 443 rare species highly valued by birdwatchers. Due to these factors, Colombia has recorded a steady increase in birdwatching tourism over the past decades (Ocampo-Peñuela & Winton, 2017, p. 1). Through various strategies and programs, efforts are being made in Colombia to ensure that birdwatching tourism benefits both local communities and biodiversity (Mu´nera-Rolda´n & Ocampo-Peñuela, 2022). One such initiative is the Vision Amazonia project, which aims to stimulate the local economy and promote regional development in a sustainable way, while at the same time reducing climate change and preventing deforestation in the Colombian Amazon (Vision Amazonia, 2025). Local communities that generate income from birdwatching tourism are required to protect bird habitats, develop the necessary specialized infrastructure, organize training programs for local residents, and ensure the safety of tourists (Winton & Ocampo-Peñuela, 2018). It is also worth mentioning the project "The Northern Colombia Birding Trail," which encompasses a network of trained birding guides and specialized birding tour operators, key birding sites such as national parks and nature reserves, as well as small businesses and support services for the development of birdwatching tourism (National Audubon Society, 2025). The project aims to use birdwatching as a tool for economic development and biodiversity conservation in northern Colombia. Through professional training sessions organized within the project, 44 local residents, including members of native ethnic groups, have been qualified to work as bird guides. A special emphasis within the project was placed on English language skills. Some of the most significant birdwatching destinations in this area are Eco-parque Los Besotes (home to over 210 bird species), Perijá Mountains (habitat of endangered and endemic bird species), Los Flamencos Flora and Fauna Sanctuary (a coastal wetland and dry forest reserve created to protect a large population of American flamingos, also home to 185 other bird species, 80% of which

are migratory), Tayrona National Park (the most visited national park in Colombia, home to over 280 bird species), and the Santa Marta Mountains (habitat for more than 600 bird species, including 19 endemic ones) (Northern Colombia Birding Trail Project, 2025).

Alaska is home to the highest concentration of coastal birds in the world, hosting more than one-third of the global population of these species, some of which nest nowhere else and are threatened by habitat loss and climate change (Alaska Shorebird Group, 2019, p. 1). From large birds such as eagles to tiny hummingbirds, around 500 bird species can be found in Alaska. Although birds can be observed throughout the year, the main birdwatching season lasts from late April to middle of September (Travel Alaska, 2025). Through birdwatching tourism, Alaska strives to diversify and further develop local economies and attract new revenue to remote and underdeveloped parts of the state, which are predominantly inhabited by rural indigenous populations. In these remote areas, birdwatching tourism provides opportunities for employment and income generation for local residents (Goldsmith, 2007). Many migratory and resident bird species have high conservation status and significant cultural importance (Schwoerer & Dawson, 2022). Some of the most notable birdwatching destinations in Alaska include Glacier Bay National Park (around 240 bird species), Kenai Fjords National Park (around 190 species), Pribilof Islands (around 220 species), Denali National Park and Preserve (167 species), and Kodiak Island (more than 240 species). Birdwatching is an extremely popular form of tourism in Alaska, and the state organizes numerous birding festivals throughout the year. For example, in early May, the Copper River Delta Shorebird Festival takes place, attracting around five million coastal birds. In November, the Haines Bald Eagle Festival is held, where over 3,000 bald eagles can be observed along a 6.4 km stretch of the Chilkat River. During the third week of August, the Tanana Valley Sandhill Crane Festival celebrates the beginning of the fall migration of the sandhill crane, featuring artists, guides, and numerous activities and workshops for all ages (Travel Alaska, 2025).

When it comes to Europe, Białowieża Forest in Poland is one of the most famous birdwatching sites. In 2016, this area recorded around 14,000 birdwatchers, who spent nearly 2.2 million USD (Czeszczewik et al., 2019, p. 2967). Białowieża Forest is a World Heritage Site located on the border between Poland and Belarus. It comprises a diverse complex of protected forest ecosystems, as well as a number of connected non-forest habitats, including wet meadows, river valleys, and other marshy areas. It is home to the largest population of European bison and more than 250 bird species. Situated within the watershed of the Baltic and Black Seas, this transboundary property offers exceptional opportunities for biodiversity conservation (UNESCO, 2025). The most prominent tourist village is Białowieża, which annually attracts between 120,000 and 200,000 visitors, many of whom come for birdwatching, as Białowieża Forest contains forest bird species not found elsewhere in Europe (Wesołowski et al., 2015). It is the only site in Poland listed as a UNESCO World Heritage Site based on natural values and represents a true paradise for birdwatchers. According to research by Czeszczewik et al. (2019, p. 2971), birdwatching contributes approximately 2,170,374 USD annually to the local economy, most of which comes from foreign visitors. Birdwatchers tend to spend more than other tourists, as they hire licensed professional guides who can show them various species of woodpeckers and owls. Many specialized agencies offer tours accompanied by professional ornithologists who guide tourists through diverse habitats. These tours

allow participants to learn how to identify bird species by call and song, including rare woodpeckers. In addition, professional optical equipment (binoculars and telescopes) is available for rent (Poland Travel, 2025; Nature Tours to Poland, 2025). Some programs last up to a week, making a significant contribution to the improvement of the local rural economy. Tourists spend their money on accommodation in local guesthouses, sampling local cuisine, and purchasing local souvenirs and other products.

Special Nature Reserve Zasavica - Case Study

The Special Nature Reserve Zasavica is located in the south-western part of Vojvodina, within the municipalities of Sremska Mitrovica and Bogatić. This wetland area consists of floodplain meadows and forests. The Zasavica River, approximately 30 km long, is a calm and gentle watercourse that has enabled the survival of a rich and diverse flora and fauna. In order to preserve this natural wealth, Zasavica and its surrounding area have been placed under state protection as a natural asset of category I, *of exceptional importance*.

It is one of the most significant bird conservation areas in Serbia, with around 216 bird species recorded (Zasavica Special Nature Reserve, 2025), more than 120 of which are active breeders. This diversity makes Zasavica extremely important for scientific research, as well as for nature enthusiasts and birdwatchers. Artificial nesting platforms have been installed at 20 selected locations to provide optimal conditions for bird breeding. This project greatly contributes to the preservation and growth of populations of rare and protected bird species.

Visitors can observe how birds prepare for seasonal migrations, care for their young, and coexist with other species in this rich ecosystem. The most notable event is the organized birdwatching and bird ringing during the European Birdwatching Days, traditionally held on the first weekend of October across Europe. This event offers tourists the opportunity to closely observe various bird species that reside in or migrate through Zasavica. Experts ring birds to monitor their migrations, contributing to both their conservation and research, while also educating visitors about the importance of bird ringing and protection.

For tourists, several activities are available, including a 7 km tourist boat ride that allows observation of rare wetland and forest bird species in their natural habitats, a photo safari boat ride through Zasavica, and guided educational walking tours led by professional guides. The reserve also features a Tourist-Educational Centre with a Visitor Centre built in an ethno style, made of wood to blend harmoniously with the surrounding environment.

Within this centre stands an 18 meter high observation tower with 150 seats, offering a panoramic view of the widest and most beautiful part of the Zasavica River. Accommodation within the reserve is modest, consisting of two apartments located in the Visitor Centre and the Zasavica auto camp with 42 camping spots. In the surrounding area, tourists can stay at rural households, traditional farmsteads (*salaši*), or private apartments (Birdingplaces.eu, 2025).

Methodology

The research was conducted using a questionnaire designed to collect data about visitors' experiences and perceptions of birdwatching tourism in the Special Nature Reserve Zasavica. The questionnaire was developed based on previous studies by Đorđević et al. (2025), Stemmer et al. (2022) and Lee et al. (2010), which examined visitor preferences and willingness to pay in the context of birdwatching and nature-based tourism. The questionnaire was distributed in early November 2025 using Google Forms and a convenience sampling method. To ensure the relevance of responses, an eliminatory question was included, only participants who had visited Zasavica could proceed with completing the questionnaire.

A total of 146 respondents participated, but only 102 valid responses were included in the analysis, as these participants confirmed visiting the Special Nature Reserve Zasavica. The questionnaire consisted of both closed-ended questions covering socio-demographic characteristics, frequency of visits, awareness of birdwatching, and perceptions of the potential development of birdwatching tourism.

The data collected were processed using descriptive statistical analysis (frequencies, percentages, and mean values) to summarize and interpret the main findings. This approach provided a clear overview of the visitors' profiles, experiences, and opinions regarding the potential of Zasavica for birdwatching tourism development.

Results

Only those who have visited the Special Nature Reserve Zasavica (n = 102) were included in further analysis. Among these visitors, the majority were male (68), while 34 were female. The largest age group consisted of visitors aged 40-50 years (42), followed by those aged 30-40 years (22) and 20-30 years (21), indicating that middle-aged adults represent the dominant group of visitors. In terms of education, most respondents held a Bachelor's degree (43), while 27 had a Master's degree and 14 completed College of Applied Studies, suggesting a generally well-educated sample. The majority of participants were employed (84), and regarding their place of residence, 64 came from other parts of Serbia, 38 lived near Zasavica (within 50 km), and only 2 were from abroad (Table 1).

Table 1. Socio-demographic characteristics of respondents

		Frequency	**Percent**
Have you ever visited the Special Nature Reserve Zasavica?	Yes	102	66.7
	No	44	33.3
Gender	Male	68	66.7
	Female	34	33.3

Age	20-30	21	20.6
	30-40	22	21.6
	40-50	42	41.2
	50-60	10	9.8
	60-70	4	3.9
	>70	3	2.9
Education	High school	12	11.8
	College of Applied Studies	14	13.7
	Bachelor's degree	43	42.2
	Master's Degree	27	26.5
	Doctorate	6	5.9
Employed	Yes	84	82.4
	No	18	17.6
Place of residence	Near Zasavica (within 50 km)	38	37.3
	In another part of Serbia	64	62.7
	Outside Serbia	2	2.0

Source: Authors

Most respondents were occasional visitors, with 45 (44.1%) visiting only once and 38 (37.3%) visiting two or three times. Fewer participants had visited more frequently, with 14 (13.7%) reporting four to ten visits and only 5 (4.9%) more than ten times. Despite the varying frequency of visits, the majority of respondents noticed a rich variety of bird species: 89 visitors (87.3%) reported seeing different birds, while 8 (7.8%) did not, and 5 (4.9%) could not remember. This indicates that Zasavica generally provides good opportunities for birdwatching, even for first-time or infrequent visitors. Awareness of birdwatching was high among respondents. Out of 102 participants, 91 (89.2%) knew exactly what birdwatching is, while 11 (10.8%) had heard of it but did not know much about it. No participant reported hearing about birdwatching for the first time, suggesting that most visitors were already familiar with the concept (Table 2).

Table 2. Descriptive statistics

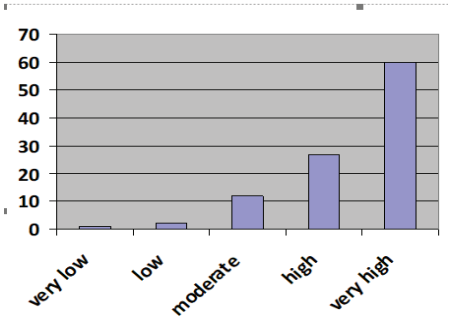
Question	Response	Frequency (f)	Percentage (%)
How many times have you visited Zasavica?	Once	45	44.1
	2–3 times	38	37.3
	4–10 times	14	13.7
	More than 10 times	5	4.9

During your visit, did you notice the presence of various bird species?	Yes	89	87.3
	No	8	7.8
	I don't remember	5	4.9
Have you heard of the term "birdwatching"?	Yes, I know exactly what it means	91	89.2
	I have heard of it, but I don't know much about it	11	10.8
	No, this is the first time I hear about it	0	0.0

Source: Authors

Respondents were very optimistic about Zasavica's potential as a birdwatching destination. When asked to rate the potential, 60 (58.8%) considered it very high, 27 (26.5%) rated it high, 12 (11.8%) moderate, 2 (2.0%) low, and only 1 (1.0%) very low (Figure 1). This suggests that visitors believe the reserve is well suited for birdwatching tourism. Regarding the facilities and services that could support this type of tourism, respondents highlighted trained guides and organized tours as most important (32.4%), followed by promotional activities such as advertising and websites (24.5%) and accommodation and catering facilities (23.5%). Viewing platforms and marked trails (12.7%) and information boards or brochures (6.9%) were considered less critical.

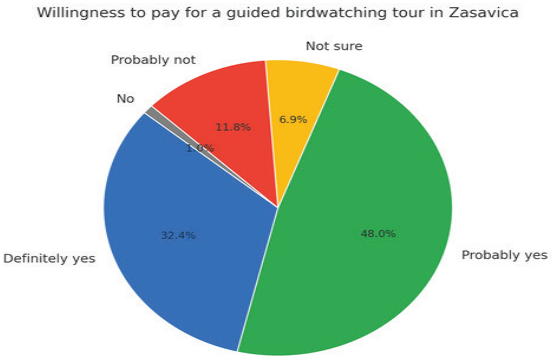
Figure 1. Zasavica's potential as a birdwatching destination



Source: Authors

Most respondents expressed willingness to pay for guided birdwatching tours, with 33 (32.4%) saying they would definitely pay and 49 (48.0%) saying they would probably pay. Seven (6.9%) were unsure, 12 (11.8%) would probably not pay, and only 1 (1.0%) would refuse (Figure 2). When asked about how much they would be willing to spend on a one-day visit, 42 participants (41.2%) chose €6-15, 32 (31.4%) up to €5, 19 (18.6%) between €16-30, 5 (4.9%) more than €30, and 4 (3.9%) would not pay at all. This suggests that birdwatching in Zasavica is considered affordable by most visitors, with moderate spending being the most common preference.

Figure 2. Willingness to pay for guided birdwatching tours



Source: Authors

The survey results show generally positive views on developing birdwatching tourism in Zasavica. Respondents rated how they believe birdwatching tourism would affect the local economy, the quality of life of the local community, and the environment. The evaluation was conducted using a five-point Likert scale, where 1 represented the lowest and 5 the highest level of agreement. They think such development would help the local economy, as shown by the high average score of 4.2. The impact on the quality of life for the local community was also seen as positive, with a slightly lower average score of 3.8, which suggests that social benefits are recognized but may be perceived as less direct than economic ones. The highest score, 4.3, was recorded for the contribution of birdwatching tourism to biodiversity and environmental protection, showing strong awareness of ecological benefits. Overall, the results indicate that developing birdwatching tourism in Zasavica is seen positively for the economy, the community, and the environment (Table 3).

Table 3. Impacts of birdwatching tourism

Items	Average rating
Developing birdwatching tourism in Zasavica would contribute to local economic development	4.2
Developing birdwatching tourism in Zasavica would contribute to the quality of life of local community	3.8
Developing birdwatching tourism in Zasavica would contribute to biodiversity conservation and environmental protection	4.3

Source: Authors

Discussion

Birdwatching tourism can provide important economic benefits (Callaghan et al., 2025), especially for local communities (Nella & Stergiou, 2025). It encourages the development of small businesses such as accommodation, guiding services, local transport, and traditional food production. These activities can create new sources of income, especially in rural areas with limited employment opportunities. In addition, birdwatching tourists usually travel outside the main season and stay longer, which contributes to a more stable local economy throughout the year. Therefore, the economic effects of birdwatching are not limited to direct spending, but also include indirect benefits through the promotion of local culture and products. Birdwatchers can also bring financial benefits to remote areas, helping local people to diversify their income and at the same time contribute to the protection of bird habitats (Schwoerer & Dawson, 2022). Since birdwatching is one of the fastest-growing forms of ecotourism, it can play an important role in strengthening local economies, particularly in regions rich in bird species (Czeszczewik et al., 2019). Because the benefits of birdwatching tourism often outweigh the costs for local communities, many governments in biodiverse tropical countries support it as a way to create low-impact jobs and promote economic development while using natural resources sustainably (Ocampo-Peñuela et al., 2025).

International examples show that the success of birdwatching destinations often depends on strategic planning and cooperation between tourism organizations, nature protection authorities, and the local population. Countries such as Colombia, Poland, and Alaska have developed well-organized birdwatching routes, visitor centres, and educational programs that help link tourism with conservation goals. These examples highlight the importance of investing in infrastructure that supports sustainable visits, such as marked trails, observation towers, information boards, and accessible facilities for all visitors. However, the potential for sustainable birdwatching tourism is often not fully used because of social, economic, and political challenges that can limit development. According to Maldonado et al. (2018), countries such as Colombia, which has faced armed conflict in the past, are now starting to develop birdwatching tourism as an important part of their local economy. Examining why some countries succeed in developing birdwatching while others do not can show where this form of ecotourism contributes to conservation and where its potential remains unfulfilled (Stronza et al., 2019).

In the context of Serbia, and particularly the Special Nature Reserve Zasavica, similar approaches could be applied. The reserve already has valuable natural resources and a recognizable image, but additional efforts are needed to improve infrastructure, promote specialized guiding services, and engage the local community in tourism development. The results of the conducted survey support this view, as most visitors (58.8%) rated Zasavica's potential for birdwatching tourism as very high. Most respondents expressed a willingness to spend money on related activities and believed that such tourism could contribute to local economic development. Therefore, the main hypothesis (H1) and all supporting hypotheses (H1a, H1b, and H1c) were confirmed. International research also indicates that birdwatchers' motivations and levels of engagement vary considerably. In a study of the largest national park in Poland, birdwatchers were primarily middle-aged urban males, motivated by the desire to be close to nature and fascination with birds (Janeczko et al., 2021). The study highlighted that well-developed infrastructure

is essential for enabling interactions with the objects of observation, while engagement tends to increase with frequency of trips and personal commitment. These findings support the results for Zasavica, emphasizing the importance of providing high-quality infrastructure, guided tours, and educational programs to cater to both amateur and highly engaged birdwatchers.

Rural areas are increasingly shifting away from the traditional paradigm of being exclusively tied to agriculture, embracing new opportunities related to tourism, recreation, and the promotion of local products (Dimitrijević, 2025). Ensuring destination sustainability requires the active involvement and collaboration of all relevant stakeholders, including local residents, tourism organizations, and conservation authorities (Ivkov et al., 2024). By applying lessons from international experiences, Zasavica could strengthen its position as a sustainable birdwatching destination that contributes both to local economic growth and to biodiversity conservation.

The discussion confirms the initial assumption that the richness of bird species alone is not sufficient for the success of birdwatching tourism. Well-developed infrastructure, quality visitor experience, and active involvement of local residents are essential for achieving long-term sustainability and economic benefits. Additionally, the success of birdwatching tourism depends on basic and specialized infrastructure, such as access to habitats, lodging, food, guidance, and comfort, which politically unstable or conflict-affected countries often lack, limiting visits to only the most adventurous birdwatchers (Echeverri et al., 2022).

Conclusion

Birdwatching tourism represents a form of sustainable tourism that combines environmental protection with local economic development. The analysis has shown that this type of tourism can create multiple benefits for rural areas, especially by supporting small businesses and extending the tourist season. However, to achieve its full potential, it is necessary to develop appropriate infrastructure, ensure professional guiding services, and include local residents in planning and decision-making. Birdwatching tourism can become an important driver of sustainable local development if managed responsibly and supported by cooperation between conservation institutions, tourism stakeholders, and local communities. The survey conducted among visitors to Zasavica supports this potential, as most respondents rated the reserve's birdwatching tourism potential as very high and expressed willingness to pay for guided tours and related services, while recognizing its contribution to local economic development.

International examples demonstrate that destinations with a clear management strategy, adequate facilities, and community participation are more successful and more attractive to visitors. These experiences can serve as useful guidelines for improving birdwatching tourism in Serbia. In the case of the Special Nature Reserve Zasavica, applying these principles could enhance both its ecological value and its economic contribution to the region.

The study provides valuable insights into visitors' perceptions, but it also has some limitations. The sample included 102 visitors, and the survey was conducted online, which left out some potential respondents. In addition, the study focused only on visitors,

without including local stakeholders, tourism operators, or conservation authorities. Despite these limitations, combining the survey results with lessons from international examples gives a clearer picture of the opportunities and challenges for birdwatching tourism in Zasavica. The findings point to clear ways to support sustainable development, such as improving visitor-friendly infrastructure, offering guided services, engaging the local community, and running educational programs. By continuing to track visitor behaviour and economic impacts, birdwatching tourism in places like Zasavica can help local economic growth, involve the community, and protect biodiversity. Future research could include a larger sample, multiple stakeholder perspectives, and look at the long-term effects of birdwatching tourism on the local economy and environment.

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TEMETTUAT DEFTER (PROFIT REGISTER) OF THE CHRISTIAN MAHALLES OF NIŠ (1845): POP ĐORĐE'S, POP KOSTA'S, POP JONA'S MAHALLE WITH ATTACHED ÇIFLIKS

Abstract

The paper represents a phased result of a broader research on the economic, social and demographic conditions in Niš based on the temettuat defter for the territory of this city (1845). As the research focuses on non-Muslim communities in Niš, the paper deals with three Christian districts named after the priests (Đorđe, Kosta, Jona) as well as with the rural estates (çiftliks) inhabited by Christians and administratively attached in the defter alongside the aforementioned mahalles.

Key words: *Niš, Ottoman Empire, Balkans, Christians, temettuat defter, 19th century*

JEL classification: *N33, N530, N930*

TEMETUAT DEFTER (ДЕФТЕР ПРОФИТА) ХРИШЋАНСКИХ МАХАЛА У НИШУ (1845): МАХАЛЕ ПОПА ЂОРЂА, ПОПА КОСТЕ И ПОПА ЈОНЕ СА ПРИДРУЖЕНИМ ЧИФЛИЦИМА

Апстракт

Рад представља фазни резултат ширег истраживања о економским, друштвеним и демографским приликама у Нишу на основу теметуат дефтера за територију овог града из 1845. године. Како је у истраживању стављен акценат на немуслиманске заједнице у Нишу, рад се бави са три хришћанска насеља именована по свештеницима (Ђорђу, Кости, Јони), као и приградским чифлицима које су насељавали хришћани и који су у дефтеру административно наведени уз поменуте махале.

Кључне речи: *Ниш, Османско царство, Балкан, хришћани, теметуат дефтер, 19. век*

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About the Analyzed Communities

The lists of the aforementioned mahalles are kept at the Archives of the Presidency of the Republic of Turkey (BOA) in Istanbul. They are recorded with unique archival signatures, as separate documents of the temettuat defter for Niš (1845). Of the mahalles that we have dealt with in this paper, the largest mahalle (according to the number of households) was Pop Đorđe's mahalle with 49 households, while the smallest was the Pop Jona's[3] mahalle, with only 3 registered households. Given that in the temettuat defter for Niš (1845) no additional pages were identified for Pop Jona's mahalle, it is possible that this Christian community was still in the formation phase, therefore, the latest of the mentioned ones. In this regard, unless the preserved defters of other purposes indicate its older origin, it is possible to assume that the Pop Jona's mahalle was founded by settlers who moved to Niš in the years after the Great Niš Uprising (1841). That theory supports the fact that at that time Christian population migrated to the towns of Niš Eyalet, for the sake of safety (Ranđelović & Ranđelović, 2025).

The third mahalle (Pop Kosta's mahalle) had 34 households on 33 locations (2 independent entries are on household no. 26). Unfortunately, the last pages of defter's section which refer to this mahalle have not been preserved, so it is possible that the mahalle was more populous than Pop Đorđe's. Three çiftliks are adjacent to this mahalle – two named and the one whose name is not identified due to torn pages in the defter. Due to the connection of the Pop Kosta's mahalle with these çiftliks, it can be assumed that the mahalle was located somewhere in the outskirts of Niš, where the urban structure bordered the rural suburban hinterland. Now, it is difficult to determine with certainty whether the location of the mahalle was, except guessing it was in *varoş*, somewhere on the left bank of the Nišava River (Kordiç, 2019). The majority of the local Christian population lived there, as it can be seen from the maps of Niš from 1878 (Stojančević, 1984). Two more things differ Pop Kosta's mahalle from other mahalles and çiftliks mentioned in the paper. The scriber enumerated households at Pop Kosta's mahalle which is not the case with the Pop Đorđe's and Pop Jona's mahalles, as well as with the çiftliks we dealt with in this paper. Also, in most of the cases, the scriber recorded precisely the places where the residents had their land, bringing more info on economic links between communities in Niš and the region which gravitated to this city.

As for the personal names mentioned in the defter, we could easily identify most of them, including possible variations such as with the names Miladin/Mladen/Milutin, Krsta/Hrista/Rista, or names with the usual root Jov- (Jovan, Jova) and St- (Stojan, Stanoje, Stanko, Stanča/Stansa). Same goes for the Muslim names, though we had a unique case. A certain landlord (çiftlik sahibi) bore two nicknames, one taken from his place of origin (village Pasjača, in Prokuplje region) and the other from the place where he lived (Prokuplje). So, we entitled him as Sulja (Suleyman) the Pasjačian from Prokuplje.

[3] In the previous paper on the temettuat defter for Niš (1845), we mentioned this mahalle named as Pop Jova's mahalle. However, further work on this defter led us to the consensus that the name of this priest was actually Jona, not Jova. For more on this, see: Ranđelović, M, Çekmez, O. (2025). Temettuat defter (profit register) of the Christian mahalles of Niš: Pop Stanko's mahalle, *Ekonomika*, 74(4), 47–64.

Identification of toponyms was more difficult, although some places that we identified in the previous paper appear again (Malošište, Batušinac, Sudurun*) (Ranđelović & Çekmez, 2025). Many new places arose. Some of them exist today, like villages Blata (Pirot region), (Donja) Trnava, Smrdan and Pasjača (Prokuplje region). The rest were Slavic toponyms vulgarised in Ottoman Turkish form, so they either led to nothing or couldn't be identified with 100% certainity. Such is the case with the villages Hrastinče, Iržana. As far as we are concerned, Iržana could be the village Visočka Ržana (Pirot region), but it is very loose interpretation, so we left it as it was written. Identification of toponyms may be a futile task for researchers, since it is questionable how reliably the scribers transliterated the Slavic toponyms on Ottoman Turkish language from the people who provided them with those names. In addition, even if the names of all the places were correctly transliterated in the defter, the question is how many of such toponyms would be remembered today or remained in the same form they had in the 19th century. In any case, we have placed an asterix* next to the toponyms that we could not translate, as in the previous paper.

The names of the professions have been translated if they had an English equivalent. With clarification, we have kept in the original the professions that are specific to Ottoman society or listed with a too general terms (therefore, have multiple meanings), such as rençber (meaning farmer, but also a worker on heavy physical jobs) or, as in the previous work, *kiracı* (Ranđelović & Çekmez, 2025). Though specifically Ottoman and complex term, *erbab-i zirat* (the one who owns/cultivates a land) we translated with simple *farmer* (Todorov, 2019). We kept in original, for the sake of authenticity, another Ottoman term which also indicates a person who provides by growing /working with the crops (with hoe), *capaci*.

When entering data on the registered persons the same matrix was used as in the previous paper, which we consider to be clear and concise. The only novelty is the introduction of a new economic category listed in the temettuat defter, *cizye*. As the main payment of non-Muslims to the Ottoman state, *cizye* was a key parameter for determining the economic status of an individual (Erkal, 1983). Depending on this economic power, the *cizye* was charged in a low (15 kuruş), medium (30 kuruş) and high amount (60 kuruş). Specific taxes, such as *adet-i agnam* (tax on sheep) and *bedel-i arpacık* (tax on onion) that were listed in the previous paper are retained in this paper, too.

Temettuat Defter of Pop Đorđe's Mahalle

Potter Nikola (f. Lazar). He pays low cizye. Last year he paid vergi with 20 kuruş. He rents 0,5 dönüms of land (income 140 kuruş per year) and 1 dönüm of vineyard (income 60 kuruş). In total, he earns 250 kuruş from the job and 60 kuruş from other things.

Carpenter Spasa (f. Jovan). He pays low cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş and 20 para), 10 kiye of barley (2 kuruş) and 15 kiye of corn (3 kuruş), tax on sheep (12 para) and tax on alcohol (60 kuruş). He owns 12 dönüms of vineyards (income 360 kuruş per year, taxed with 60 kuruş), 7 dönüms of land (income 145 kuruş, taxed with 14 kuruş and 20 para) and 3 dönüms of meadows (income 45 kuruş). He rents 2 dönüms of land from Osman, son of Sulejman Bey (income 30 kuruş per year, taxed with 3 kuruş to the state and same amount of hiring tax was paid to Osman). He

keeps 6 milking sheep (income 43 kuruş) and 4 lambs, 2 oxen, 1 waterbuffalo, 1 barren cow, 1 yearling and 1 calf. In total, he earns 300 kuruş from the job and 514 kuruş from other things.

Rençber Stanoje (f. Jovan). He pays low cizye. Last year he paid vergi with 25 kuruş. He owns 2 dönüms of vineyards (income 24 kuruş per year), 2 pot distillers (income 200 kuruş) and 1 store which he rents out (income 50 kuruş). In total, he earns 150 kuruş from the job and 174 kuruş from other things.

Capaci Mita (f. Mitar). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 20 kiye of corn (4 kuruş) and tax on alcohol (4 kuruş). He rents 2 dönüms of land from Osman Agha (income 40 kuruş per year, taxed with 4 kuruş to the state and same amount of hiring tax was paid to Osman Agha). He owns 2 dönüms of vineyard (income 72 kuruş). In total, he earns 104 kuruş from the job and 72 kuruş from other things.

Kiraci Ranđel (f. Stojko). He pays low cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 80 kiye of wheat (12 kuruş and 20 para), 10 kiye of barley (2 kuruş), 1,5 kiye of lentils (30 para), 40 kiye of corn (8 kuruş) and tax on alcohol (45 kuruş). He owns 10 dönüms of vineyards (income 240 kuruş per year) and rents 9 dönüms of land from Ibiš Agha from Prokuplje (income 287 kuruş and 20 para per year, taxed with 28 kuruş and 20 para to the state and same amount of hiring tax was paid to Ibiš Agha). He keeps 10 milking sheep (income 60 kuruş), 7 lambs and 4 oxen. In total, he earns 150 kuruş from the job and 469 kuruş from other things.

Innkeeper Jova (f. Stojko). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 25 kiye of corn (5 kuruş) and tax on alcohol (5 kuruş). He owns 10 dönüms of vineyards (income 120 kuruş), 5 dönüms of uncaultivated land and rents 2 dönüms of land from Mehmed Bey (income 50 kuruş, taxed with 5 kuruş the state and same amount of hiring tax was paid to Mehmed Bey). In total, he earns 400 kuruş from the inn and 160 kuruş from other things.

Potter Stanča (f. Milenko). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 25 kiye of corn (5 kuruş). He rents 2 dönüms of land from Sulja the Pasjačian (income 50 kuruş per year, taxed with 3 kuruş to the state and same amount of hiring tax was paid to Sulja). In total, he earns 300 kuruş from the job and 40 kuruş from other things.

House servant Mita (f. Rista). He pays low cizye (vergi is not recorded). He pays aşar for 25 kiye of corn (5 kuruş). He keeps 1 cow and 1 yearling. He owns 2 stores (income 140 kuruş). In total, he earns 100 kuruş from the service and 140 kuruş from other things.

House servant Petar (f. Rista). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays tax on alcohol (18 kuruş). He rents 1 dönüm of land (income 120 kuruş) and owns 5 dönüms of vineyard (income 72 kuruş). He holds 1 barren cow and 1 yearling. He owns 1 store (income 100 kuruş). In total, he earns 100 kuruş from the service and 172 kuruş from other things.

Priest Đorđe (f. Ivan). He pays low cizye (vergi is not recorded). He pays aşar for 20 kiye of corn (5 kuruş), tax on onion (25 kuruş) and tax on alcohol (33 kuruş and 10 para). He rents 2 parcels of land – 1 dönüm (income 50 kuruş, taxed with 5 kuruş to the state and same amount of hiring tax was paid to Mehmed) and 2 dönüms (income 250 kuruş). He owns 7,5 dönüms of vineyard (income 180 kuruş). He keeps 1 barren cow, 1 female yearling and 1 jenny. He owns a house (income 40 kuruş). In total, he earns 200 kuruş from the service and 500 kuruş from other things.

House servant Mile (f. Đoka). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 20 kiye of corn (4 kuruş) and tax on alcohol (18 kuruş). He rents

1,5 dönüms of land from Ali Agha the Nišlian (income 40 kuruş, taxed with 4 kuruş to the state and same amount of hiring tax was paid to Ali Agha). He owns 6 dönüms of vineyard (income 144 kuruş). He holds 5 goats (income 15 kuruş). In total, he earns 100 kuruş from the service and 172 kuruş from other things.

Gun-maker Stanoje (f. Miladin). He pays low cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 55 kiye of wheat (12 kuruş and 20 para), 2 kiye of lentils (1 kuruş), 60 kiye of corn (12 kuruş) and tax on alcohol (30 kuruş and 30 para). He rents 7 dönüms of land from Ibiš Agha from Prokuplje (income 255 kuruş, taxed with 25 kuruş and 25 para to the state and same amount of hiring tax was paid to Ibiš Agha). He keeps 5 goats (income 15 kuruş) and 2 oxen. In total, he earns 200 kuruş from the job and 459 kuruş from other things.

Innkeeper Vasa (f. Miladin). He pays low cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 30 kiye of wheat (7 kuruş and 20 para), 60 kiye of corn (12 kuruş) and tax on alcohol (35 kuruş). He owns 6 dönüms of vineyards (income 180 kuruş per year) and rents 6 dönüms of land from Ibiš Agha from Prokuplje (income 195 kuruş and 20 para per year, taxed with 19 kuruş and 20 para to the state and same amount of hiring tax was paid to Ibiš Agha). He keeps 1 milking cow (income 12 kuruş), 1 barren cow, 1 female yearling and 2 oxen. In total, he earns 350 kuruş from the tavern and 364 kuruş from other things.

Capaci Stojan (f. Krsta). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 80 kiye of corn (16 kuruş) and tax on alcohol (20 kuruş and 10 para). He owns 4,5 dönüms of vineyards (income 144 kuruş per year) and rents 1,5 dönüms of land from Ibiš Agha from Prokuplje (income 160 kuruş per year, taxed with 16 kuruş to the state and same amount of hiring tax was paid to Ibiš Agha). He owns 3 stores (income 150 kuruş). In total, he earns 120 kuruş from the job and 422 kuruş from other things.

House servant Cvetko (f. Marinko). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 50 kiye of corn (10 kuruş) and tax on alcohol (31 kuruş and 20 para). He owns 7 dönüms of vineyards (income 180 kuruş per year) and rents 6 dönüms of land from Ali Agha the Nišlian (income 100 kuruş per year, taxed with 10 kuruş to the state and same amount of hiring tax was paid to Ali Agha). He keeps 1 milking cow (income 12 kuruş) and 1 female yearling. In total, he earns 200 kuruş from the service and 260 kuruş from other things.

Petar (f. Stojan). Petar is disabled.

Carpenter Stamenko (f. Đoka) He pays low cizye. Last year he paid vergi with 20 kuruş. In total, he earns 150 kuruş from the job.

Innkeeper Vlajko (f. Nikola). He pays low cizye. Last year he paid vergi with 40 kuruş. He pays aşar for 25 kiye of corn (5 kuruş) and tax on alcohol (45 kuruş). He owns 9 dönüms of vineyards (income 180 kuruş per year) and rents 4 dönüms of land from Salih, the son of Osman the Sipahi from Prokuplje (income 50 kuruş per year, taxed with 5 kuruş to the state and same amount of hiring tax was paid to Salih). He keeps 1 barren cow. In total, he earns 300 kuruş from the tavern and 220 kuruş from other things.

Tailor Nasko (f. Jova). He pays low cizye. Last year he paid vergi with 86 kuruş. He pays aşar for 25 kiye of wheat (6 kuruş and 10 para), 1,5 kiye of lentil (1 kuruş and 20 para), 30 kiye of corn (6 kuruş) and tax on alcohol (38 kuruş and 10 para). He owns 8,5 dönüms of vineyards (income 280 kuruş per year) and rents 3 dönüms of land from Haci Effendi (income 137 kuruş and 20 para per year, taxed with 13 kuruş and 30 para

to the state and same amount of hiring tax was paid to Haci Effendi). He keeps 1 milking cow (income 12 kuruş), 1 barren cow, 1 female yearling, 1 jenny and 4 oxen. He owns 3 stores (income 280 kuruş) and 1 house (income 30 kuruş). In total, he earns 150 kuruş from the job and 700 kuruş from other things.

House servant Stojko (f. Jova). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays tax on alcohol (22 kuruş and 10 para). He owns 5 dönüms of vineyards (income 80 kuruş per year) and rents 3 dönüms of land so he could grow corn (expected income 60 kuruş[4]). In total, he earns 100 kuruş from the service and 180 kuruş from other things.

Tailor Ilija (f. Stamenko). He pays low cizye. Last year he paid vergi with 28 kuruş. He pays aşar for 35 kiye of corn (7 kuruş) and tax on alcohol (40 kuruş and 10 para). He owns 8,5 dönüms of vineyards (income 212 kuruş per year), 5 dönüms of uncultivated land and rents 2 dönüms of land from Haci Bekir (income 70 kuruş, taxed with 7 kuruş to the state and same amount of hiring tax was paid to Haci Bekir). He keeps 2 oxen. In total, he earns 150 kuruş from the job and 268 kuruş from other things.

Tailor Mile (f. Miladin). He pays low cizye. Last year he paid vergi with 14 kuruş. He pays aşar for 144 kiye of wheat (36 kuruş), 160 kiye of barley (32 kuruş) and tax on alcohol (40 kuruş). He owns 50 dönüms of uncultivated land, 9 dönüms of land (income 670 kuruş, taxed with 67 kuruş) 40 dönüms of vineyards (income 720 kuruş per year), 5 dönüms of meadows (income 75 kuruş) and rents 2 dönüms of garden (income 200 kuruş). He keeps 2 milking cows (income 25 kuruş), 1 female and 1 male yearling, 1 mule, 1 donkey, 1 mare and 6 oxen. He owns 1 mill and 1 mill stone (income 250 kuruş), pot distiller (or) pot distillers (income 1000 kuruş), 2 stores (income 300 kuruş) and 1 tavern (income 200 kuruş). In total, he earns 650 kuruş from the job and 3273 kuruş from other things.

Grocer Mihailo (f. Dimitrije). He pays low cizye. Last year he paid vergi with 32 kuruş. He pays tax on alcohol (45 kuruş). He owns 10 dönüms of vineyards (income 240 kuruş per year) and rents 1 dönüm of land for growing corn (income 280 kuruş). He keeps 1 mare. In total, he earns 150 kuruş from the job and 240 kuruş from other things.

Capaci Pera (f. Jova). He pays low cizye. Last year he paid vergi with 24 kuruş. He pays aşar for 10 kiye of corn (2 kuruş) and tax on alcohol (13 kuruş and 20 para). He owns 3 dönüms of vineyards (income 280 kuruş per year) and rents 1,5 dönüms of land from Osman Agha (income 20 kuruş, taxed with 2 kuruş to the state and same amount hiring tax to Osman Agha). In total, he earns 150 kuruş from the job and 296 kuruş from other things.

Tailor Mane (f. Dimitrije). He pays low cizye. Last year he paid vergi with 42 kuruş. He pays aşar for 10 corn (2 kuruş) and tax on alcohol (13 kuruş and 20 para). He owns 3 dönüms of vineyards (income 48 kuruş per year) and rents 2 dönüms of land from Suleyman Bey from Prokuplje (income 20 kuruş per year, taxed with 2 kuruş to the state and same amount of hiring tax was paid to Suleyman Bey). In total, he earns 200 kuruş from the job and 64 kuruş from other things.

Cvetko (f. Miljko). Cvetko is ill. He pays tax on alcohol (15 kuruş). He owns 3 dönüms of vineyards (income 84 kuruş per year).

[4] The income in the entry was projected for the year 1845, therefore Stojko wasn't taxed with tithe while the parcel was still in cultivating phase, without harvested crops.

Capaci Mihailo (f. Ilija). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays tax on alcohol (9 kuruş). He owns 2 dönüms of vineyards (income 36 kuruş per year) and rents 1,5 dönüms of land for growing corn (expected income 150 kuruş[5]). He keeps 1 mule. In total, he earns 120 kuruş from the job and 36 kuruş from other things.

Innkeeper Đorđe (f. Stojan). He pays low cizye. Last year he paid vergi with 18 kuruş. He pays aşar for 60 kiye of corn (2 kuruş) and tax on alcohol (40 kuruş). He owns 8 dönüms of vineyards (income 120 kuruş per year) and rents 1,5 dönüms of land from Mutiš (income 20 kuruş per year, taxed with 2 kuruş to the state and same amount of hiring tax was paid to Mutiš). He keeps 1 mule. In total, he earns 500 kuruş from the tavern and 136 kuruş from other things.

Mutafç[6] Cvetan (f. Stojan). He pays low cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 30 kiye of corn (6 kuruş) and tax on alcohol (24 kuruş and 10 para). He owns 5,5 dönüms of vineyards (income 144 kuruş per year) and rents 1,5 dönüms of land from Ali from Pasjača (income 60 kuruş per year, taxed with 6 kuruş to the state and same amount of hiring tax was paid to Ali). In total, he earns 300 kuruş from the job and 192 kuruş from other things.

Tailor Todor (f. Stanko). Last year he paid vergi with 12 kuruş (cizye is not recorded). He pays aşar for 25 kiye of corn (5 kuruş) and tax on alcohol (15 kuruş and 10 para). He owns 3,5 dönüms of vineyards (income 100 kuruş per year) and rents 1 dönüm of land from a muezzin Suleyman (income 50 kuruş per year, taxed with 5 kuruş to the state and same amount of hiring tax was paid to Suleyman). In total, he earns 520 kuruş from the job and 140 kuruş from other things.

House servant Đoka (patronym can't be read). He pays low cizye (vergi is not recorded). He pays aşar for 30 kiye of corn (6 kuruş) He rents 1 dönüm of land (income 60 kuruş per year, taxed with 5 kuruş to the state and the same amount is charged as hiring tax). In total, he earns 120 kuruş from the job and 48 kuruş from other things.

Mould-maker Stevan (f. Veljko). Last year he paid vergi with 10 kuruş (cizye is not recorded). He keeps 1 mule. In total, he earns 120 kuruş.

Capaci Antanas (f. Đorđe). Last year he paid vergi with 10 kuruş (cizye is not recorded). In total, he earns 120 kuruş.

Gardener Tasa (f. Mitar). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 25 kiye of corn (5 kuruş) and tax on alcohol (13 kuruş and 20 para). He owns 2,5 dönüms of garden (income 500 kuruş), 3 dönüms vineyard (income 72 kuruş per year) and rents 1,5 dönüms of land from Sulja the Pasjačian from Prokuplje (income 50 kuruş per year, taxed with 5 kuruş to the state and same amount of hiring tax was paid to Sulja). He keeps 1 mule. In total, he earns 250 kuruş from the job and 612 kuruş from other things.

Farmer Zdravko (f. Stojko). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 30 kiye of corn (6 kuruş) and tax on alcohol (36 kuruş). He owns 8 dönüms of vineyard (income 96 kuruş) and rents 2 dönüms of land from Osman Agha (income 60 kuruş per year, taxed with 6 kuruş to the state and same amount of hiring tax

[5] The same case like with a house servant Stojko, the son of Jova.

[6] A craftsman who makes sackcloth and similar products woven from goat hair (srb. mutavdžija).

was paid to Osman Agha). In total, he earns 120 kuruş from „Hüdaiden"[7] and 144 kuruş from other things.

House servant Zdravko (f. Mitar). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 25 kiye of corn (5 kuruş). He rents 1 dönüm of land from Mola Jusuf (income 50 kuruş per year, taxed with 5 kuruş to the state and same amount of hiring tax was paid to Mola Jusuf). In total, he earns 120 kuruş from the service and 40 kuruş from other things.

Cart-driver Miljko (f. Mitar). He pays low cizye. Last year he paid vergi with 24 kuruş. He pays aşar for 50 kiye of corn (10 kuruş). He owns 5 dönüms of vineyard (income 120 kuruş) and rents 2 dönüms of land from the nüfus nazir[8] Ali Agha (income 100 kuruş per year, taxed with 10 kuruş to the state and same amount of hiring tax was paid to Ali Agha). In total, he earns 150 kuruş from the job and 200 kuruş from other things.

Capaci Đorđe (f. Stojan). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 30 kiye of wheat (6 kuruş) and tax on alcohol (15 kuruş). He owns 3,5 dönüms of vineyards (income 144 kuruş per year) and rents 4 dönüms of land from the nüfus nazir Ali Agha (income 60 kuruş per year, taxed with 6 kuruş to the state and same amount of hiring tax was paid to Ali Agha). He keeps 1 male and 3 female calves, 4 sheep (taxed with 4 para), 2 goats (income 6 kuruş) and 2 oxen. In total, he earns 120 kuruş from the job and 198 kuruş from other things.

Kiraci Stoša (f. Neša). He pays low cizye. Last year he paid vergi with 12 kuruş. He pays aşar for 60 kiye of corn (12 kuruş) and tax on alcohol (29 kuruş and 10 para). He owns 6,5 dönüms of vineyards (income 150 kuruş per year) and rents 3 dönüms of land from Osman Agha (income 120 kuruş per year, taxed with 12 kuruş to the state and same amount of hiring tax was paid to Osman Agha). He keeps 2 oxen. In total, he earns 100 kuruş from the job and 246 kuruş from other things.

Capaci Nikola (f. Janko). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 30 kiye of wheat (6 kuruş) and tax on alcohol (15 kuruş). He owns 3 dönüms of vineyards (no income) and rents 4 dönüms of land (expected income 244 kuruş[9]). He keeps 1 milking cow (income 12 kuruş), 1 male yearling, 1 calf and 3 oxen.. In total, he earns 120 kuruş from the job.

Kiraci Postal (?) (f. Neša). He pays low cizye. Last year he paid vergi with 10 kuruş. He pays aşar for 30 kiye of corn (6 kuruş) and tax on alcohol (11 kuruş and 10 para). He owns 2,5 dönüms of vineyards (income 30 kuruş per year) and rents 4 dönüms of land from Osman Agha (income 60 kuruş per year, taxed with 6 kuruş to the state and same amount of hiring tax was paid to Osman Agha). He keeps 4 milking goats (income 12 kuruş) with 3 kids, 1 milking cow (income 12 kuruş), 1 male yearling, 1 female yearling, 2 oxen and 2 calves. In total, he earns 150 kuruş from the job and 78 kuruş from other things.

Gardener Anđelko (f. Cvetko). He pays low cizye. Last year he paid vergi with

[7] As additional category next to this entry term „Hüdaiden" is recorded, as well as the value of 120 kuruş. Unfortunately, we couldn't identify what does it mean or to what source of income it refers to.

[8] A clerk responsible for the management and supervision of censuses, registrations and citizenship affairs.

[9] The same case like with a house servant Stojko, the son of Jova.

14 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş and 20 para), 30 kiye of corn (6 kuruş), tax on garden (58 kuruş) and tax on alcohol (9 kuruş). He owns 2 dönüms of vineyards (income 24 kuruş per year), 2 dönüms of garden (income 580 kuruş) and rents 3 dönüms of land from Osman Agha (income 185 kuruş per year, taxed with 18 kuruş and 20 para to the state and same amount of hiring tax was paid to Osman Agha). He keeps 1 milking cow (income 12 kuruş), 1 male yearling and 1 mule. In total, he earns 250 kuruş from the job and 752 kuruş from other things.

Kiraci Lazar (f. Neša). He pays low cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 30 kiye of corn (6 kuruş) and tax on alcohol (35 kuruş and 30 para). He owns 7,5 dönüms of vineyards (income 140 kuruş per year) and rents 3 dönüms of land from Osman Agha (income 60 kuruş per year, taxed with 6 kuruş to the state and same amount of hiring tax was paid to Osman Agha). He keeps 2 oxen. In total, he earns 180 kuruş from the job and 388 kuruş from other things.

Innkeeper Rajko (f. Vučko). He pays low cizye. Last year he paid vergi with 20 kuruş. He owns 6,5 dönüms of vineyards (income 520 kuruş) and rents 2 dönüms of land (expected income 160 kuruş[10]). In total, he earns 400 kuruş.

Candle-maker Vojin (f. Ranđel). He pays low cizye. Last year he paid vergi with 30 kuruş. In total, he earns 350 kuruş from the job.

House servant Jefta (f. Milutin). He pays low cizye. Last year he paid vergi with 10 kuruş. In total, he earns 150 kuruş from the service.

House servant Đorđe (patronym unknown). He pays low cizye (vergi unrecorded). He pays aşar for 100 kiye of barley (20 kuruş). He rents 2 dönüms of land from Osman Agha (income 200 kuruş per year, taxed with 20 kuruş to the state and same amount of hiring tax was paid to Osman Agha). He keeps 2 oxen. In total, he earns 100 kuruş from the service and 160 kuruş from other things.

Innkeeper Miljko (f. Stevan). He pays low cizye. Last year he paid vergi with 45 kuruş. In total, he earns 500 kuruş.

Craftman Zdravko (f. Paun). He pays low cizye. Last year he paid vergi with 15 kuruş. In total, he earns 150 kuruş.

In 1844 the residents of aforementioned mahalle paid verg-i mahsus with general amount of 1017 kuruş, they earned the profit of 22688 kuruş and paid aşar in amount of 368 kuruş (BOA, ML. VRD. TMT d, 11025/4–18).

Pop Kosta's Mahalle

Household no. 1. Carpenter Cveta (f. Veljko). He pays medium cizye. Last year he paid vergi with 28 kuruş. He pays tax on alcohol (10 kuruş). He owns 3 dönüms of vineyards (income 145 kuruş per year. In total, he earns 300 kuruş from the job and 145 kuruş from other things.

Household no. 2. Crop field worker Živko (f. Marinko). He pays medium cizye. Last year he paid vergi with 38 kuruş. He pays tax on alcohol (10 kuruş). He pays aşar for 75 kiye of wheat (18 kuruş and 30 para). He owns 4 dönüms of land in Malošište (income 167 kuruş and 20 para per year, taxed with 18 kuruş and 30 para). He keeps 2 oxen. In

[10] The same case like with a house servant Stojko, the son of Jova.

total, he earns 250 kuruş from the job and 168 kuruş and 30 para from other things.

Household no. 3. Kiraci Jova (f. Svetan). He pays medium cizye. Last year he paid vergi with 20 kuruş. He pays tax on alcohol (30 kuruş). He owns 4 dönüms of vineyards (income 185 kuruş per year) and rents 4 dönüms of land from Mahmud Agha from Pirot (income 80 kuruş per year, taxed with 8 kuruş to the state and 36 kuruş hiring tax to Mahmud Agha). He keeps 2 oxen. In total, he earns 250 kuruş from the job and 211 kuruş from other things.

Household no. 4. Mutafçı[11] Spasa (f. Janko). He pays medium cizye. Last year he paid vergi with 37 kuruş. He pays aşar for 20 kiye of wheat (5 kuruş), 20 kiye of corn (4 kuruş) and tax on alcohol (10 kuruş). He owns 2 dönüms of land in Hrastinče* (income 90 kuruş per year, taxed with 9 kuruş) and 1 dönüm of vineyard (income 90 kuruş per year). He keeps 1 mare and 1 milking cow (income 12 kuruş). In total, he earns 250 kuruş from the job and 187 kuruş from other things.

Household no. 5. Carpenter Cvele (f. Tričko). He pays medium cizye. Last year he paid vergi with 100 kuruş. He pays tax on alcohol (21 kuruş). He owns 3 dönüm of vineyard (income 255 kuruş per year). He keeps 1 mare and 1 milking cow (income 12 kuruş). In total, he earns 900 kuruş from the job and 225 kuruş from other things.

Household no. 6. Carpenter Panajot (f. Cvele). He pays medium cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş) and tax on alcohol (28 kuruş). He owns 4 dönüm of land in Malošište (income 250 kuruş per year, taxed with 25 kuruş) and 4 dönüm of vineyard (income 120 kuruş). In total, he earns 450 kuruş from the job and 345 kuruş from other things.

Household no. 7. Potter Mane (f. Marko). He pays medium cizye. Last year he paid vergi with 38 kuruş. He earns 450 kuruş from the job.

Household no. 8. Kiraci Petar (f. Jovan). He pays medium cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş and 20 para) and 20 kiye of corn (4 kuruş). He owns 8 dönüm of land in Hrastinče* (income 415 kuruş per year, taxed with 41 kuruş and 20 para). He keeps 2 oxen and 2 yearlings. In total, he earns 650 kuruş from the job and 373 kuruş and 20 para from other things.

Household no. 9. Carpenter Čole (f. Janko). He pays medium cizye (vergi unrecorded). He pays tax on alcohol (5 kuruş and 20 para). He owns 1 dönüm of vineyard (income 78 kuruş per year). He keeps 2 oxen and 2 yearlings. In total, he earns 350 kuruş from the job and 78 from other things.

Household no. 10. Carpenter Ćira (f. Nikola). He pays medium cizye. Last year he paid vergi with 60 kuruş. He pays tax on alcohol (21 kuruş). He owns 3 dönüm of vineyard (income 180 kuruş per year). In total, he earns 650 kuruş from the job and 180 from other things.

Household no. 11. Carpenter Bidža (f. Boško). He's gone. He pays medium cizye. Last year he paid vergi with 50 kuruş.

Household no. 12. Innkeeper Kole (f. Veljko). He pays medium cizye. Last year he paid vergi with 95 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş and 20 para), 40 kiye of corn (8 kuruş) and tax on alcohol (40 kuruş). He owns 15 dönüms of land in Hrastinče* (income 455 kuruş per year, taxed with 45 kuruş and 20 para) and 5 dönüms of vineyard (income 255 kuruş per year). He keeps 1 mule, 1 milking cow (income 12 kuruş) and 2 oxen. In total, he earns 950 kuruş from the tavern and 646 kuruş and 20 para from other things.

[11] A craftsman who makes sackcloth and similar products woven from goat hair (srb. mutavdžija).

Household no. 13. Kiraci Ranča (f. Miša). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 40 kiye of corn (8 kuruş). He owns 2 dönüms of land in Malošište (income 80 kuruş per year, taxed with 8 kuruş). He keeps 2 calves and 2 oxen. In total, he earns 550 kuruş from the job and 72 kuruş from other things.

Household no. 14. Kiraci Pavle (f. Miša). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 40 kiye of corn (8 kuruş) and tax on alcohol (10 kuruş). He owns 2 dönüms of land in Malošište (income 80 kuruş per year, taxed with 8 kuruş) and 2 dönüms of vineyard (income 75 kuruş per year). He keeps 2 oxen. In total, he earns 350 kuruş from the job and 147 kuruş from other things.

Household no. 15. Carpenter Ćira (f. Miša). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays tax on alcohol (10 kuruş). He owns 2 dönüms of vineyard (income 75 kuruş per year). He keeps 2 oxen. In total, he earns 450 kuruş from the job and 75 kuruş from other things.

Household no. 16. Carpenter Stojan (f. Miša). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 40 kiye of corn (8 kuruş) and tax on alcohol (10 kuruş). He owns 2 dönüms of land in Malošište (income 80 kuruş per year, taxed with 8 kuruş) and 2 dönüms of vineyard (income 75 kuruş per year). He keeps 2 oxen. In total, he earns 450 kuruş from the job and 147 kuruş from other things.

Household no. 17. Gardener Bone (f. Anta). He pays medium cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 100 kiye of corn (25 kuruş) and tax on alcohol (17 kuruş). He owns 12 dönüms of land in Malošište (income 250 kuruş per year, taxed with 25 kuruş) and 3 dönüms of vineyard (income 75 kuruş per year). In total, he earns 650 kuruş from the job and 300 kuruş from other things.

Household no. 18. Kiraci Janko (f. Jovan). He pays medium cizye. Last year he paid vergi with 85 kuruş. He pays aşar for 200 kiye of wheat (50 kuruş), 60 kiye of corn (12 kuruş) and tax on alcohol (28 kuruş). He owns 10 dönüms of land in Hrastinče* (income 620 kuruş per year, taxed with 62 kuruş), 4 dönüms of vineyard (income 225 kuruş per year) and 2 dönüms of meadows in Sudurgah* (income 40 kuruş). He keeps 1 milking cow (income 12 kuruş) and 2 oxen. In total, he earns 600 kuruş from the job and 835 kuruş from other things.

Household no. 19. Kiraci Miloje (f. Jovan). He pays medium cizye. Last year he paid vergi with 65 kuruş. He pays aşar for 200 kiye of wheat (50 kuruş), 60 kiye of corn (12 kuruş) and tax on alcohol (28 kuruş). He owns 10 dönüms of land in Hrastinče* (income 620 kuruş per year, taxed with 62 kuruş), 4 dönüms of vineyard (income 225 kuruş per year) and 2 dönüms of meadows in Sudurgah* (income 40 kuruş). He keeps 1 milking cow (income 12 kuruş), 2 yearlings and 2 oxen. In total, he earns 350 kuruş from the job and 835 kuruş from other things.

Household no. 20. Inkeeper Panajot (f. Pane). He pays medium cizye. Last year he paid vergi with 170 kuruş. He pays aşar for 200 kiye of wheat (50 kuruş), 150 kiye of corn (30 kuruş), 150 kiye of chickpeas (22 kuruş and 20 para) and tax on alcohol (100 kuruş). He owns 28 dönüms of land, from which 18 dönüms are in Malošište, 5 dönüms in Batušinac and 5 dönüms in Iržana* (income 1025 kuruş per year, taxed with 102 kuruş and 20 para). He also owns 2 dönüms of garden (income 80 kuruş), 12 dönüms of vineyard (income 600 kuruş per year), 8 dönüms of meadows in Sudurgah* (income 160 kuruş) and 2 pot distillers (income 100 kuruş). He keeps 2 barren water bufallos. In total, he earns 550 kuruş from the tavern and 1862 kuruş and 20 para from other things.

Household no. 21. Kiraci Đorđe (f. Petko). He pays medium cizye. Last year he paid vergi with 115 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş and 20 para) and 200 kiye of corn (40 kuruş). He owns 18 dönüms of land, from which 9 dönüms are in Hrastinče* and 9 dönüms in Malošište (income 775 kuruş per year, taxed with 77 kuruş and 20 para). He also owns 3 dönüms of meadows (income 60 kuruş). He keeps 2 milking cow (income 24 kuruş), 3 mules, 1 calf and 2 oxen. In total, he earns 650 kuruş from the job and 781 kuruş and 20 para from other things.

Household no. 22. Kiraci Neša (f. Zdravko). He pays medium cizye. Last year he paid vergi with 125 kuruş. He pays aşar for 60 kiye of wheat (15 kuruş) and 100 kiye of corn (20 kuruş). He owns 9 dönüms of land in Malošište (income 350 kuruş per year, taxed with 35 kuruş). He keeps 2 mules and 1 barren cow. In total, he earns 900 kuruş from the job and 315 kuruş from other things.

Household no. 23. (profession unrecorded) Mladen (patronym unrecorded). He pays medium cizye. Last year he paid vergi with 35 kuruş.

Household no. 24. Butcher Toša (f. Zdravko). He pays medium cizye. Last year he paid vergi with 75 kuruş. He pays aşar for 40 kiye of wheat (10 kuruş), 40 kiye of corn (8 kuruş) and tax on alcohol (18 kuruş). He owns 4 dönüms of land in Malošište (income 180 kuruş per year, taxed with 18 kuruş) and 2 dönüms of vineyard (income 150 kuruş). In total, he earns 550 kuruş from the job and 212 kuruş from other things.

Household no. 25. Carpenter Stamen (f. Božin). He pays medium cizye. Last year he paid vergi with 80 kuruş. He pays aşar for 80 kiye of wheat (20 kuruş), 80 kiye of corn (16 kuruş) and tax on alcohol (21 kuruş). He owns 3 dönüms of land in Malošište and 4 dönüms in Hrastinče* (income 360 kuruş per year, taxed with 36 kuruş) and 4 dönüms of vineyard (income 120 kuruş per year). He keeps 1 mare, 1 milking cow (income 12 kuruş), 1 yearling and 2 oxen. In total, he earns 650 kuruş from the job and 496 kuruş from other things.

Household no. 26. Gardener Bane (f. Lila[12]). He pays medium cizye. Last year he paid vergi with 70 kuruş. He earns 800 kuruş from the job.

Household no. 26. Innkeeper Krsta (f. Peša). He pays medium cizye. Last year he paid vergi with 105 kuruş). He owns 1 dönüms of garden (income 100 kuruş per year) and keeps 1 mule. He earns 900 kuruş from the tavern.

Household no. 27. Gardener Peša (f. Rista). He pays medium cizye. Last year he paid vergi with 65 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş and 20 para) and 50 kiye of corn (10 kuruş). He owns 3 dönüms of land in Batušinac (income 225 kuruş per year, taxed with 22 kuruş and 20 para) and 1 dönüm of garden (income 60 kuruş per year). He keeps 1 mule. In total, he earns 550 kuruş from the job and 262 kuruş and 20 para from other things.

Household no. 28. Gardener Tričko (f. Nikola). He pays medium cizye. Last year he paid vergi with 104 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş), 50 kiye of corn (10 kuruş) and tax on alcohol (72 kuruş). He owns 8 dönüms of land in Blata (income 350 kuruş per year, taxed with 35 kuruş), 1 dönüm of garden (income 120 kuruş per year) and 8 dönüms of vineyard (income 525 kuruş). He keeps 1 mare. In total, he earns 900 kuruş from the job and 960 kuruş from other things.

[12] The name Lila we already emphasized in the previous paper on the temettuat defter of Pop Stanko's mahalle as the one we could not identify in its full proper form. However, while analyzing the Ottoman mazbatas, arzuhals and other forms of collective appeals from the region, we came to conclusion that Lila/Lilko are the shortern forms of the Christian name Ilija (Iliyas).

Household no. 29. Gardener Bane (f. Nikola). He pays medium cizye. Last year he paid vergi with 80 kuruş. He pays aşar for 60 kiye of wheat (13 kuruş and 30 para). He owns 3 dönüms of land in Malošište (income 137 kuruş per year, taxed with 13 kuruş and 30 para) and 2 dönüms of garden (income 150 kuruş per year). He keeps 1 milking cow (income 12 kuruş) and 2 oxen. In total, he earns 600 kuruş from the job and 285 kuruş and 30 para from other things.

Household no. 30. Gardener Goga (f. Stanoje). He pays medium cizye. Last year he paid vergi with 85 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş and 20 para) and 50 kiye of corn (10 kuruş). He owns 3 dönüms of land in Malošište and 2 dönüms in Batušinac (income 225 kuruş per year, taxed with 22 kuruş and 20 para), 2 dönüm of garden (income 300 kuruş per year) and 2 dönüms of vineyard (income 90 kuruş). In total, he earns 550 kuruş from the job and 592 kuruş from other things.

Household no. 31. Kiraci Pane (f. Paun). He pays medium cizye. Last year he paid vergi with 30 kuruş. He earns 400 kuruş from the job.

Household no. 32. Carpenter Anđelko (f. Cvetko). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş and 20 para) and 50 kiye of corn (10 kuruş). He owns 3 dönüms of land in (Donja) Trnava[13] and Smrdan[14] (income 225 kuruş per year, taxed with 22 kuruş and 20 para). In total, he earns 350 kuruş from the job and 202 kuruş and 20 para from other things.

The remaining pages of the defter which refer to Pop Kosta's mahalle have been torn out. However, the entries which refer to çiftlik attached to it have been preserved. Unfortunatelly, since the missing pages from Pop Kosta's mahalle included the first page from the mentioned çiftlik, the name of this rural estate was lost. That's why we have entitled it as the Unidentified çiftlik.

Unidentified Çiftlik

Stanko The Limping one (f. Veljko). He rents 6 dönüms of land (income 170 kuruş per year). He keeps 1 mule and 2 oxen.

Kiraci Kole (f. Jovan). He pays medium cizye. Last year he paid vergi with 25 kuruş. He pays aşar for 75 kiye of wheat (18 kuruş and 30 para) and 40 kiye of corn (8 kuruş). He owns 6 dönüms of land in Malošište (income 267 kuruş and 20 para per year, taxed with 26 kuruş and 30 para). He keeps 2 oxen. In total, he earns 120 kuruş from the job and 240 kuruş and 30 para from other things.

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[13] Donja Trnava. There are two villages related to this toponym, Gornja (Upper) and Donja (Lower) Trnava. Though in the temettuat defter this village is recorded only as Trnava (Trnane), we came to conclusion that is it Donja Trnava, because it is closer to another village mentioned in the entry, Smrdan, than Gornja Trnava.

[14] Smrdan, village located west from Prokuplje. It worths to mention there is another village with the same name in vicinity of Niš. It is village Smrdan located half way from Niš to Leskovac. But to identify which Smrdan was mentioned in this entry, we were led by its relation to another village mentioned in the same entry. So, village Smrdan (Prokuplje region) was mentioned with village Trnane (Donja Trnava), but there are no villages with similar names like Trnane close to Smrdan in Leskovac region.

Kiraci Ćira (f. Petko). He pays medium cizye. Last year he paid vergi with 10 kuruş and 20 para. He pays aşar for 50 kiye of wheat (12 kuruş), 40 kiye of corn (8 kuruş) and tax on alcohol (8 kuruş). He owns 6 dönüms of land in Maloište (income 205 kuruş per year, taxed with 20 kuruş and 20 para) and 2 dönüms of vineyard (income 75 kuruş). He keeps 1 milking cow (income 12 kuruş), 1 male yearling and 2 oxen. In total, he earns 150 kuruş from the job and 267 kuruş and 20 para from other things.

Kiraci Živko (f. Petko). He pays medium cizye. Last year he paid vergi with 10 kuruş and 20 para. He pays aşar for 50 kiye of wheat (12 kuruş), 40 kiye of corn (8 kuruş) and tax on alcohol (13 kuruş and 30 para). He owns 6 dönüms of land in Maloište (income 205 kuruş per year, taxed with 20 kuruş and 20 para) and 2 dönüms of vineyard (income 75 kuruş). He keeps 2 oxen. In total, he earns 150 kuruş from the job and 259 kuruş and 20 para from other things.

Kiraci Velja (f. Neša). He pays medium cizye. Last year he paid vergi with 21 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş), 75 kiye of barley (15 kuruş), 80 kiye of corn (16 kuruş) and tax on alcohol (10 kuruş). He owns 15 dönüms of land in Maloište (income 560 kuruş per year, taxed with 56 kuruş) and 2 dönüms of vineyard (income 75 kuruş). He keeps 2 calves and 2 oxen. In total, he earns 180 kuruş from the job and 579 kuruş from other things.

Wood-cutter and farmer Rista (f. Stojan). He pays medium cizye. Last year he paid vergi with 25 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş), 75 kiye of barley (15 kuruş), 80 kiye of corn (16 kuruş), tax on sheep (2 kuruş and 4 para) and tax on alcohol (50 kuruş). He owns 4 dönüms of land in Maloište and 8 dönüms in Sudurun* (income 685 kuruş per year, taxed with 68 kuruş and 20 para), 4 dönüms of vineyard (income 150 kuruş). He keeps 1 mule, 2 mares, 6 milking and 11 barren sheep (income 125 kuruş), 2 milking cows (income 20 kuruş) and 4 oxen. In total, he earns 200 kuruş from the job and 911 kuruş and 20 para from other things.

Kiraci Ćira (f. Veljko). He pays medium cizye. Last year he paid vergi with 21 kuruş. He pays aşar for 80 kiye of wheat (20 kuruş), 50 kiye of barley (10 kuruş) and 50 kiye of corn (10 kuruş). He owns 8 dönüms of land in Maloište (income 400 kuruş per year, taxed with 40 kuruş). He keeps 1 milking cow (income 12 kuruş), 1 male yearling and 2 oxen. In total, he earns 150 kuruş from the job and 371 kuruş from other things

Kiraci Krsta (f. Bone). He pays medium cizye. Last year he paid vergi with 28 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş), 50 kiye of barley (10 kuruş), 70 kiye of corn (14 kuruş) and tax on alcohol (24 kuruş). He owns 9 dönüms of land in Maloište, 8 dönüms in Sudurun* and 2 dönüms in Hristćet* (income 409 kuruş per year, taxed with 49 kuruş) and 3 dönüms of vineyard (income 150 kuruş). He keeps 1 mare and 1 colt, 1 milking cow (income 10 kuruş) and 3 oxen. In total, he earns 120 kuruş from the job and 601 kuruş from other things.

Kiraci Mane (f. Janikije). He pays medium cizye. Last year he paid vergi with 20 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş), 50 kiye of barley (7 kuruş and 20 para)[15], 40 kiye of corn (8 kuruş) and tax on alcohol (24 kuruş). He owns 10 dönüms of land in Maloište and 6 dönüms in Sudurun* (income 405 kuruş per year, taxed with 40 kuruş and 20 para). He keeps 2 female yealings and 2 oxen. In total, he earns 150 kuruş from the job and 364 kuruş and 20 para from other things.

[15] The amount of aşar paid for 50 kiye of barley does not match the amount stated in the previous household, so in this case here it had to be the mistake of the scriber who wrote the wrong input.

Binali Çiftlik

Kiraci Pavle (f. Todor). He pays medium cizye. Last year he paid vergi with 23 kuruş. He pays aşar for 75 kiye of wheat (18 kuruş), 150 kiye of barley (30 kuruş), 10 kiye of corn (2 kuruş) and tax on alcohol (9 kuruş). He owns 10 dönüms of land (which belong to Christian woman Bona from Smrdan, a stepdaughter of aforementioned Pavle) (income 207 kuruş and 20 para per year, taxed with 20 kuruş and 30 para), 1 dönüm of vineyard which also belongs to Bona (income 120 kuruş) and he rents 10 dönüms of land from Osman Agha (income 300 kuruş, taxed with 30 kuruş to state and 135 kuruş hiring tax was paid to Osman Agha). He keeps 1 ox. In total, he earns 200 kuruş from the job and 441 kuruş and 30 para from other things.

Kiraci Đorđe (f. Stamen). He pays medium cizye. Last year he paid vergi with 60 kuruş. He pays aşar for 100 kiye of wheat (25 kuruş), 50 kiye of barley (10 kuruş), 90 kiye of corn (2 kuruş) and tax on sheep (2 kuruş and 20 para). He owns 11 dönüms of land in Malošište (income 530 kuruş per year, taxed with 53 kuruş). He keeps 1 mule, 1 horse, 1 milking cow (income 10 kuruş), 15 milking and 5 barren sheep (income 150 kuruş), 5 lambs and 2 oxen. In total, he earns 250 kuruş from the job and 637 kuruş from other things.

Kiraci Vlatko/Jelenko (f. Stojan). He pays medium cizye. Last year he paid vergi with 65 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş and 20 para), 140 kiye of barley (28 kuruş), 120 kiye of corn (24 kuruş), tax on sheep (3 kuruş and 5 para) and tax on alcohol (38 kuruş and 20 para). He owns 12 dönüms of land (income 240 kuruş, taxed with 24 kuruş) and rents 15 dönüms of land from Osman Agha (income 655 kuruş, taxed with 65 kuruş to the state and 294 kuruş hiring tax was paid to Osman Agha). He keeps 1 milking cow (income 10 kuruş), 4 oxen, 18 milking and 7 barren sheep (income 180 kuruş). In total, he earns 200 kuruş from the job and 700 kuruş and 30 para from other things.

In 1844 the residents of Binali çiftlik paid verg-i mahsus with general amount of 148 kuruş, they earned the profit of 2429 kuruş and 20 para, and they paid through hiring taxes 429 kuruş and 30 para to their agha.

Emin Agha's Çiftlik

Kiraci Ika (f. Cvetko). He pays medium cizye. Last year he paid vergi with 55 kuruş. He pays aşar for 150 kiye of wheat (37 kuruş and 20 para), 50 kiye of barley (10 kuruş), 50 kiye of corn (10 kuruş) and tax on sheep (3 kuruş and 5 para). He owns 5 dönüms of land in Malošište and 4 dönüms in Batušinac (income 575 kuruş, taxed with 57 kuruş and 20 para), 4 dönüms of a new vineyard (which he still hasn't profited from) and 3 dönüms of meadows (income 60 kuruş). He keeps 1 mule, 1 mare, 25 milking and 5 barren sheep (income 225 kuruş), 5 lambs and 2 oxen. In total, he earns 150 kuruş from the job and 802 kuruş and 20 para from other things.

Kiraci Stanko (f. Milenko). He pays medium cizye. Last year he paid vergi with 30 kuruş. He pays aşar for 50 kiye of wheat (12 kuruş), 50 kiye of barley (10 kuruş) and 100 kiye of corn (20 kuruş). He owns 7 dönüms of land in Malošište (income 425 kuruş, taxed with 42 kuruş and 20 para), 3 dönüms of a new vineyard (which he still hasn't

profited from) and rents 4 dönüms of land (income 112 kuruş and 20 para). He keeps 2 oxen. In total, he earns 350 kuruş from the job and 495 kuruş from other things.

Kiraci Mladen (f. Kole). He pays medium cizye. Last year he paid vergi with 35 kuruş. He pays aşar for 80 kiye of wheat (20 kuruş), 50 kiye of barley (10 kuruş), 50 kiye of corn (10 kuruş), tax on sheep (2 kuruş and 20 para) and tax on alcohol (20 kuruş). He owns 6 dönüms of land in Iržana* (income 300 kuruş, taxed with 30 kuruş), 2 dönüms of vineyard (income 90 kuruş), 1 dönüm of meadows (income 20 kuruş) and rents 2 dönüms of land in Batušinac (income 90 kuruş). He keeps 2 oxen, 15 milking and 5 barren sheep (income 130 kuruş). In total, he earns 200 kuruş from the job and 600 kuruş and 20 para from other things.

In 1844 the residents of Emin Agha's çiftlik paid verg-i mahsus with general amount of 110 kuruş, they earned the profit of 2597 kuruş (BOA, ML. VRD. TMT d, 11038/2–18).

Pop Jona's Mahalle

Gardener Mihailo (f. Sokol). He pays medium cizye. Last year he paid vergi with 67 kuruş. He earns 500 kuruş from the job.

Gardener Jona (f. Petar). He pays medium cizye. Last year he paid vergi with 65 kuruş. He pays tax on alcohol (19 kuruş). He owns 3 dönüms of vineyard (income 180 kuruş). In total, he earns 500 kuruş from the job and 180 kuruş and 20 para from other things.

Carpenter Krsta (f. Marko). He pays medium cizye. Last year he paid vergi with 58 kuruş. He pays aşar for 20 kiye of wheat (5 kuruş), 60 kiye of corn (12 kuruş) and tax on alcohol (19 kuruş). He owns 3 dönüms of land (income 50 kuruş, taxed with 5 kuruş), 3 dönüms of vineyard (income 180 kuruş) and rents 4 dönüms of land from Petko (income 120 kuruş, taxed with 12 kuruş to the state and 54 kuruş hiring tax was paid to Petko). In total, he earns 360 kuruş from the job and 279 kuruş from other things (BOA, ML. VRD. TMT d, 11027/2).

Conclusion

We projected the data on the demographic origin of the registered persons according to the places where they had their properties, so it is logical that most of them were also connected to those places by origin, not only economically. Unfortunately, the analysis provides only limited results, since the entries are precise only in the case of the Pop Kosta's mahalle. According to it, 24 residents of this mahalle had property in Malošište, 7 in Hrastinče*, 5 in Batušinac, 3 in Sudurgah*, 2 in Smrdan and one each in Blato, Donja Trnava, Iržana* and Hristćet*. There were cases of overlap, so several residents had property in 2 or more of these places.

Statistics on the occupations of the residents indicate that almost all the inhabitants of the çiftliks were kiracis. Socially and economically, this makes sense whether the *kiraci* refers to their settler status or to people who, in addition to agriculture, also were engaged in the transport of goods and passengers as an additional source of income.

The number of people engaged in agriculture was lowest in the Pop Đorđe's mahalle (15/49), followed by the Pop Kosta's mahalle (17/34) and Pop Jona's mahalle (2/3). The percentage of craftsmen who provided services in the mahalles was roughly up to 30%, in the Pop Kosta's mahalle (13/34), followed by Pop Đorđe's mahalle (9/49), while there were none in the Pop Jona's mahalle. The largest number of craftsmen engaged in manufacturing activities was in the Pop Đorđe's mahalle (25/49), followed by Pop Kosta's mahalle (3/34) and Pop Jona's mahalle (1/3). Whether in percentage or number, the statistics do not tell us much due to the large differences in numbers of population in the aforementioned mahalles, and it should be taken into account that the statistics for the Pop Kosta's mahalle are not complete due to the lack of the last pages. The only thing which can be conclude from the statistics about the professions is that the Pop Đorđe's mahalle could be closer to the central, main city mahalles, since it had the most craftsmen and the fewest people who lived exclusively from agriculture.

When it comes to economic relations, in the Pop Kosta's mahalle, Pop Jona's mahalle and on the Binali çiftlik several exceptions are striking. In the Pop Kosta's mahalle, the kiraci Jovan (household no. 3) paid the land rent to the çiftlik-sahibi Mahmud Agha from Pirot significantly higher than the tax paid to the state on the income from that rented plot (~50% of the total income from the rented land, after the tax was paid to the state). In the Pop Jona's mahalle, the kiraci Krsta paid the çiftlik-sahibi Petko the same 50%, as did the kiracis Pavle and Vlatko/Jelenko to Osman Aga on the Binali çiftlik. Thus, it is a case of a 50%-50% sharecropping that is not based on laws, but exclusively on an internal agreement between both parties. It may be that the kiracis who rented the land under this condition were forced to agree to such a relationship due to the bad economic situation. This is especially noticeable in the case of Osman Agha, who also appears as a land renter in several cases in Pop Đorđe's mahalle, but there he collected fees from the rent in the same amount that was paid to the state for taxes (10%). These cases of the 50%-50% sharecropping might be a peculiarity in the case of the temettuat defter for Niš, considering that it was precisely the poor economic relations which led to the Great Niš Uprising only 3-4 years before this defter was implemented. This issue requires a broader analysis, which will be served by the results and statistics we will come up with in future research on the temettuat defter for Niš (1845). Also, it might it is interesting that Christian Petko was mentioned among the çiftlik-sahibi. In years after the proclamation of Tanzimat (1839) more and more non-Muslims will be documented as the landlords and the owners of vast rural estates. Their full expanse will happen in the 1860ties, when by social and economic role and cultural imagery as well they will mimic the previous (exclusively) Muslim elite (Ranđelović, 2022).

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THE IMPACT OF GOVERNMENT EXPENDITURE ON THE SUSTAINABILITY OF PUBLIC DEBT IN WESTERN BALKAN COUNTRIES: PANEL EVIDENCE 2008-2024

Abstract

This study examines the impact of government expenditure on public debt dynamics in five Western Balkan countries over the period 2008–2024. The analysis applies panel regression techniques, including pooled OLS, random effects, and fixed effects models, supported by diagnostic and panel unit root tests. Since public debt is found to be non-stationary, the final specification is estimated using a fixed effects model with first-differenced variables. The results identify changes in interest costs as the main determinant of short-run public debt dynamics, while government expenditure has a positive effect, significant only at the 10% level. Inflation, real GDP growth, and the primary balance are not statistically significant. The study contributes to the literature by isolating the effect of government expenditure while controlling for key macroeconomic determinants and financing costs, providing region-specific evidence that may support the design of sustainable fiscal policies in the Western Balkans.

***Key words**: government expenditure, public debt, fiscal sustainability, Western Balkan countries*

***JEL classification**: H50, H62, H63, C23, E62*

УТИЦАЈ ДРЖАВНЕ ПОТРОШЊЕ НА ОДРЖИВОСТ ЈАВНОГ ДУГА У ЗЕМЉАМА ЗАПАДНОГ БАЛКАНА: ПАНЕЛ АНАЛИЗА 2008-2024

Апстракт

Ово истраживање испитује утицај државних расхода на динамику јавног дуга у пет земаља Западног Балкана у периоду од 2008. до 2024. године. Анализа се заснива на примени панел регресионих техника, укључујући обједињену OLS регресију (pooled OLS), модел случајних ефеката и модел фиксних ефеката, уз спровођење дијагностичких тестова и панел тестова јединичног корена. Будући да је утврђено да јавни дуг није стационаран, коначна спецификација процењена је применом модела фиксних ефеката на првим диференцама свих варијабли. Резултати показују да промене трошкова камата

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представљају главну детерминанту краткорочне динамике јавног дуга, док промене државних расхода имају слабији позитиван ефекат, статистички значајан само на нивоу од 10%. Инфлација, реални раст БДП-а и примарни биланс нису статистички значајни. Истраживање доприноси постојећој литератури издвајањем ефекта државних расхода уз истовремену контролу кључних макроекономских детерминанти и трошкова финансирања, пружајући емпиријске доказе специфичне за земље Западног Балкана који могу допринети креирању одрживих фискалних политика.

***Кључне речи*:** *државна потрошња, јавни дуг, фискална одрживост, земље Западног Балкана*

Introduction

The issue of public debt sustainability represents one of the central questions of contemporary macroeconomic policy, particularly in developing and transition economies characterized by limited fiscal capacities and increased exposure to external economic shocks. The global financial crisis of 2008, followed by the consequences of the COVID-19 pandemic, led to a significant increase in public debt in a large number of countries, including the Western Balkan states (Stojadinović Jovanović et al., 2020). Under such circumstances, the relationship between government expenditure and public debt sustainability has become the subject of intensive theoretical and empirical debate (Reinhart & Rogoff, 2010; IMF, 2013; 2021).

Economic literature frequently emphasizes that the growth of government expenditure may contribute to the deterioration of the fiscal position and the increase in public debt, especially in conditions of budget deficits and slow economic growth (Alesina & Ardagna, 2011). However, contemporary theoretical approaches indicate that public debt sustainability does not depend solely on the level of public expenditure, but also on financing costs, economic growth dynamics, inflation, and the quality of fiscal policy (Reinhart & Rogoff, 2010; IMF, 2021). In this context, an important question arises as to whether the problem of fiscal sustainability in the Western Balkan countries is the result of the size of government expenditure itself or of the structure of expenditures and the methods of their financing.

The Western Balkan countries represent a specific subject of analysis due to the combination of relatively high levels of public debt, pronounced dependence on external financing, limited institutional capacities, and frequent macroeconomic instabilities. At the same time, most of these countries face problems related to the inefficient implementation of public investments and increased sensitivity to changes in borrowing conditions on the international financial market. These characteristics further increase the importance of researching the factors affecting public debt sustainability in the region (WBG, 2025).

The aim of this paper is to empirically analyze the impact of government expenditure on short-run public debt dynamics in the Western Balkan countries during the period from 2008 to 2024. By examining the determinants of annual changes in the public debt-to-GDP ratio, the study provides empirical evidence relevant for assessing public

debt sustainability in the region. In addition to government expenditure, the analysis includes key macroeconomic factors such as inflation, real GDP growth, the primary fiscal balance, and interest costs. The empirical analysis is based on the application of panel regression models, accompanied by appropriate diagnostic and stationarity tests in order to ensure the methodological validity of the results.

Based on the research objective and the theoretical framework, the following research hypotheses are formulated:

H1: Government expenditure has no statistically significant effect on public debt dynamics after controlling for macroeconomic and fiscal factors.

H2: Interest costs have a statistically significant positive effect on public debt dynamics.

H3: Inflation has a statistically significant negative effect on public debt dynamics.

H4: Real GDP growth has a statistically significant negative effect on public debt dynamics.

H5: The primary fiscal balance has a statistically significant negative effect on public debt dynamics.

The remainder of the paper is organized as follows. Following the introduction, a review of the relevant theoretical and empirical literature is presented. The next section outlines the data, variable construction, and methodological framework of the research. This is followed by the results of the descriptive and empirical analysis. The subsequent section discusses the main limitations of the study, while the final section presents the conclusions and their implications for fiscal policy in the Western Balkan countries.

Literature Review

Economic literature dealing with public debt sustainability and the role of fiscal policy has evolved through several complementary theoretical and empirical approaches encompassing the analysis of fiscal discipline, public debt dynamics, and the macroeconomic determinants of debt stability. Contemporary research increasingly emphasizes an integrated approach in which public debt sustainability is viewed as the result of the interaction between fiscal policy, economic growth, inflation, and borrowing costs.

From a theoretical perspective, the foundation of public debt sustainability analysis lies in the intertemporal government budget constraint, according to which the long-term stability of public debt depends on the relationship between the interest rate and the economic growth rate. Blanchard (1990) points out that debt sustainability does not necessarily imply debt reduction, but rather the government's ability to service its obligations without the need for unsustainable fiscal adjustments. Similarly, Bohn (1998) empirically confirms that fiscal authorities respond to rising public debt by improving the primary balance, thereby ensuring long-term sustainability.

Within the domain of fiscal policy, particular attention has been devoted to the role of government expenditure in shaping public debt dynamics. Barro (1979), within the framework of the tax-smoothing theory, demonstrates that governments use borrowing to smooth tax distortions over time, while Alesina and Perotti (1995) emphasize that

the structure and composition of fiscal adjustments play a crucial role in stabilizing public debt. Empirical studies, such as Alesina and Ardagna (2011), indicate that fiscal consolidations based on expenditure reductions are more likely to successfully stabilize debt compared to those relying primarily on tax increases. The structure of public expenditure therefore plays a significant role in the formation of public debt.

Research conducted by the International Monetary Fund (Gupta et al., 2025) suggests that fiscal consolidation programs based on reducing current expenditures, particularly public sector wages, are generally more effective in reducing deficits and consequently public debt than measures primarily focused on reducing capital expenditures. In the Western Balkan countries, a long-standing tendency of underrealization of planned capital investments can be observed, indicating limited efficiency in the implementation of public investment projects. Such a phenomenon further complicates public debt management, as inefficient public spending undermines confidence in fiscal policy (IMF, 2018).

Interest costs represent one of the key factors in public debt dynamics (Van Bon, 2025). Reinhart and Rogoff (2010) argue that high levels of indebtedness may lead to an increase in risk premiums and interest rates, thereby further worsening debt sustainability. Similarly, Laubach (2009) demonstrates that an increase in public debt leads to higher long-term interest rates, which raises financing costs and slows economic growth. These findings confirm the importance of the interest rate channel as a mechanism through which public debt may become self-reinforcing.

The role of economic growth in public debt sustainability is particularly emphasized in contemporary literature. Snowdon and Vane (2005) point out that higher growth rates facilitate debt stabilization through increased fiscal revenues and reduced relative debt burden compared to GDP. Likewise, the IMF (2013) stresses that favorable macroeconomic conditions, including stable growth and low interest rates, represent key determinants of public debt sustainability, especially in developing countries. Real GDP growth constitutes one of the main factors of fiscal sustainability, as it directly affects the ratio of public debt to gross domestic product. Higher economic growth rates contribute to increased fiscal revenues and a reduction in the relative debt burden, while economic slowdown operates in the opposite direction. Escolano (2010) shows that public debt dynamics largely depend on the relationship between real growth and interest rates, whereas Blanchard and Leigh (2013) indicate that weaker growth following fiscal consolidation may lead to an increase in public debt even under conditions of fiscal discipline. Similar conclusions are presented by Reinhart and Rogoff (2010), who emphasize that periods of low economic growth are often accompanied by rising debt levels and slower fiscal adjustment.

Inflation represents one of the key macroeconomic determinants directly affecting the movement and sustainability of public debt. From a theoretical standpoint, moderate inflation may contribute to reducing the real value of debt through the so-called "inflation tax," as nominal GDP growth lowers the ratio of public debt to economic activity (Reinhart & Rogoff, 2010). However, if inflation reaches high or unstable levels, its effect becomes negative, as it leads to increased risk premiums, reduced investor confidence, and higher debt servicing costs, particularly in economies characterized by significant euroization and a large share of external borrowing (Escolano, 2010). Blanchard (2019) emphasizes that in an environment of low interest rates, inflation may temporarily ease the fiscal burden, but without structural reforms it cannot improve fiscal sustainability in the long run. In the context of the Western Balkan countries, inflation has an ambivalent

effect – while it may reduce the public debt-to-GDP ratio in the short run (in the long term) due to structural constraints and import dependence, it may contribute to rising public expenditures and interest costs.

Although numerous studies have examined public debt sustainability, empirical evidence focusing specifically on the role of government expenditure in Western Balkan countries remains limited. Existing studies have generally emphasized fiscal deficits, debt levels, or broader macroeconomic determinants, while relatively little attention has been devoted to assessing the independent contribution of government expenditure after controlling for key fiscal and macroeconomic factors within a unified panel framework. By addressing this gap, the present study extends the empirical literature on transition economies by providing evidence on the relative importance of government expenditure and financing costs for short-run public debt dynamics in the Western Balkans.

From a methodological perspective, panel econometrics represents the standard approach in the analysis of public debt and fiscal policy because it enables the simultaneous observation of temporal and cross-country differences. Wooldridge (2010) emphasizes that panel models allow for the control of unobserved heterogeneity and increase the reliability of estimates, which is particularly important in analyses involving countries with similar, though not identical, economic structures, such as the Western Balkan countries.

Contemporary literature suggests that public debt sustainability does not depend exclusively on the level of government expenditure, but rather on the complex interaction between fiscal policy, economic growth, inflation, and borrowing costs. The intensity and direction of these effects depend on the structural characteristics of the economy, the institutional framework, and financing conditions, which further justifies the application of panel methodology in analyzing the impact of government expenditure on short-run public debt dynamics, thereby providing evidence relevant to public debt sustainability.

Data, Variable Construction, and Methodological Framework

The empirical analysis in this paper is based on panel data for five Western Balkan countries: Serbia, Montenegro, North Macedonia, Bosnia and Herzegovina, and Albania. The observed period covers the years from 2008 to 2024, resulting in a balanced panel dataset with a total of 85 observations. The data were obtained from the International Monetary Fund (IMF) database, specifically from the DataMapper tool, which contains comparable macroeconomic indicators for a large number of countries. The observed variables include public debt expressed as a percentage of gross domestic product (GDP), government expenditure as a percentage of GDP, the inflation rate, real GDP growth, and the primary fiscal balance.

The variable related to interest costs is not directly available in the utilized database and was therefore constructed as the difference between the primary fiscal balance and the overall fiscal balance, thereby obtaining government interest expenditures expressed as a percentage of GDP. Since the primary balance excludes interest payments while the overall balance includes them, this construction yields positive values for interest expenditures (IMF, 2014). Furthermore, all variables in the model are expressed as percentages, enabling comparability between countries of different economic sizes and

allowing for an adequate assessment of public debt sustainability relative to the economic capacity of the economy. This approach also eliminates the scaling problem that would arise if nominal values were used.

The initial empirical specification of the relationship between public debt and its determinants can be expressed as follows:

$$PD_{i,t} = \beta_0 + \beta_1 GOV_EXP_{i,t} + \beta_2 INF_{i,t} + \beta_3 GDPG_{i,t} + \beta_4 PB_{i,t} + \beta_5 INT_{i,t} + \mu_i + \varepsilon_{i,t}$$

Where $PD_{i,t}$ represents public debt expressed as a percentage of GDP for country i in time period t, $GOV_EXP_{i,t}$ denotes government expenditure, $INF_{i,t}$ the inflation rate, $GDPG_{i,t}$ real GDP growth, $PB_{i,t}$ the primary fiscal balance, while $INT_{i,t}$ indicates the interest cost on public debt. The component μi represents unobserved individual effects specific to each country, whereas εi,t symbolizes the random error term. This specification represents a standard framework in panel data analysis, enabling the separation of individual and time effects (Wooldridge, 2010).

The methodological framework of the research is based on the application of panel regression models, which enable the simultaneous observation of the temporal and cross-sectional dimensions of the data. In the first step, pooled OLS, random effects, and fixed effects models were estimated, after which appropriate specification tests were conducted to identify the most suitable panel model. To ensure the validity of the estimated model, diagnostic tests for heteroskedasticity and multicollinearity, as well as panel unit root tests, were performed. Since the dependent variable was found to be non-stationary and one explanatory variable produced mixed evidence, all variables were transformed into first differences to ensure methodological consistency. This approach reduces the risk of spurious regression and enables the estimated coefficients to be interpreted as the effects of changes in the explanatory variables on annual changes in the public debt-to-GDP ratio, while controlling for country-specific unobserved heterogeneity.

Descriptive Statistics of the Overall Sample and Comparative Analysis by Country

To gain insight into the basic characteristics of the data, this section presents a descriptive analysis of the key variables. Descriptive statistics enable a preliminary examination of data distribution, variability, and potential differences among the observed countries. Particular attention is devoted to identifying the main trends and deviations that may play a significant role in the subsequent empirical analysis. In this context, descriptive statistics for the overall sample are presented first.

Table 1. Descriptive Statistics of the Overall Sample

Variable	Mean	Std. Dev.	Min	Max
PD	51.58	16.16	20.64	108.4
GOV_EXP	39.04	6.90	28.23	54.95
INF	3.39	3.72	-1.60	14.2

GDPG	2.50	3.54	-15.00	13
PB	-1.57	2.37	-8.18	3.76
INT	1.60	0.80	0.00	3.32

Source: Authors' calculations based on the statistical software Stata.

The descriptive analysis presented in Table 1 provides a basic insight into the distribution of key macroeconomic variables within the observed sample. The average level of public debt amounts to 51.6% of GDP, accompanied by a relatively high standard deviation, indicating significant differences among countries. The range of public debt values, from approximately 21% to more than 100% of GDP, confirms the presence of substantial heterogeneity in fiscal positions across the region.

Government expenditure averages around 39% of GDP, while considerably lower variability is observed compared to public debt. This finding suggests that the level of government expenditures in the observed countries moves within a relatively narrow range despite pronounced differences in public debt levels. This may indicate that the size of government expenditure alone is insufficient to explain differences in indebtedness, and that its effect depends on the broader macroeconomic context, including economic growth dynamics and financing costs.

Inflation and real GDP growth exhibit greater variability compared to the other observed variables, indicating higher sensitivity of these indicators to changes in the economic environment. The average primary balance is negative, pointing to the presence of fiscal deficits in most observed years, while interest costs amount to approximately 1.6% of GDP, which further burdens public debt dynamics.

In order to provide a more detailed overview of the relationship between public debt and government expenditure, Table 2 presents the average values of variables for individual countries.

Table 2. Average Values of Variables by Country

Countries	**PD**	**GOV_EXP**	**INF**	**GDPG**	**PB**	**INT**
SRB	51.31	41.56	5.84	2.08	-0.93	1.80
MNE	64.28	46.65	3.28	2.60	-2.65	1.89
MCD	38.68	33.13	3.08	2.33	-2.48	1.08
BiH	37.89	43.84	2.19	2.48	-0.79	0.72
ALB	65.75	30.02	2.58	3.24	-0.98	2.52

Source: Authors' calculations based on the statistical software Stata

The country-level analysis further confirms the absence of a simple relationship between the level of government expenditure and public debt. Albania and Montenegro record the highest levels of public debt, with Montenegro simultaneously exhibiting the highest government expenditure, while Albania records a relatively lower level of public spending. On the other hand, Bosnia and Herzegovina and North Macedonia have significantly lower levels of public debt despite differing levels of government expenditure.

From the perspective of fiscal balance, most countries record negative primary balances, with the largest deficits observed in Montenegro and North Macedonia. At

the same time, interest costs vary across countries, which may indicate differences in borrowing conditions and perceptions of fiscal risk. These findings suggest that public debt sustainability does not depend solely on the level of government expenditure, but also on the manner in which it is financed and the overall macroeconomic environment.

Such a data structure indicates the presence of significant heterogeneity among the observed countries, which further justifies the application of panel methodology in the subsequent analysis in order to more precisely examine the impact of government expenditure on public debt sustainability while controlling for other relevant factors.

Empirical Estimation and Model Validation

After the descriptive analysis, the next step involves estimating the relationship between the observed variables using panel regression models. In the first stage, pooled OLS, random effects, and fixed effects models were estimated in order to obtain insights into the stability and consistency of the results.

Table 3. Results of Pooled OLS, Random Effects, and Fixed Effects Models

Variable	**Pooled OLS**	**Random effects**	**Fixed effects**
GOV_EXP	0.4563	0.4563	0.4814
	(0.004)	(0.003)	(0.411)
INF	-0.1831	-0.1831	-0.0902
	(0.508)	(0.506)	(0.765)
GDPG	0.0351	0.0351	-0.2507
	(0.917)	(0.917)	(0.460)
PB	-0.8417	-0.8417	-0.3539
	(0.098)	(0.094)	(0.629)
INT	17.3674	17.3674	13.9105
	(0.000)	(0.000)	(0.000)
Number of countries	5	5	5
Number of observations	85	85	85
R^2	0.7058	0.7058	0.6977

Source: Authors' calculations based on the statistical software Stata.

Note: Values in parentheses represent p-values.

The results presented in Table 3 indicate relatively stable coefficients between the pooled OLS and random effects models, which is expected given that the preliminary results do not indicate significant variation across panel units. On the other hand, certain differences are observed within the fixed effects model, suggesting the presence of heterogeneity across countries that may affect the estimates.

Looking at the individual variables, government expenditure exhibits a positive coefficient across all estimated models and is statistically significant in the pooled

OLS and random effects specifications, while it loses statistical significance in the fixed effects model. This suggests that the estimated effect of government expenditure is sensitive to the treatment of unobserved country-specific heterogeneity. Inflation displays a negative coefficient in all model specifications, although without statistical significance. Real GDP growth does not have a statistically significant effect in any of the estimated models; however, its coefficient changes sign in the fixed effects model compared with the pooled OLS and random effects models. The primary balance exhibits a negative coefficient across all model specifications and is statistically significant at the 10% significance level in the pooled OLS and random effects models, while it loses statistical significance in the fixed effects specification. In contrast, interest costs have a positive and statistically significant effect across all estimated models, indicating that they represent the most consistently significant determinant of public debt among the variables considered.

The observed differences between the estimates further indicate the need for formal testing of model adequacy in order to determine whether it is justified to use pooled OLS, random effects, or fixed effects approaches.

Table 4. Model Selection Test Results

Test	**Null hypothesis**	**Statistic test**	**p-value**	**Decision**	**Conclusion**
Breusch-Pagan LM	Variance of the individual effect = 0	$\chi^2(1) = 0.000$	1.000	Not rejected H_0	There is no evidence in favor of the Random Effects model.
F test	All intercepts are equal	$F(4,75) = 3.040$	0.022	Rejected H_0	Fixed effects are present (FEM is justified).

Source: Authors' calculations based on the statistical software Stata

In order to select the appropriate panel model specification, the Breusch–Pagan LM test and the F-test for fixed effects were conducted. The results of the LM test do not indicate the presence of random effects ($p = 1.000$), meaning that there is no statistically significant variation across panel units that would justify the use of a random effects approach. On the other hand, the results of the F-test indicate the presence of fixed effects ($p = 0.022$), implying that countries differ from each other and that the fixed effects model provides a more appropriate specification compared to the pooled OLS model.

Overall, the obtained results suggest that within the level model specification, the fixed effects approach is methodologically justified, while the random effects model is not supported by the empirical evidence.

Table 5. Diagnostic Tests

Field of validation	Test	Statistic	p-value	Conclusion
Homoskedasticity	Wald	$\chi^2 = 15.930$	0.000	Presence of heteroskedasticity
Multicollinearity	Variance Inflation Factors (max VIF)	max(VIF) = 1.460	/	No multicollinearity

Source: Authors' calculations based on the statistical software Stata

The diagnostic test results presented in Table 5 indicate certain limitations of the estimated level model. Specifically, the Wald test suggests the presence of heteroskedasticity ($p = 0.0001$), indicating that the error variance is not constant across panel units. This may affect the reliability of the estimated standard errors and, consequently, the statistical significance of the estimated coefficients. On the other hand, the multicollinearity analysis does not indicate any problems, as the VIF values are low, confirming that there is no high interdependence among the explanatory variables.

Overall, the diagnostic results indicate that, although the fixed effects specification is supported, the level model exhibits certain econometric limitations, particularly the presence of heteroskedasticity. In addition, before estimating the final model, it is necessary to examine the stationarity properties of the variables in order to avoid potential spurious regression and determine whether variable transformations are required.

Table 6. Panel data stationarity testing

Variable	LLC	Breitung	IPS	Conclusion
PD	-0.8865	0.2287	-0.3433	Non-stationary
	(0.1877)	(0.5905)	(0.3657)	
GOV_EXP	-3.2470	-2.4129	-1.9953	Stationary
	(0.001)***	(0.0079)***	(0.0230)**	
INF	-2.9235	-2.4577	-2.5603	Stationary
	(0.002)***	(0.007)***	(0.0052)***	
GDPG	-2.5501	-3.9843	-4.9958	Stationary
	(0.005)***	(0.000)***	(0.000)***	
PB	-2.7845	-2.9313	-2.6039	Stationary
	(0.003)***	(0.002)***	(0.0046)***	
INT	-2.1544	0.8075	0.7625	Mixed evidence
	(0.016)**	(0.7903)	(0.7771)	

Source: Authors' calculations based on the statistical software Stata

*Note: Values in parentheses represent p-values. *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.*

The results of the panel stationarity tests presented in Table 6 indicate different statistical properties of the observed variables. First, the public debt variable does not exhibit stationarity in any of the applied tests, indicating the presence of a unit root and a potential problem of spurious regression in the level model. This finding is particularly

important given that this is the dependent variable, as non-stationarity may lead to systematically biased estimates and unreliable conclusions. In contrast, government expenditure, inflation, real GDP growth, and the primary balance exhibit consistent stationarity across all applied tests, suggesting stable statistical properties of these series. This implies that their values fluctuate around a stable mean over time, without the presence of long-term trends that could undermine the validity of the regression analysis.

For the interest cost variable, mixed results are obtained. While the Levin–Lin–Chu test indicates stationarity, the Breitung and IPS tests do not confirm this finding, pointing to sensitivity of the results to the chosen methodology and potential instability of the series. This mixed outcome calls for additional caution in interpretation and justifies further testing.

The results indicate that the level model includes a combination of stationary and non-stationary variables, which may lead to methodological issues, particularly the risk of spurious regression and incorrect inference about the relationships between variables To ensure methodological consistency and eliminate potential biases associated with different orders of integration, additional panel unit root tests were conducted on the first differences of all variables. The results are reported in Table 6a.

Table 6a. Additional panel unit root tests for first-differenced variables

Variable	**LLC**	**Breitung**	**IPS**	**Conclusion**
ΔPD	-3.7289	-2.9964	-2.9265	Stationary
	(0.000)***	(0.001)***	(0.001)***	
ΔGOV_EXP	-4.5810	-5.5086	-4.7178	Stationary
	(0.000)***	(0.000)***	(0.000)***	
ΔINF	-3.9165	-3.2918	-4.0210	Stationary
	(0.000)***	(0.000)***	(0.000)***	
ΔGDPG	-7.1231	-3.5752	-5.9693	Stationary
	(0.000)***	(0.000)***	(0.000)***	
ΔPB	-3.5059	-5.1319	-4.9510	Stationary
	(0.000)***	(0.000)***	(0.000)***	
ΔINT	-1.4394	-3.5683	-2.5782	Stationary
	(0.075)*	(0.000)***	(0.005)***	Stationary

Source: Authors' calculations based on the statistical software Stata

*Note: Values in parentheses represent p-values. *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.*

The results of the additional panel unit root tests presented in Table 6a indicate that the first differences of all observed variables satisfy the stationarity assumption. For five of the six variables, stationarity is confirmed by all three applied tests (LLC, Breitung, and IPS) at a high level of statistical significance. For the ΔINT variable, the Breitung and IPS tests confirm stationarity at the 1% significance level, while the Levin–Lin–Chu test also supports stationarity at the 10% significance level. These findings indicate that first differencing successfully eliminates the problem of non-stationarity in the panel and ensures that the assumptions required for valid panel regression analysis are satisfied.

Based on these findings, the final model specification is estimated using the first differences of all variables. This approach ensures methodological consistency, eliminates the risk of spurious regression, and allows the estimated coefficients to be interpreted as the effects of changes in the explanatory variables on annual changes in the public debt-to-GDP ratio.

Table 7. Fixed Effects Model Estimated Using First-Differenced Variables

Variable	**FEM**
ΔGOV_EXP	0.7163*
	(0.075)
ΔINF	-0.0720
	(0.642)
ΔGDPG	-0.1638
	(0.207)
ΔPB	-0.3472
	(0.396)
ΔINT	9.4094***
	(0.001)
Number of observations	80
Number of countries	5
R^2 (within)	0.5356
R^2 (overall)	0.5382

Source: Authors' calculations based on the statistical software Stata

*Note: Values in parentheses represent p-values. *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.*

The results of the final model specification, presented in Table 7, are based on a fixed effects model estimated using the first differences of all variables. This specification enables the analysis of short-run changes in public debt and its determinants, with the estimated coefficients interpreted as the effects of changes in the explanatory variables on annual changes in the public debt-to-GDP ratio.

Compared with the level specification presented in Table 3, the estimated coefficient of interest costs decreases in the final model estimated using first-differenced variables, although it remains positive and highly statistically significant. This result suggests that part of the long-run variation captured in the level model is removed after first differencing, while changes in interest costs continue to represent the strongest determinant of short-run public debt dynamics. The persistence of statistical significance across both specifications further confirms the robustness of the interest-cost channel in explaining public debt dynamics.

With respect to the main research question, the results indicate that changes in government expenditure have a positive effect on changes in public debt, with the estimated coefficient being statistically significant at the 10% significance level. This finding suggests that increases in government expenditure may contribute to higher public

debt in the short run, although the relatively weak level of statistical significance calls for caution in interpreting the result. This outcome is partially consistent with theoretical approaches emphasizing the importance of fiscal discipline and expenditure control for maintaining fiscal sustainability (Alesina & Ardagna, 2011; Alesina & Perotti, 1995). At the same time, it suggests that the effect of government expenditure is not dominant relative to other fiscal and financial factors.

In contrast, changes in interest costs exert a positive and highly statistically significant effect on changes in public debt. The estimated coefficient indicates that increases in borrowing costs represent the most important driver of public debt growth in the observed Western Balkan countries. This finding is consistent with the results of Reinhart and Rogoff (2010), who argue that rising public debt increases risk premia and borrowing costs, as well as with the findings of Laubach (2009), according to which higher public debt leads to higher government financing costs.

Changes in inflation, real GDP growth, and the primary balance exhibit the expected negative coefficients; however, their effects are not statistically significant in the final model specification. This suggests that, after controlling for the remaining explanatory variables and unobserved country-specific heterogeneity, there is insufficient empirical evidence to confirm their independent contribution to changes in public debt during the observed period.

Overall, the empirical findings provide mixed support for the proposed hypotheses. H2 is confirmed, as interest costs exert a positive and highly statistically significant effect on public debt dynamics. H1 receives partial support, as government expenditure exhibits a positive effect that is statistically significant only at the 10% significance level, whereas it is not statistically significant at the conventional 5% and 1% significance levels. In contrast, H3, H4, and H5 are not supported, since inflation, real GDP growth, and the primary balance do not have statistically significant effects in the final model specification.

Study Limitations

This study has several limitations that should be considered when interpreting the results. The primary limitation is that the panel comprises only five Western Balkan countries. Although these countries provide a relevant sample for examining public debt dynamics in the region, the relatively small number of countries limits the generalizability of the findings beyond the observed sample. Consequently, the results should be interpreted as evidence specific to the Western Balkans rather than as conclusions applicable to other groups of countries.

Another limitation relates to the use of aggregate government expenditure, which does not distinguish between current and capital expenditure. Since different expenditure categories may have different effects on public debt dynamics, the estimated coefficients should be interpreted as reflecting the overall effect of government expenditure rather than the impact of its individual components. In addition, the analysis is limited to a selected set of fiscal and macroeconomic variables, while other factors, such as the maturity and currency structure of public debt, institutional quality, and political conditions, may also influence debt sustainability. Future research could extend the analysis by including a

larger sample of countries, distinguishing between current and capital expenditure, and incorporating additional institutional and financial variables in order to provide a more comprehensive assessment of the determinants of public debt sustainability.

Conclusion

The subject of this research was the analysis of the impact of government expenditure on short-run public debt dynamics in the Western Balkan countries during the period from 2008 to 2024, with the objective of providing empirical evidence relevant to public debt sustainability. The empirical analysis was conducted using panel regression models on a sample comprising Serbia, Montenegro, North Macedonia, Bosnia and Herzegovina, and Albania, supported by appropriate diagnostic and panel unit root tests to ensure the methodological validity of the results.

The research results indicate that government expenditure exerts a positive effect on changes in public debt, which is statistically significant only at the 10% significance level after controlling for macroeconomic and fiscal factors. Consequently, the findings do not support the view that government expenditure represents the primary determinant of short-run public debt dynamics in the observed countries. This result partially departs from approaches emphasizing expenditure-based fiscal consolidation, while supporting contemporary theoretical perspectives that public debt sustainability depends on a broader set of fiscal and macroeconomic determinants.

In contrast, interest costs exhibit a positive and highly statistically significant effect on changes in public debt, confirming the importance of financing conditions for fiscal sustainability. Although inflation, real GDP growth, and the primary balance display the expected negative coefficients, their effects are not statistically significant in the final model specification. This suggests that, after controlling for the remaining explanatory variables and country-specific effects, there is insufficient empirical evidence to confirm their independent contribution to short-run public debt dynamics.

The empirical findings provide partial support for the proposed research hypotheses. H2 is confirmed, as interest costs exert a positive and highly statistically significant effect on public debt dynamics. H1 is partially confirmed, as government expenditure exerts a positive effect that is statistically significant only at the 10% significance level after controlling for the remaining variables. In contrast, H3, H4, and H5 are not confirmed, since inflation, real GDP growth, and the primary balance do not have statistically significant effects in the final model specification.

Overall, the results indicate that short-run public debt dynamics in the Western Balkan countries are driven primarily by financing costs rather than by the overall level of government expenditure. These findings suggest that maintaining favorable borrowing conditions represents an important prerequisite for preserving fiscal sustainability in the region. At the same time, the limited effect of government expenditure indicates that future research should pay greater attention to the composition and efficiency of public expenditure, as well as to additional institutional and financial factors that may influence public debt dynamics.

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STRATEGIC EMPLOYEE MOTIVATION THROUGH NON-MATERIAL INCENTIVES: A MANAGERIAL PERSPECTIVE

Abstract

Drawing upon these best understandings of motivation, this article provides a holistic view of the empirical evidence for managers to incorporate those non-material incentives, including public recognition, autonomy, flexible work schedules, and developmental opportunities, to enhance employees' motivation and ultimately firm performance. This paper focuses on intrinsic motivation, sustained engagement, and better work outcomes. Studies confirm that while psychological safety and focused development improve knowledge sharing and workforce capability, public recognition and flexible work schedules consistently contribute to greater performance and engagement. With that being said, this article offers valuable insights for the development of context-sensitive, successful non-monetary incentive schemes.

***Key words**: employee motivation, non-material incentives, self-determination theory, job demands, psychological safety, work design, recognition, flexible work, employee engagement*

***JEL classification:** O15, M12*

СТРАТЕШКА МОТИВАЦИЈА ЗАПОСЛЕНИХ КРОЗ НЕМАТЕРИЈАЛНЕ ПОДСТИЦАЈЕ: МЕНАЏЕРСКА ПЕРСПЕКТИВА

Апстракт

Ослањајући се на најбоље разумевања мотивације, овај рад пружа холистички поглед на емпиријске доказе који менаџерима омогућавају да укључе нематеријалне подстицаје, укључујући јавно признање, аутономију, флексибилно радно време и могућности за развој, како би побољшали мотивацију запослених и на крају учинке фирме. Овај рад се фокусира на унутрашњу мотивацију, одрживо ангажовање и боље радне резултате.

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Студије потврђују да, иако психолошка безбедност и фокусирани развој побољшавају размену знања и капацитете радне снаге, јавно признање и флексибилно радно време константно доприносе већим учинцима и ангажовању. Уз то речено, овај рад нуди вредне увиде за развој контекстуално осетљивих, успешних шема немонетарних подстицаја.

Кључне речи: *мотивација запослених, нематеријални подстицаји, самоодређење, захтеви посла, психолошка сигурност, дизајн посла, признање, флексибилан рад, ангажовање запослених*

Introduction

Teams are being pushed by managers beyond money, more and more. Non-material rewards like public recognition, autonomy, flexible work, and opportunities for further development cultivate authentic motivation and involvement (Omazić et al., 2011). And these factors enhance motivation, meaning, autonomy, and growth, and not just in the short run. This type of experience correlates with learning, retention, and enhanced organizational performance. Managers are not, however, able to see and appreciate how and why it influences their decisions, either in context. But it must also be seen that, for reasons of important boundary conditions. Such an approach presents a theoretical and empirical point of view, which evidences the effective use of non-material motivation. This analysis looks at three primary theories, each from a different perspective. First of all, Self-Determination Theory (SDT) implies that motivation is affected by three underlying factors: autonomy, competence, and relatedness (Deci & Ryan, 2012). Organisations that meet these needs allow employees to demonstrate stronger internal motivation. Second, Herzberg's motivation-hygiene theory distinguishes motivators (like recognition, responsibility, and growth) from hygiene factors (salary, policies, and working conditions). Satisfaction and motivation are driven by only motivators. Third, the Job Demands-Resources (JD-R) model proposes job resources, including autonomy, feedback, and support, increase engagement and protect well-being at peak demand. Two other key elements that other studies mention are also important: psychological safety, which is the belief that taking risks on a team is safe to do so that employees can learn and articulate; and work design theory, which considers autonomy, significance, and feedback essential for motivating work. Citations substantiate all three of these central theoretical claims.

Literature Review

Non-material incentives are management actions that exist purposefully to influence work and learning beyond pay. They essentially serve to meet psychological needs, generate interest, and induce high-energy, hard work in a positive environment. For instance, periodic peer recognition during meetings provides tangible, actionable rewards. Such examples translate theory into practice in a way which demonstrates its utility. The following sections outline four primary non-material incentives and summarise key supporting evidence. Recognition links effort with competence and

social value, a central pathway in SDT and a Herzberg motivator. Timely and authentic recognition enhances performance, in real field experiments. One field study reported increased output due to surprise public recognition, particularly among high performers (Bradler et al., 2016). Stajković and Luthans (1997) states that meta-analyses found positive performance boosts from social recognition, feedback, and goal-oriented reinforcement. The presence of recognition also increases engagement as perceived return on personal investment is increased (Kahn, 1990). A big part is making sure that recognition that is given is specific and credible, both for employees and for their bosses. Do not lean too much into rankings and prioritize fairness and transparency in order to mitigate favouritism or the crowding-out effect of a business (Colquitt, 2001). Autonomy is central to self-determination theory (SDT), a motivational model, as a crucial job attribute with significant increases in meaningfulness and responsibility (Hackman & Oldham, 1976). The literature of work design research correlates autonomy – the freedom and control over work methods and timing – with job satisfaction and job performance (Humphrey et al., 2007). "Time and place" (both location- and time-out options – e.g., at home and at work) work autonomy is provided by remote or flexible work arrangements. A well-documented experiment in a Chinese travel agency resulted from remote work led to 13% increase in performance and halved turnover, but promotion levels were reduced as the on-location visibility got reduced (Bloom et al., 2015). Meta-analyses/reviews of telecommuting and flexibility reveal both the positive and contingent effects. It is said to depend on task interdependence, communication infrastructures, or managerial practice (Gajendran & Harrison, 2007; Allen et al., 2013). Managers must commit to a few tasks if flexible work plans are to genuinely foster autonomy. Give meaningful options for time and tasks to the employees. Recognize how employees feel and put themselves in the situation, developing trust. Organizations can avoid controlling practices that decrease intrinsic motivation by integrating flexibility with supportive management. Job crafting, however – when employees reconfigure work tasks, relationships or perceptions – helps companies better align roles with employees' strengths and values. Job crafting is supported by resources and defined goals, and engagement levels increase (Bakker & Demerouti, 2017). Managers need to set clear outcomes and guardrails, coordinate for work that is interdependent, and track the equity impacts, so that flexibility is inclusive. Psychological safety has been linked to increased voice, experimentation and error-learning in teams (Edmondson, 1999). Psychological safety is a predictor of performance, citizenship, and engagement, even controlling for associated traits (Frazier et al., 2017). Managers can take non-material levers to use to model fallible behaviour, such as openly admitting errors in team meetings, or ask real inquiries like "What can we learn from this?" to promote a learning environment. Also important is good practice for holding blameless post-mortems and normalizing dissent. By identifying learning behaviours (e.g., raising risks early) and outcomes, create a safety climate for reinforcement. Developmental chances fulfil competence needs and demonstrate durable reciprocity. Several meta-analytic approaches show that training and development benefit individuals and organizations – enhancing human capital, knowledge transfer and performance (Aguinis & Kraiger, 2009). Development expands the resources that sustain engagement and resilience in the JD-R model (Bakker & Demerouti, 2017). Researchers have shown a link in research between feedback, coaching, and learning resources and greater vigor, dedication, and absorption (Schaufeli

& Bakker, 2004; Bailey et al., 2017). Based on the Self-Determination Theory, Job Demands–Resources model, and work design theory, non-material incentives fulfil crucial strategic roles in organizations. Such incentives are important for (1) meeting psychological demands for autonomy, competence, and relatedness, (2) increasing resources for long-term engagement, and (3) a learning culture in the organization that promotes employee voice and ongoing learning. Examples include ongoing feedback and recognition practices, which are instrumental drivers of not just basic psychological needs (e.g., self-determination) but also active participation and choice at work. However, to achieve the maximum potential of non-material incentives, firms need clearly established connections between certain incentive sources and their motivational goals and institutions and processes of delivery and monitoring performance and related organisational effects. It guarantees that interventions make systematic links to motivation and goals, hence aiding in effective and sustainable change. In the synthesis of the SDT, JD-R, and work design theory, we find three major processes that NMI mechanisms work through: need satisfaction (autonomy, competence, and relatedness for increased quality of motivation), resource building (enhances engagement and ameliorates work demands), and climate shaping (paving the way for greater employee voice and ongoing learning). However, operationalizing these mechanisms requires: first of all, clearly defining causal processes (for instance, recognition promotes perceptions of competence); second, creating positive organizational structures (e.g. regular performance dialogues, ongoing peer feedback); thirdly, analyzing equity and justice perceptions in a systematic manner for procedural fairness (Colquitt, 2001); lastly monitoring the leading indicators (engagement and psychological safety) as well as primary outcomes (performance and retention) to an extent consistent to the research process. This consolidated, in-depth methodology ensures that there is no duplication and makes sure each and every design principle is focused on the function it is used for.

Implementation Roadmap

Phase 1 – Diagnose: Use well-validated instruments like the Utrecht Work Engagement Scale (UWES-9) and Edmondson's Team Psychological Safety Survey to conduct a full assessment of job demands, resources, employee engagement, and psychological safety. And integrate some other psychometric tools like the Maslach Burnout Inventory (to quantify workplace stress) and the Psychological Capital Questionnaire (based on employees' self-efficacy, optimism, hope, and resilience). Aggregate these numbers with qualitative perspectives derived from semi-structured interviews or open-ended surveys to illustrate specific times when the pressures of the job consistently come before the resources available to keep productive people working. In their assessments at this stage, culturally responsive assessment techniques should also be part of the process; for example: anonymous digital surveys can mitigate power distance biases (e.g., anonymous digital surveys in hierarchical organizations to reduce power distance biases and ensure candid feedback), or bilingual facilitators for multilingual environments so that people from different backgrounds in the workplace could help employees' trust build up the confidence and also respond to information accurately (Balducci et al., 2009).

Phase 2 – Design: Design Work together to define the recognition processes (e.g., a formalized peer-nomination process with a defined list of objectives, criteria, roles autonomy, and personal development plans by collaborating to design workshops or design-thinking workshops which is done in the design process by relevant individual employee groups.) Institutionalize non-physical motivation, implementing micro-practices, e.g., weekly "learning showcase" meetings, and hold to showcase some skills where team members share skills developed or lessons learned. Implement the Perceived Organizational Support scale to assess employees' overall sense of organizational appreciation and value. Examine the influence of existing cultural norms such as power distance or collectivistic values on the design of rituals and incentive mechanisms to validate appropriateness and legitimacy (Balducci et al., 2009).

Phase 3 – Pilot: Implement proposed interventions in controlled, time-limited pilots, typically over 6–8 weeks, based on well-defined hypotheses (for example, "Will public recognition increase cross-departmental collaboration?") and standardized measures of success (e.g., changes in UWES scores or in participation rates). Employ mixed-methods evaluation of both pre- and post-intervention surveys and real-time feedback mechanisms, such as digital suggestion boxes, organized focus groups, and staff diaries. Watch for culturally specific barriers (e.g., reluctance to engage in recognition drives in high-context cultures, hesitation to contribute critical feedback) and adjust pilot procedures to promote engagement, and authentically record employee sentiment (Balducci et al., 2009).

Phase 4 – Scale: This stage is to standardize and incorporate the things that change engagement, performance, or retention. If the target indicators are not met, then we will phase out or redevelop. Conduct periodic equity audits. This includes systematic analyses of incentive allocation patterns by demographic group (e.g., quantitative comparisons of recognition awards across different departments or sexes or of different tenure levels) to avoid disparities and maintain fairness. Throughout the scaling process, adapt your communication strategies and change management initiatives to fit current organizational culture. For example, if a situation calls for the use of influential internal opinion leaders, adopt collectivist organizations. You can also hold town hall sessions to help get buy-in throughout the organization. The implementation continues to be responsive and sustainable, across heterogeneous organizational landscapes, by embedding cultural and contextual considerations at every level (Balducci et al., 2009).

Contributions of Emerging Scholars and Regional Perspectives

Recent studies by Karabašević et al. (2015; 2016; 2016a; 2016b; 2018) have highlighted the use of multi-criteria decision-making in human resource management (HRM), especially in recruitment and performance evaluation. Therefore, they illustrated the utility of quantitative models in increasing transparency and objectivity in personnel recruitment that enhances employee sense of fairness and recognition. Whereas Mirčetić et al. (2022) emphasized new concept of HRM, particularly green competencies, as critical for organizational performance. This connection between quality of decision making and motivating climate underscores an underappreciated managerial lever of non-material incentives. More recent contributions also broaden the discussion. For

example, Saks (2006) developed a social exchange model of engagement, suggesting that when organizations provide non-material resources, employees respond with increased levels of dedication and citizenship behaviour in return. Osterman (2010) stressed the need for leadership behaviours that allow climates to stimulate engagement resources. These perspectives deepen the theoretical framing and highlight the need for managerial decision-making of employee experience design.

Discussion and Conclusion

Extensive analysis of non-material incentives requires a scrutinizing of methodological limitations (such as reliance on self-reported survey instruments, narrow representation of participants and potential selection biases) and situational contingencies which characterise current studies. The dominance of self-report data makes findings vulnerable to social desirability biases, recall errors, and self-assessment errors, and thus, the extent of statistical conclusion validity and risk of overestimation of effect sizes increases. Additionally, the continual reliance on small, or monolithic, sample characteristics limits external validity and its generalizability to the larger organizational context. For practitioners, this highlights the need for prudent extrapolation, and the need to supplement quantitative findings with qualitative knowledge on multiple levels and for replication into other locations. These methodological restrictions inform recommendations that are practical: organizations are suggested to test out non-material incentive programs using measurement instruments, carefully collect multi-source feedback, and tailor interventions to the diverse workforce, the managerial skillset, or the technological environment in which those incentives take effect. Furthermore, organizational moderators – factoring in the level of employee interconnectedness, technological resources, and perceived fairness of operational process – have a great impact on non-material effects on motivation. For example, not customizing work-life arrangements or recognition systems to specific operating or occupational environments may inadvertently discourage career progress, or foster a sense of unfairness. Thus, this explicit recognition of such limits informs the planning and enforcement, and so can increase the probability that these interventions would produce their intended motivational and performance effects in the context of a specific organisational situation. However, in order to elaborate on the circumstances when non-material inducements might be less effective – or even counterproductive we must examine three important moderators of situational feedback, and each is illustrated with practical examples.

The presence of the union on its face can limit how non-monetary incentives are rolled out and enforced. In heavily unionized manufacturing industries, collective bargaining agreements might be enforced as a means of negotiating collective recognition, with standard recognition processes and an emphasis on financial rewards, thus reducing managerial discretion to offer individualized non-monetary rewards, for example, spontaneous public recognition or flexible scheduling. Second, the completeness and quality of technologies that facilitate remote work are critical drivers to the effectiveness of telework-related incentives. At a global consulting firm, the use of advanced collaboration software and secure remote enablement can create a setting for the employees to work effectively and independently remotely. On the other hand, small organisations that only have a few years of digital

infrastructure need to put these efforts into practice, otherwise staff engagement in terms of motivation will be undermined by unreliable access times and interrupted processes. Third, organizational culture is an essential determinant of the acceptance of non-material incentives. As an illustration, such initiatives could be viewed by employees in a hierarchical, risk-averse organization as dubious at best, which could deter employees with low trust that such initiatives will work in reality. On the other hand, the most effective means of encouraging employee participation through non-material incentives are a participative leadership, innovation culture. These are examples suggesting the necessity of aligning non-material incentives with the particular organizational environment that may result in their best motivational effect. Future studies should look at the effects of team safety and leadership on the effect of job crafting and the effects between multiple non-monetary motivators and one intervention in the long run. This article contributes to the literature by synthesizing well respected motivational theories with new emergent empirical evidence into a comprehensive managerial lens concerning non-material incentives. For Serbia and the larger Southeast European (SEE) region, the strategic power of these activities is compounded by the backdrop of emerging economic changes, where employee's engagement is closely tied with perceptions of fairness, safety and acknowledgment of recognition. In reality, as an example, the Serbian IT sector leader is a good place here, but the application of these techniques is relatively new, an example. The company implemented a systematic, transparent peer recognition program in response to employee feedback, achieving measurable improvements in retention and engagement. The regional example illustrates, not only the importance of such non-material incentives to resolving particular contexts, but also reinforces the generalizability of underlying motivation principles. Effective transfer across international or organizational settings, however, requires adaptation of practices/policy to local cultural and institutional parameters, but the main principles of fairness, acknowledgment, and security provide a strong foundation to create motivation of employees across disparate contexts.

The management approach based on non-material motivators like recognition, autonomy, flexibility, development, and psychological safety is in line with leading motivational theories and empirical evidence. Organizations that structure work and social spaces in ways that foster fundamental needs, build resources, and promote learning are better able to realize sustained improvements in engagement and performance and do not solely depend on financial rewards. Managers are a key way to ensure fairness, monitor progress, and continuously refine practices. And as a wrap-up, managers could query: which non-material incentive would they prototype this quarter? The challenge leads to action and creates a culture of experimentation and continuous improvement.

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RESHAPING LABOUR MARKET NEEDS THROUGH ARTIFICIAL INTELLIGENCE: CHANGING SKILL DEMAND, GREEN SKILLS, AND SECTORAL HETEROGENEITY

Abstract

Purpose – This paper examines how artificial intelligence (AI) is reshaping labour-market skill needs, focusing on the change in employer skill demand, the resilience of green skills, and sectoral heterogeneity in the European Union. Design/methodology/approach – Three hypotheses are tested against official statistics from Eurostat and the International Labour Organization for the last available decade (2014–2024); absolute and percentage change and compound annual growth rates are computed and triangulated with recent scholarly literature. Findings – Employment of ICT specialists rose by about 61% (to 4.9% of total employment) and hard-to-fill ICT vacancies doubled; employment in the environmental goods and services sector grew by about 60%, led by renewable energy (+92%); and high-AI-exposure services expanded roughly three times faster than lower-exposure sectors. All three hypotheses are confirmed. Practical implications – Education and labour-market policy should treat digital, green, and AI-complementary skills as a single, integrated agenda, since the binding constraint is the supply of skills. Originality/value – The paper integrates the digital, green, and sectoral dimensions within one twin-transition framework using harmonised official statistics.

Key words: *artificial intelligence, digital skills, green skills, labour market, skills mismatch, sectoral employment*

JEL classification: *J24, J21, O33, Q56, C10*

ОБЛИКОВАЊЕ ПОТРЕБА ТРЖИШТА РАДА ПОД УТИЦАЈЕМ ВЕШТАЧКЕ ИНТЕЛИГЕНЦИЈЕ: ПРОМЕНА ТРАЖЊЕ ЗА ВЕШТИНАМА, ЗЕЛЕНЕ ВЕШТИНЕ И СЕКТОРСКА ХЕТЕРОГЕНОСТ

Апстракт

Сврха – Рад испитује како вештачка интелигенција (ВИ) преобликује потребе тржишта рада за вештинама, са фокусом на промену захтева послодаваца за вештинама, отпорност зелених вештина и секторску хетерогеност у Европској унији. Дизајн/методологија/приступ – Три хипотезе тестирају се на званичним статистикама Евростата и Међународне организације рада за последњу расположиву деценију (2014–

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2024); израчунавају се апсолутна и процентуална промена и просечна годишња стопа раста (CAGR), а резултати се триангулишу са савременом литературом. Резултати – Запосленост ИКТ стручњака порасла је за око 61% (на 4,9% укупне запослености), а удео предузећа са тешко попуњивим ИКТ радним местима се удвостручио; запосленост у сектору еколошких добара и услуга порасла је за око 60%, предвођена обновљивом енергијом (+92%); сектори високе изложености ВИ расли су отприлике три пута брже од сектора ниже изложености. Све три хипотезе су потврђене. Практичне импликације – Образовне политике и политике тржишта рада треба да третирају дигиталне, зелене и ВИ-комплементарне вештине као јединствену, интегрисану агенду, будући да је ограничавајући фактор понуда вештина. Оригиналност/вредност – Рад обједињује дигиталну, зелену и секторску димензију у оквиру јединственог концепта „двојне транзиције“, користећи хармонизоване званичне статистике.

Кључне речи: *вештачка интелигенција (ВИ), дигиталне вештине, зелене вештине, тржиште рада, неусклађеност вештина, секторска запосленост*

Introduction

In less than a decade, artificial intelligence (AI) has moved from a specialised technological field to a general-purpose technology that is reshaping how work is organised, valued, and demanded. The rapid development of large language models and generative AI tools after 2022 further accelerated this process, shifting the focus of public and scholarly debate from the question of "will AI replace jobs" to the more subtle question of "how is AI changing the content of jobs and the structure of skills that employers demand." The relevance of the topic at this particular moment stems from a twofold circumstance: on the one hand, the speed of technological diffusion outpaces the speed at which education systems and labour market policies adapt; on the other hand, this transformation is unfolding simultaneously with the green transition, which raises the question of how two parallel, potentially competing or complementary, pressures on skills, the digital and the ecological, relate to one another. For developing and transition economies such as Serbia, this question also carries strategic significance, since the competitiveness and inclusiveness of the labour market depend on the timely adjustment of skills.

The key trends framing this debate can be summarised along three lines. The first is the automation of routine tasks, documented in the earlier wave of robotisation and digitalisation, which exerted pressure primarily on medium-skilled, procedural jobs and contributed to labour market polarisation. The second is the emergence of generative AI, which, unlike previous waves, affects cognitive, clerical, and highly educated profiles to a greater extent, thereby altering the traditional assumption about who is "exposed" to technology (Eloundou et al., 2024). The third line is the change in the demanded skills structure: demand for technical and digital competencies is rising, but so is demand for so-called soft and transversal skills (analytical reasoning, management, creativity, collaboration), while the importance of formal qualifications is being redefined in favour of concrete, demonstrable skills. In parallel, "green skills" are becoming a subject of

particular attention as a component of the sustainable transition, while the question of their autonomous durability relative to increasingly dominant digital competencies remains open (Erceg & Zoranović, 2020).

The subject of this paper is an analysis of the way in which artificial intelligence transforms the needs of the labour market, viewed through the prism of skills rather than solely through the number of jobs. The aim of the paper is to determine, drawing on scholarly literature and official statistical sources (the International Labour Organization, ILO, and Eurostat), in which direction employers' requirements are changing, what the status of green skills is in the age of AI, and how uniform or differentiated AI's impact is across sectors. Accordingly, the paper is guided by three research questions: (1) How are employers' requirements regarding employees' skills changing under the influence of AI? (2) How relevant do "green skills" remain in the era of AI transformation? and (3) How differently does AI affect individual industries and sectors?

On this basis, the following hypotheses are formulated:

H1: Under the influence of artificial intelligence, employers' requirements are systematically shifting from routine and procedural skills toward technical, digital, and higher cognitive-social skills, accompanied by a declining importance of formal qualifications in favour of concrete (demonstrable) skills.

H2: Green skills retain their relevance in the labour market, but their demand increasingly depends on complementarity with digital and technical competencies; their significance is therefore not autonomous but conditioned by the coupling of the green and digital transitions.

H3: The impact of artificial intelligence on the labour market is sector-differentiated, in sectors with a high share of routine tasks the substitution effect prevails, whereas in sectors with analytical, technical, and interpersonal tasks the effect of augmentation and increasing skill complexity prevails.

The paper is structured into four parts. Following this *introduction*, in which the subject, aim, and hypotheses are defined, comes the *theoretical framework and literature review*, organised thematically around the change in skill demand, automation and digital competencies, green skills, and sectoral differences. The third chapter, *research and discussion*, presents the statistical analysis of data from official institutions (ILO and Eurostat), by which the stated hypotheses are empirically tested against comparative indicators. Furthermore, the discussion of results is elaborated. The paper concludes with a *conclusion*, in which the findings are synthesised, the status of the hypotheses is assessed, and implications for education and employment policies under the twofold, digital and green, transition are formulated.

2. Theoretical Background and Literature Review

2.1. Changing Skill Demand Under the Influence of AI

Empirical studies based on online job-posting data consistently show that AI changes the *structure* of demanded skills, not merely their volume. Alekseeva et al. (2021), analysing a database of online vacancies (Burning Glass Technologies) for the U.S. labour market over the period 2010–2019, document a dramatic increase in

demand for AI skills across almost all industries and occupations, with the highest concentration in IT, engineering, science, and management; they also find that AI skills carry a wage premium of about 11% within the same firm and 5% within the same job title (quantitative analysis of a large sample of vacancies). Green (2024), within the OECD series of papers on AI, estimates the effects of AI on skill demand in occupations that do not require specialised AI skills, and finds that in occupations highly exposed to AI the most sought-after skills are managerial and business skills (project management, finance, administration), indicating the complementarity of AI with coordination and reasoning skills (method based on online vacancies). Eloundou et al. (2024) develop a framework for assessing occupations' exposure to large language models and estimate that about 80% of the U.S. workforce could have at least 10% of their tasks affected by this technology, with a reversed pattern relative to earlier waves of automation, greater exposure is shown by better-paid and more educated occupations based on research that combine human expertise and GPT-4 task classification.

The consensus in the literature is that AI is rapidly rising demand for technical and interdisciplinary skills and that it operates primarily in an augmentation mode, alongside complementary managerial and analytical skills. The main disagreement concerns the direction of the distribution of exposure. While generative AI appears to affect highly skilled cognitive profiles as well (Eloundou et al., 2024), studies based on vacancies emphasise that demand and wage premiums still rise most for narrowly specialised AI competencies (Alekseeva et al., 2021). The extent to which measured "exposure" translates into actual changes in jobs also remains open.

2.2. Automation, Digital, and Technical Skills

The conceptual foundation is the thesis of the automation of routine tasks and its distributional consequences. Acemoglu and Restrepo (2020), analysing local U.S. labour markets, provide robust evidence of the negative effect of industrial robots on employment and wages: one additional robot per thousand workers reduces the employment-to-population ratio by about 0.2 percentage points and wages by about 0.42% (quantitative analysis across commuting zones). This finding confirms that technological substitution is not neutral but affects particular skill profiles. Felten et al. (2021) construct a measure of occupational exposure to artificial intelligence (AIOE), linking ten AI applications to 52 human abilities, and show that exposure differs markedly across occupations, with the possibility of aggregation to the industry (AIIE) and geographic levels as a quantitative approach based on cross-linking abilities and applications. On the side of skill-structure adjustment, Wang et al. (2024), using panel data for 31 Chinese provinces (2010–2019) and fixed-effects, mediation, threshold, and spatial econometric models, find that AI promotes growth in high- and medium-skilled employment while reducing low-skilled employment, with non-linear effects and spatial spillovers across regions (open access, Heliyon).

The literature agrees that technology systematically "upgrades" demanded skills (skill upgrading) and displaces routine, low-skilled tasks, confirming the polarisation framework. Disagreements arise over the *net* effect on employment, while earlier work on robotisation emphasises substitution and losses (Acemoglu & Restrepo, 2020), more recent studies of AI emphasise recomposition and increasing skill complexity (Wang et

al., 2024). The common conclusion is that digital and technical skills are becoming a basic condition of employability across a wide range of occupations.

2.3. Green Skills and Sustainability in the Context of AI Transformation

Research on green skills shows that they are qualitatively different from non-green skills but also increasingly intertwined with digital competencies. Consoli et al. (2016), in a foundational study based on U.S. occupational data (ONET), find that green jobs make more intensive use of higher cognitive and interpersonal skills and are characterised by higher levels of education, work experience, and training than non-green jobs (quantitative occupational profiling). Gasparini et al. (2025) critically re-examine official taxonomies of green occupations and skills, combining ONET and ESCO with a regional input-output model of investments in energy technologies in the Netherlands, and find that only a minority of occupations relevant to the energy transition can be strictly classified as "green," while the majority rest on non-green skills, with digital competencies proving more decisive than narrowly "green" expertise. Bone et al. (2025), analysing about eleven million online vacancies in the United Kingdom (2018–mid-2024), record that the number of vacancies with at least one green skill grew by about 67%, and show that employers increasingly apply "skill-based hiring" for both green and AI jobs, with a decline in requirements for formal university education (a quantitative time series of vacancies).

The consensus is that green skills remain relevant and increasingly in demand, but that their operational value increasingly depends on their coupling with digital and technical skills within the "twin transition". Literature disagreements exist over measurement: taxonomy-based approaches (which identify "green occupations") risk underestimating the role of non-green and digital skills in achieving the green transition (Gasparini et al., 2025). The open question is whether green skills constitute an independent demand category or an increasingly complementary layer within a broader digital-technical skills base.

2.4. Sectoral and Industry Differences in the Impact of AI

The literature emphasises that AI's impact is highly heterogeneous across sectors. Gmyrek et al. (2023), in an ILO working paper, estimate the global exposure of occupations to generative AI using task descriptions from the ISCO-08 classification and the GPT-4 model, and conclude that for most occupations augmentation is more likely than full automation, with the greatest exposure among clerical jobs and more pronounced effects in higher-income countries; the refined version of the index (ILO Working Paper 140, 2025) introduces "exposure gradients" and estimates that about one quarter of the global workforce is in the zone of potential transformation due to generative AI (an institutional report methodologically based on task assessment). Felten et al. (2021), with their industry-specific measure (AIIE), empirically confirm that exposure to AI differs significantly across industries. Wang et al. (2024) add the dimension of sectoral and regional structure, showing that AI operates through the optimisation of industrial structure and produces spatial spillovers, whereby the effects are not uniform but depend on the attained level of economic development.

The literature agrees that there is no single "story" about AI's impact, outcomes vary by sector, task type, skill level, and geography, with routine and administrative sectors carrying a higher risk of substitution, while analytical, technical, and interpersonal ones predominantly record augmentation. The main difference in academic analyses is between approaches and methodologies applied: exposure studies (Gmyrek et al., 2023; Felten et al., 2021) estimate potential, whereas econometric studies (Wang et al., 2024) measure realised effects, which explains part of the divergence in conclusions. The common implication is that adaptation policies must be sector-differentiated.

2.5. Recent Empirical Evidence and the Regional Context

Recent empirical work reinforces and extends these themes. Analyses that separate tasks from jobs find that AI adoption reshapes the task content of work more than it eliminates whole jobs (Bonney et al., 2024), while reviews of automation technologies conclude that their employment effects are heterogeneous and contingent on skill level and sector (Filippi et al., 2023; Chun & Shin, 2025). Evidence on the dual character of AI shows that it simultaneously creates and displaces labour demand (Choi & Leigh, 2024), and a systematic review of generative AI confirms that the transformation of jobs, rather than their wholesale substitution, is the dominant expected outcome (Salari et al., 2025). On the green side, occupation- and flow-based evidence documents an ongoing greening of the labour market driven by changing occupational content and worker reallocation (Bachmann et al., 2026), consistent with the twin-transition reading advanced in this paper.

For the regional and Serbian context, the digital dimension of this transformation is well documented: digitalisation has been shown to raise economic growth, productivity, and employment (Arsić, 2020), while the Serbian labour market has undergone marked structural transformation, including along gender lines (Stanković, 2016), a dimension echoed by international evidence on the uneven exposure of women to AI. The coupling of the digital and green agendas is increasingly examined through regenerative-economy frameworks, both for Serbia specifically (Manasijević, 2024) and in terms of the broader principles linking sustainability to business practice (Sessa, 2025).

3. Research and Discussion

This subtitle subjects the three hypotheses formulated in the introduction to an empirical test against comparative indicators drawn exclusively from official statistical sources. It proceeds hypothesis by hypothesis: after a methodological note (3.1), Sections 3.2–3.4 present, for each hypothesis, the relevant tables and figures together with a discussion that reads the statistics against the scholarly literature. Section 3.5 synthesises the evidence and states, for each hypothesis, whether the official data confirm, partially confirm, or contradict it.

3.1 Methodological Note: Sources, Period, and Data Limitations

The analysis relies on two families of official sources. The first is Eurostat, the statistical office of the European Union, from which harmonised indicators for the aggregate "European Union – 27 countries (from 2020)" (EU-27) are drawn. The second is the International Labour Organization (ILO), whose institutional estimates and its

joint work with the International Renewable Energy Agency (IRENA) are used for the global picture and, in particular, for dimensions that Eurostat does not measure directly (occupational exposure to generative AI; worldwide renewable-energy employment).

The analysis covers the last ten available years. The operational window is 2014–2024 wherever the series allows (ICT specialists; enterprise recruitment of ICT specialists; employment by economic activity). For indicators with a shorter or interrupted coverage the exact period is stated at each table: individuals' digital skills (2015–2019 under the 2015 framework and 2021–2025 under the 2021 framework), and employment in the environmental goods and services sector (EGSS), for which the latest available year at the time of writing is 2022.

For the first hypothesis, H1 (a shift of employer demand towards digital, technical, and AI-complementary skills) the analysis uses employed ICT specialists (Eurostat *isoc_sks_itspt*), individuals' level of digital skills (*isoc_sk_dskl_i* / *isoc_sk_dskl_i21*), and enterprises' recruitment of and hard-to-fill vacancies for ICT specialists (isoc_ske_itrcrn2); the latter is read as a demand-side proxy for the skills mismatch that the ILO documents on the supply side. For the second hypothesis, H2 (the resilience of green skills) it uses employment in the EGSS (env_ac_egss1), broken down by environmental domain, complemented by the global ILO-IRENA renewable-energy employment estimate. For the third hypothesis, H3 (sectoral heterogeneity) it uses employment by NACE Rev. 2 economic activity (Eurostat Labour Force Survey, lfsa_egan22d), aggregated to NACE sections and grouped into "higher" and "lower" exposure sectors following the occupational-exposure literature.

For every indicator three simple trend measures are reported: the absolute change and the percentage change over the period, and, where meaningful, the compound annual growth rate (CAGR = (V_t / V_0) ^ $(1/n)$ - 1). Sectoral employment reported at the NACE two-digit (division) level was aggregated to the NACE section level (A-U) by the author; the "no-response" category and the very small sections T (household employers) and U (extraterritorial organisations) are excluded from the sectoral figure but not from the economy-wide total.

Regarding limitations, four caveats apply. First, break in series where the EU digital-skills indicator was redefined in 2021 (the DSK2 framework is not comparable with the pre-2021 DSK framework), so the two sub-periods must not be chained. Second, unit heterogeneity, where EGSS employment is measured in full-time equivalents (FTE) whereas total employment is measured in persons; the EGSS employment share reported here therefore relates FTE to persons and should be read as an approximation. Third, provisional and estimated values, i.e. the most recent Eurostat observations (notably 2024–2025) are partly estimated and may be revised. Fourth, and most important for interpretation, the official statistics measure employment stocks and skill supply, not the causal effect of AI as such; movements in these series are consistent with, but do not by themselves prove, an AI-driven mechanism. The discussion is framed accordingly, and the statistical signal is triangulated with the scholarly literature throughout.

3.2 The Shift of Employer Demand Towards Digital, Technical, and AI-Complementary Skills

Analysis of H1 holds that, under the influence of artificial intelligence, employers' requirements are shifting systematically from routine and procedural skills towards

technical, digital, and higher cognitive-social skills. Three official indicators speak to the demand side of this claim: the weight of ICT specialists in employment, the digital-skill endowment of the population, and the difficulty enterprises report in recruiting ICT specialists.

Table 1. Employed ICT specialists, EU-27, 2014–2024

Year	ICT specialists (% of total employment)	ICT specialists (thousand persons)
2014	3.4	6,334.5
2015	3.5	6,555.0
2016	3.6	6,919.5
2017	3.7	7,181.2
2018	3.8	7,570.4
2019	4.0	7,880.4
2020	4.3	8,442.4
2021	4.5	8,920.3
2022	4.6	9,370.1
2023	4.8	9,749.5
2024	4.9	10,189.9
Change 2014–2024 (abs.)	+1.5 pp	+3,855.4
Change 2014–2024 (%)	+44.1%	+60.9%
CAGR 2014–2024	3.72%/yr	4.87%/yr

Source: Eurostat, Employed ICT specialists (isoc_sks_itspt), unit "% of total employment" and "thousand persons", EU-27. Data extracted 12 July 2026. 2024 values are provisional. pp = percentage points; CAGR = compound annual growth rate. Calculations by the author.

Table 2. Individuals with at least basic overall digital skills, EU-27 (share of individuals aged 16–74)

Year	Basic or above-basic overall digital skills (%)	Measurement framework
2015	53.7	2015 framework (DSK)
2016	54.3	2015 framework (DSK)
2017	55.3	2015 framework (DSK)
2019	56.1	2015 framework (DSK)
2021	53.9	2021 framework (DSK2)
2023	55.6	2021 framework (DSK2)
2025	60.4	2021 framework (DSK2)

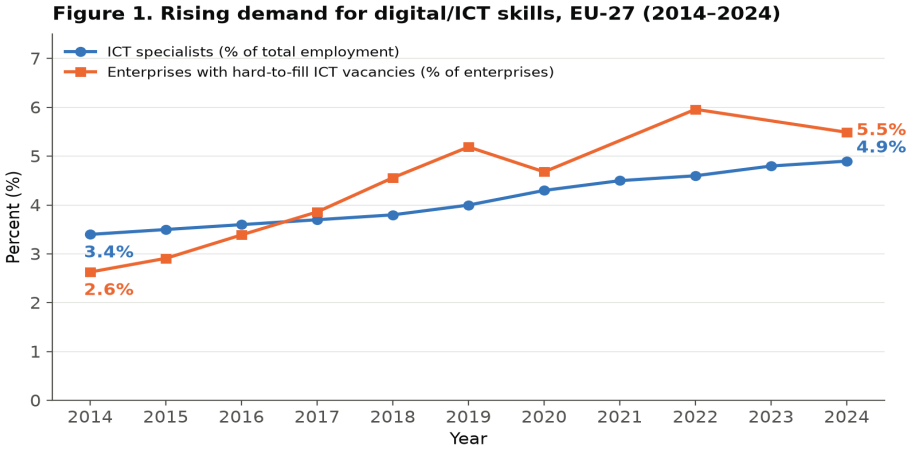
Source: Eurostat, Individuals' level of digital skills: isoc_sk_dskl_i (2015–2019) and isoc_sk_dskl_i21 (2021–2025), indicator "basic or above-basic overall digital skills", all individuals, EU-27. Data extracted 12 July 2026. Note the 2021 break in series: the two frameworks are not directly comparable.

Table 3. Enterprises and the recruitment of ICT specialists, EU-27, 2014–2024

Year	Enterprises that recruited / tried to recruit ICT specialists (%)	Enterprises with hard-to-fill ICT vacancies (%)
2014	7.08	2.63
2015	7.58	2.91
2016	7.92	3.39
2017	8.09	3.86
2018	8.49	4.56
2019	8.97	5.19
2020	8.47	4.68
2022	9.49	5.96
2024	9.55	5.49
Change 2014–2024 (abs.)	+2.5 pp	+2.9 pp
Change 2014–2024 (%)	+34.9%	+108.7%

Source: Eurostat, Enterprises that recruited or tried to recruit ICT specialists (isoc_ske_itrcrn2), enterprises with 10+ persons employed, all activities except finance, EU-27. Data extracted 12 July 2026. The survey is not conducted every year (no observation for 2013, 2021, 2023). Calculations by the author.

Figure 1. Rising demand for digital/ICT skills, EU-27 (2014–2024)



Source: author's elaboration on Eurostat isoc_sks_itspt and isoc_ske_itrcrn2 (EU-27), extracted 12 July 2026.

The three indicators converge on the same direction of travel. The number of ICT specialists in the EU-27 rose from 6,334.5 thousand in 2014 to 10,189.9 thousand in 2024, an absolute increase of about 3,855.4 thousand persons (60.9%, CAGR 4.87% per year), while their share of total employment climbed from 3.4% to 4.9% (Table 1, Figure 1). Because total employment grew by only 10.4% over the same decade (Section 4.4), ICT employment expanded roughly six times faster than the labour market as a whole. This is

the clearest possible statistical fingerprint of a structural re-weighting of demand towards technical and digital competencies, and not merely of general employment growth.

The supply of digital skills in the population moved in the same direction but far more slowly. Under the 2015 framework the share of individuals with at least basic overall digital skills rose only from 53.7% (2015) to 56.1% (2019); under the redefined 2021 framework it moved from 53.9% (2021) to 60.4% (2025), a gain of 6.5 percentage points (Table 2). Two readings follow. First, digital-skill supply is improving but remains a binding constraint: even on the most recent figure roughly four in ten adults still lack basic digital skills. Second, the gap between rapidly rising specialist demand (Table 1) and slowly rising general skill supply (Table 2) is precisely the condition under which recruitment difficulties should intensify, which is what Table 3 shows.

The share of enterprises that recruited or tried to recruit ICT specialists rose from 7.1% (2014) to 9.6% (2024, +34.9%), and, more tellingly, the share reporting hard-to-fill ICT vacancies more than doubled, from 2.6% to 5.5% (+108.7%, peaking at 6.0% in 2022). Read together, these figures describe a demand curve for digital talent shifting out faster than supply can follow: a labour-market tightness that operates as the demand-side counterpart of the qualification mismatch the ILO documents on the supply side.

These patterns align closely with the empirical literature. Studies of online vacancies find a broad-based rise in demand for AI and digital skills across almost all industries, concentrated in IT, engineering, science, and management, and carrying a distinct wage premium (Alekseeva et al., 2021). More recent vacancy-based work confirms that digital skills command a measurable pay premium, consistent with genuine scarcity rather than mere credential inflation (Garcia-Lazaro et al., 2025). Worker-level evidence from Germany similarly shows that exposure to AI is associated with shifts in task and skill composition and with wage effects that vary by the type of skills a worker holds (Engberg et al., 2025). The direction of adjustment is also consistent with Wang et al. (2024), who find that AI raises high- and medium-skilled employment while compressing low-skilled employment. At the same time, the literature qualifies a naive "more technical skills" reading: in occupations highly exposed to AI the most sought-after competencies are often managerial and analytical rather than narrowly technical (Green, 2024), and generative AI extends exposure to highly educated, cognitive profiles rather than sparing them (Eloundou et al., 2024). Where the official statistics and the literature diverge is on interpretation: Eurostat can show that specialist demand and recruitment difficulty are rising, but it cannot, on its own, separate an AI-specific effect from the broader digitalisation of the economy. On balance, the EU evidence supports H1 in its core claim, a systematic tilt of demand towards digital and technical skills, while leaving the finer point about the declining value of formal qualifications to be established by the vacancy-level studies (Bone et al., 2025).

3.3 The Resilience of Green Skills Under AI Transformation

H2 holds that green skills retain, and even increase, their relevance in the labour market, although their demand increasingly depends on complementarity with digital and technical skills. The most direct official measure of green employment is Eurostat's environmental goods and services sector (EGSS), which counts the labour input devoted to environmental protection and resource management across the whole economy.

Table 4. Employment in the environmental goods and services sector (EGSS), EU-27, 2014–2022

Year	EGSS employment (thousand FTE)	EGSS as % of total employment*
2014	4,165.0	2.22
2015	4,316.0	2.28
2016	4,393.0	2.28
2017	4,625.0	2.37
2018	4,795.0	2.43
2019	5,091.0	2.55
2020	5,307.0	2.70
2021	5,903.0	2.98
2022	6,673.0	3.29
Change 2014–2022 (abs.)	+2,508.0	+1.07 pp
Change 2014–2022 (%)	+60.2%	-
CAGR 2014–2022	6.07%/yr	-

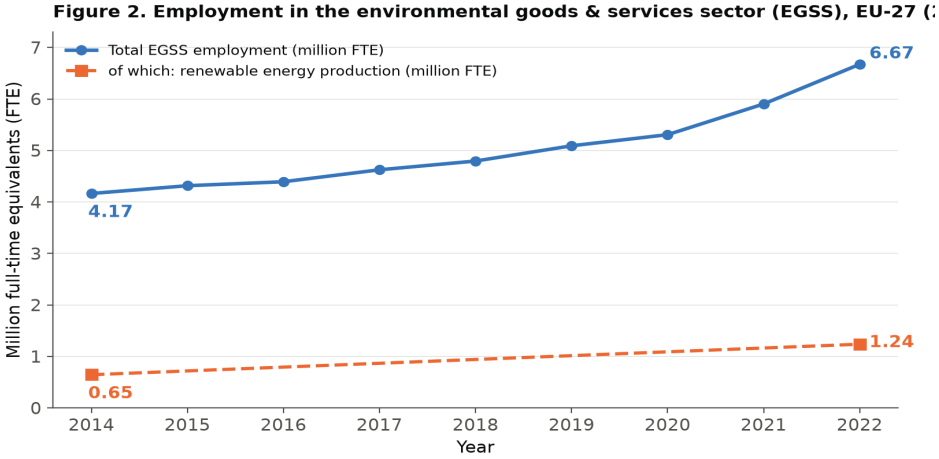
Source: Eurostat, Employment in the environmental goods and services sector (env_ac_egss1), unit full-time equivalents (FTE), EU-27; total employment from Eurostat lfsa_egan22d. Data extracted 12 July 2026.
**The share relates EGSS employment measured in FTE to total employment measured in persons and is therefore an approximation (see 3.1). Calculations by the author.*

Table 5. EGSS employment by environmental domain, EU-27, 2014 vs 2022 (thousand FTE)

Environmental domain	2014 (k FTE)	2022 (k FTE)	Change (%)	CAGR
Total EGSS	4,165	6,673	+60.2%	6.07%/yr
Environmental protection (CEPA, total)	2,571	3,826	+48.8%	5.09%/yr
- of which waste management (CEPA 3)	1,103	1,961	+77.8%	7.46%/yr
Resource management (CReMA, total)	1,594	2,847	+78.6%	7.52%/yr
- of which renewable energy production (CReMA 13A)	646	1,239	+91.8%	8.48%/yr
- of which heat/energy saving & management (CReMA 13B)	790	1,411	+78.6%	7.52%/yr

Source: Eurostat, env_ac_egss1 (EU-27), classification of environmental activities CEPA/CReMA. Data extracted 12 July 2026. Calculations by the author.

Figure 2. Employment in the environmental goods & services sector (EGSS), EU-27 (2014–2022)



Source: Author's elaboration on Eurostat env_ac_egss1 (EU-27), extracted 12 July 2026.

Green employment did not merely hold its ground during the decade of accelerating digitalization, it expanded strongly. EGSS employment in the EU-27 rose from 4,165 thousand FTE in 2014 to 6,673 thousand FTE in 2022, an increase of about 2,508 thousand FTE (+60.2%, CAGR 6.07% per year), lifting its share of total employment from 2.22% to 3.29% (Table 4, Figure 2). Against a whole-economy employment growth of about 10.4% over 2014–2024, EGSS employment grew several times faster, the opposite of what a 'crowding-out by digital skills' narrative would predict.

The domain breakdown (Table 5) shows that the growth is led precisely by the energy transition. Employment in renewable-energy production (CReMA 13A) almost doubled, from 646 to 1,239 thousand FTE (+91.8%), heat and energy saving (CReMA 13B) rose by 78.6%, and total resource-management employment increased by 78.6%; waste management (CEPA 3) grew by 77.8%. The EU picture is consistent with the global one: the ILO and IRENA estimate that worldwide renewable-energy employment reached a record 16.2 million jobs in 2023, up from 13.7 million in 2022 (an 18% year-on-year rise), with the EU accounting for about 1.8 million (ILO & IRENA, 2024).

The literature helps interpret why this expansion supports, rather than contradicts, the AI transformation story. Green jobs have long been shown to be skill-intensive, drawing more heavily on higher cognitive and interpersonal skills and on formal education than comparable non-green jobs (Consoli et al., 2016). Crucially, recent work finds that the green transition rests less on narrowly 'green' expertise than on the coupling of green and digital competencies: re-examining official taxonomies, Gasparini et al. (2025) conclude that digital skills are often more decisive than strictly green ones for the energy transition, while systematic evidence from manufacturing identifies a common core of digital, specialised-technical, and resilience skills required for the 'twin'

green-digital transition (Hofmann Trevisan et al., 2024). Vacancy-based evidence points the same way: the number of UK job advertisements requiring at least one green skill grew by roughly 67% between 2018 and mid-2024, and employers increasingly hire for green and AI roles on a skills basis rather than by formal degree (Bone et al., 2025). The official EU statistics and the literature therefore agree on the central point of H2, green skills are resilient and rising, and they jointly refine it: the demand is real but increasingly hybrid, realised through the twin transition rather than as an autonomous 'green' category. H2 is thus confirmed in its first clause and supported in its conditional clause about complementarity with digital and technical skills.

3.4. Sectoral Heterogeneity in the Impact of AI

The H3 holds that AI's impact on the labour market is sector-differentiated: substitution should predominate where routine tasks are concentrated, and augmentation and rising skill complexity where analytical, technical, and interpersonal tasks prevail. Employment by economic activity (NACE Rev. 2) over 2014–2024 provides a direct test of whether the labour market has in fact diverged across sectors, and in the direction the exposure literature predicts.

Table 6. Employment by economic activity (NACE Rev. 2 section), EU-27, 2014 and 2024

NACE section	2014 (thousand persons)	2024 (thousand persons)	Abs. change	% change	CAGR
J – Information and communication	5,207.5	8,026.2	+2,818.7	+54.1%	+4.42%
M – Professional, scientific, and technical	9,726.3	12,515.9	+2,789.6	+28.7%	+2.55%
L – Real estate activities	1,475.0	1,839.6	+364.6	+24.7%	+2.23%
R – Arts, entertainment, and recreation	2,916.1	3,618.6	+702.5	+24.1%	+2.18%
E – Water supply; sewerage, waste management	1,451.3	1,738.7	+287.4	+19.8%	+1.82%
D – Electricity, gas, steam, and air conditioning	1,411.4	1,688.1	+276.7	+19.6%	+1.81%
Q – Human health and social work	19,540.0	23,344.3	+3,804.3	+19.5%	+1.79%
I – Accommodation and food service	8,337.9	9,953.1	+1,615.2	+19.4%	+1.79%
P – Education	13,346.4	15,422.4	+2,076.0	+15.6%	+1.46%
H – Transportation and storage	9,663.9	11,146.4	+1,482.5	+15.3%	+1.44%
S – Other service activities	4,511.6	5,159.6	+648.0	+14.4%	+1.35%
F – Construction	12,568.2	14,243.3	+1,675.1	+13.3%	+1.26%
N – Administrative and support services	7,587.6	8,536.9	+949.3	+12.5%	+1.19%
O – Public administration and defence	13,262.4	14,381.2	+1,118.8	+8.4%	+0.81%

K – Financial and insurance activities	5,271.7	5,626.2	+354.5	+6.7%	+0.65%
G – Wholesale and retail trade; repair	26,566.6	27,752.0	+1,185.4	+4.5%	+0.44%
C – Manufacturing	30,657.1	31,689.2	+1,032.1	+3.4%	+0.33%
B – Mining and quarrying	707.7	567.1	-140.6	-19.9%	-2.19%
A – Agriculture, forestry, and fishing	9,872.9	6,876.0	-2,996.9	-30.4%	-3.55%

Source: Eurostat, Employment by sex, age and economic activity (lfsa_egan22d), persons aged 15+, both sexes, EU-27; two-digit divisions aggregated to NACE sections by the author. Data extracted 12 July 2026. Sorted by percentage change (descending). 2024 values are provisional.

Table 7. Employment change in higher- vs lower-AI-exposure sector groups, EU-27, 2014–2024

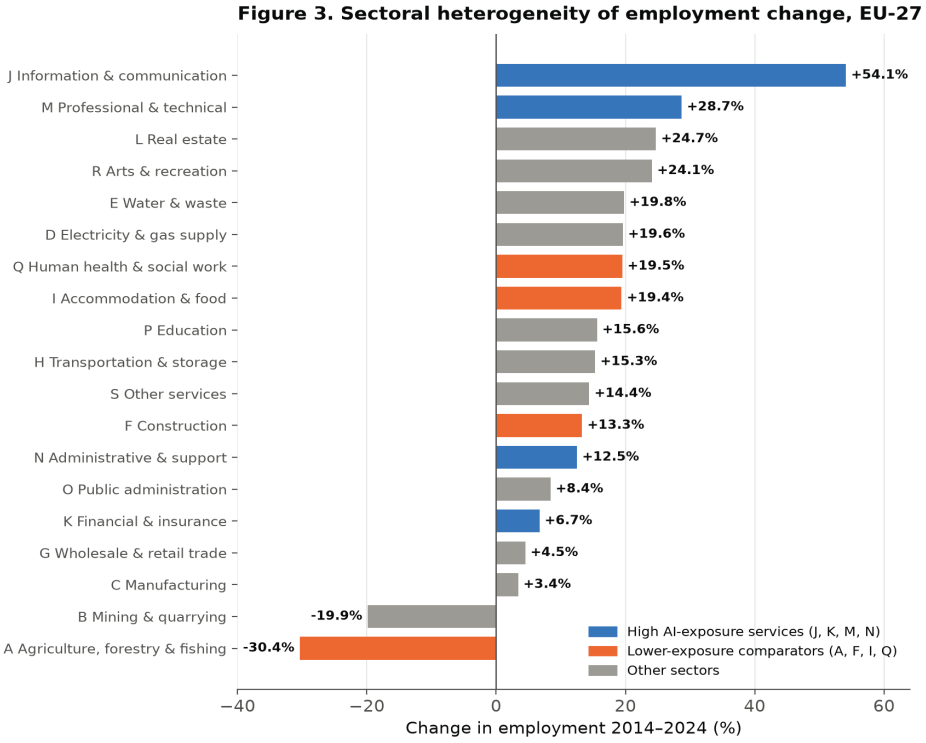
Sector group	2014 (thousand persons	2024 (thousand persons	Abs. change	% change	CAGR
Higher-exposure services (J, K, M, N)	27,793.1	34,705.2	+6,912.1	+24.9%	+2.25%
Lower-exposure comparators (A, F, I, Q)	50,319.0	54,416.7	+4,097.7	+8.1%	+0.79%
Whole economy (all NACE)	187,644.4	207,172.7	+19,528.3	+10.4%	+0.99%

Source: author's elaboration on Eurostat lfsa_egan22d (EU-27), extracted 12 July 2026. The higher-exposure grouping follows the occupational-exposure literature (Felten et al., 2021; Gmyrek et al., 2023, 2025); it is indicative, not an official Eurostat classification.

The decade's employment growth is strikingly uneven across sectors (Table 6, Figure 3). At one extreme, information and communication (J) expanded by 54.1% (CAGR 4.42%) and professional, scientific and technical activities (M) by 28.7% (CAGR 2.55%); at the other, agriculture (A) contracted by 30.4% and mining (B) by 19.9%, while manufacturing (C, +3.4%) and wholesale and retail trade (G, +4.5%) barely moved. The within-J detail is even more revealing: computer programming and consultancy (division J62) more than doubled, from about 2,354 to 4,981 thousand persons, a direct labour-market imprint of digitalisation and AI adoption.

Aggregating sectors into indicative exposure groups sharpens the contrast (Table 7). The higher-exposure services (J, K, M, N) added about 6.9 million jobs (+24.9%, CAGR 2.25%), growing more than twice as fast as the whole economy (+10.4%) and about three times faster than the lower-exposure comparator group of agriculture, construction, accommodation, and health (+8.1%, CAGR 0.79%). This is the pattern H3 anticipates: the analytically and technically intensive service sectors expanded and up-skilled, consistent with an augmentation regime in which AI raises the productivity of, and demand for, higher cognitive-technical labour.

Figure 3. Sectoral heterogeneity of employment change, EU-27 (2014–2024)



Source: author's elaboration on Eurostat lfsa_egan22d (EU-27), extracted 12 July 2026. Colour groups are indicative (see Table 7).

The data also reveal an important nuance that a simple 'high-exposure grows, low-exposure shrinks' reading would miss. Exposure and growth are not identical. Within the high-exposure group, financial and insurance activities (K) grew only 6.7%, far below ICT and professional services, consistent with the substitution of routine back-office and clerical tasks, the very tasks the ILO identifies as most exposed to generative AI. Administrative and support services (N) likewise grew modestly (+12.5%). Conversely, several lower-exposure sectors grew briskly for reasons largely unrelated to AI: human health and social work (Q, +19.5%) reflects population ageing and rising care demand, and construction (F, +13.3%) reflects the investment cycle. Agriculture's steep decline is a long-run structural and mechanisation trend that predates AI. The sectoral signal is therefore consistent with H3, but it reflects the joint operation of AI-related task effects and non-AI structural forces (demography, the business cycle, and long-run sectoral shift).

This reading matches the literature. Felten, Raj, and Seamans (2021) show that exposure to AI differs markedly across industries, and the ILO's global exposure estimates find that clerical occupations carry the highest exposure while, for most occupations, transformation (augmentation) is more likely than outright automation; about one in four workers worldwide

is in an occupation with some generative-AI exposure, with the highest-exposure category concentrated in high-income countries (34% of employment) far more than in low-income countries (11%) (Gmyrek et al., 2023; Gmyrek et al., 2025). The baseline substitution logic evidenced for industrial robots (Acemoglu & Restrepo, 2020) plausibly underlies the weak growth of routine-intensive activities such as manufacturing and parts of finance, whereas the recomposition and skill-upgrading emphasised by Wang et al. (2024) matches the surge in ICT and professional services. Where the official statistics add value is in showing that these divergent effects are already visible in realised EU employment stocks, not merely in estimates of potential exposure. H3 is thus confirmed: AI's labour-market impact is sector-differentiated, with augmentation predominating in analytical-technical services and substitution pressure concentrated in routine-intensive activities, even though the observed employment outcomes also embed non-AI structural drivers.

3.5. Synthesis of Findings

Taken together, the official statistics tell a consistent story across the three hypotheses. On H1, the EU data show an unmistakable re-weighting of demand towards digital and technical skills: ICT specialists grew from 3.4% to 4.9% of employment and from 6.3 to 10.2 million persons (+60.9%), roughly six times faster than total employment, while the doubling of hard-to-fill ICT vacancies against only slowly rising general digital-skill supply signals a persistent demand supply gap. H1 is confirmed in its core claim. On H2, far from being crowded out, green employment expanded by 60% (EGSS, 2014–2022), led by renewable-energy and energy-management jobs, and the global ILO-IRENA count reached a record 16.2 million in 2023; the literature clarifies that this resilience is increasingly realised through the twin green-digital transition. H2 is confirmed, with its complementarity clause supported. On H3, employment growth diverged sharply across sectors, higher-exposure analytical-technical services grew about three times faster than lower-exposure comparators, in a pattern of augmentation-versus-substitution that matches the exposure literature. H3 is confirmed, with the caveat that realised sectoral outcomes also reflect demography, the business cycle, and long-run structural change.

Two cross-cutting conclusions emerge. First, the three transformations are not separate: the same digital-technical skill base that drives H1 also conditions the green employment of H2 and shapes the sectoral divergence of H3, the labour market is being reorganised around a common digital-analytical core. Second, the binding constraint visible throughout the EU data is on the supply side: specialist demand, recruitment difficulty, and green-and-digital hybrid roles are all rising faster than the population's skills are adjusting. This frames the policy implication developed in the next chapter, that education and active-labour-market policy must treat digital, green, and AI-complementary skills as an integrated agenda rather than as competing priorities.

4. Conclusion

This paper set out to determine how artificial intelligence is reshaping the needs of the labour market when those needs are viewed through the prism of skills rather than the mere number of jobs. Guided by three research questions, how employer demand for skills is changing, whether green skills remain relevant, and how differentiated AI's

impact is across sectors, it combined a thematic review of the recent scholarly literature with an empirical analysis of official statistics from Eurostat and the International Labour Organization (ILO) for the last available decade. This concluding chapter draws the two strands together, states the status of each hypothesis, distils the overarching conclusions, and sets out the implications and limitations of the study.

The shift of employer demand towards digital, technical, and AI-complementary skills (H1), is confirmed. The convergence of the statistical indicators is unambiguous. In the EU-27 the number of ICT specialists rose from about 6.3 to 10.2 million between 2014 and 2024 (+60.9%), lifting their share of employment from 3.4% to 4.9%, roughly six times faster than total employment grew, while the share of enterprises reporting hard-to-fill ICT vacancies more than doubled (from 2.6% to 5.5%). These demand-side signals track the literature closely: vacancy-based studies document a broad, cross-industry rise in demand for AI and digital skills and a distinct wage premium for them (Alekseeva et al., 2021; Garcia-Lazaro et al., 2025; Popović et al., 2025), and worker-level evidence confirms that AI exposure reshapes task and skill composition (Engberg et al., 2025). The literature also refines the hypothesis in one respect: the most sought-after competencies in AI-exposed roles are frequently analytical and managerial rather than narrowly technical (Green, 2024), and generative AI extends exposure to highly educated cognitive profiles instead of sparing them (Eloundou et al., 2024). The official statistics can establish that demand is tilting decisively towards digital and technical skills, but not, on their own, isolate an AI-specific mechanism from broader digitalisation.

The resilience of green skills (H2) is confirmed, and its conditional clause about complementarity with digital and technical skills is supported. Far from being crowded out by the digital transition, employment in the environmental goods and services sector expanded by 60.2% between 2014 and 2022 (from 4.17 to 6.67 million full-time equivalents), with renewable-energy employment almost doubling (+91.8%); at the global level, the ILO and IRENA report a record 16.2 million renewable-energy jobs in 2023. The literature clarifies the nature of this resilience: green jobs are skill-intensive (Consoli et al., 2016), yet the transition increasingly rests on digital as much as on narrowly 'green' expertise (Gasparini et al., 2025) and demands a hybrid skill set characteristic of the 'twin' green-digital transition (Hofmann Trevisan et al., 2024; Bone et al., 2025). Green skills therefore endure not as an autonomous category but as an increasingly integrated layer within a broader digital-technical base.

The sectoral heterogeneity of AI's impact (H3) is confirmed, with an important qualification. Employment growth over 2014–2024 diverged sharply across sectors: information and communication grew by 54.1% and professional and technical services by 28.7%, while agriculture contracted by 30.4% and mining by 19.9%. Grouped by exposure, analytically and technically intensive services grew about three times faster than lower-exposure comparators (+24.9% versus +8.1%), matching the augmentation-versus-substitution logic of the exposure literature (Felten et al., 2021; Gmyrek et al., 2023, 2025) and the robot-substitution baseline (Acemoglu & Restrepo, 2020). The qualification is that realised employment reflects more than AI: the weak growth of finance points to the automation of routine back-office tasks, but the strong growth of health and social work reflects population ageing, and agriculture's decline is a long-run structural trend. Sectoral outcomes thus embed AI-related task effects together with demography, the business cycle, and structural change.

Two conclusions cut across the three hypotheses. The first is that the digital, green, and sectoral transformations are not separate phenomena but expressions of a single re-organisation of work around a common digital-analytical core. The same technical and cognitive skill base that drives the rise of ICT specialists (H1) also conditions the expansion of green employment (H2) and shapes which sectors grow and up-skill (H3). This is why the 'competition' between the digital and the green transition that the introduction posed as an open question is, on the evidence, better understood as a coupling: the two transitions draw on overlapping competencies and advance together rather than at each other's expense.

The second conclusion is that the binding constraint throughout the EU data lies on the supply side. Specialist demand, recruitment difficulty, and hybrid green-and-digital roles are all rising faster than the population's skills are adjusting, even on the most recent figures roughly four in ten adults still lack basic digital skills. The central labour-market risk identified by this paper is therefore not mass technological unemployment but a widening and persistent skills gap, whose distributional edge is sharp: the ILO's estimates show that exposure to generative AI is concentrated in higher-income countries and, within them, disproportionately in jobs held by women (Gmyrek et al., 2025). The transformation is real, but its costs and benefits are unevenly distributed.

These findings carry direct implications for policy. First, education and training systems should treat digital, green, and AI-complementary competencies as a single, integrated agenda rather than as competing priorities, embedding them across curricula rather than confining them to specialist tracks. Second, because employers increasingly hire on the basis of demonstrable skills and place less weight on formal degrees (Bone et al., 2025), credentialing should move towards modular, stackable, and verifiable qualifications, backed by genuine lifelong-learning infrastructure that reaches adults already in the workforce, the group least served by initial education. Third, active labour-market policy should be sector-differentiated: reskilling effort should be concentrated where substitution pressure is greatest (routine back-office and clerical roles in finance and administration, and routine manufacturing), while capacity is scaled in the expanding analytical-technical and care sectors. Fourth, the coupling of the two transitions argues for aligning green-transition and digital-skills strategies within a single 'just and twin transition' framework that anticipates the distributional effects across genders, regions, and levels of development. For transition economies such as Serbia, where the competitiveness and inclusiveness of the labour market depend on the timely adjustment of skills, the priority is to close the digital-skills gap early and to build the green-digital hybrid competencies on which future employment will increasingly rest.

The conclusions must be read against the study's limitations. The official statistics measure employment stocks and skill supply, not the causal effect of AI as such; the observed movements are consistent with, but do not prove, an AI-driven mechanism, and they embed non-AI structural forces. Several data caveats also apply: the EU digital-skills series has a break in 2021, EGSS employment is measured in full-time equivalents while total employment is in persons, the most recent observations are partly provisional, and the EU-27 aggregate conceals substantial cross-country heterogeneity. Because the diffusion of generative AI accelerated only after 2022, much of its labour-market imprint post-dates the available series and remains to be measured.

Three avenues for future research follow. First, causal, worker- and firm-level designs, of the kind pioneered on matched administrative data, are needed to separate

the AI-specific effect from general digitalisation and from structural change. Second, task-level tracking as generative AI diffuses would test whether the augmentation regime documented here persists or gives way to greater substitution among cognitive occupations. Third, the measurement of green-digital skill complementarity, through richer occupational taxonomies (ESCO/O*NET), and targeted country case studies, including transition economies, would ground the twin-transition thesis in the specific institutional and educational contexts where policy is made.

The evidence assembled in this paper supports a clear overall proposition: artificial intelligence is not primarily eliminating work but recomposing it, reorganising the labour market around a digital, analytical, and increasingly green skill core, and doing so unevenly across sectors and social groups. Whether this recomposition proves inclusive or divisive will depend less on the technology itself than on the speed and equity with which education and labour-market institutions adjust the supply of skills. That, rather than the question of how many jobs AI will destroy, is the decisive policy challenge of the coming decade.

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