

Economic Horizons



Faculty of Economics, University of Kragujevac, Serbia
ISSN 1450-863X eISSN 2217-9232 2025 27 (2)

Efayena, O. O.

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Economic Horizons



Faculty of Economics
University of Kragujevac, Serbia

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Print

InterPrint, Kragujevac

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The Journal is abstracting and indexing in:

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EBSCO, DOAJ, Index Copernicus,
ProQuest - ABI/INFORM, Ulrich's Web**

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THE JOURNAL IS PUBLISHED THREE TIMES A YEAR - in April, August and December

ISSN 1450-863X

eISSN 2217-9232

UDC 33

COBISS.SR-ID 158022663

Economic Horizons



Faculty of Economics
University of Kragujevac, Serbia

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EDITORIAL

After conducting a double-blind peer review process, the Issue 2 Volume 27 Year 2025 of the scientific journal called *Economic Horizons* contains five original scientific papers, one review paper and the Acknowledgement to the reviewers of the manuscripts submitted to the Editorial Board of the Journal in 2024.

The author *Radovan Kovačević* investigates the export performance of the CEFTA 2005 countries (namely Albania, Bosnia and Herzegovina - BiH, Montenegro, Kosovo* (UNMIK, according to the United Nations Security Council Resolution 1244), Moldova, North Macedonia and Serbia), using the ARDL (Autoregressive Distributed Lag) model. By applying the F-Bound ARDL test for the period from 2000 to 2022, the existence of a long-term equilibrium relationship between the real export of the goods and services of the CEFTA 2006 member countries and the selected variables (the net inflow of foreign direct investment (FDI), the real effective foreign-exchange rate, trade liberalization and the share of domestic bank loans granted to the private sector) was determined as such. The export performances mainly depend on the degree of trade openness (in the majority of the member countries), then the real effective foreign-exchange rate (BiH, Kosovo*, Serbia), whereas the net inflows from FDI (with the exception of Serbia) and the domestic bank loans granted to the private sector (with the exception of Kosovo*) are less significant. The author, *inter alia*, concludes that a further liberalization of trade primarily through the abolishment of the remaining non-tariff measures may significantly accelerate the flow of goods and services and lead to the growth of the real export of the CEFTA 2006 member countries.

The coauthors *Obukohwo Oba Efayena*, *Jonathan Ojarikre Oniore* and *Ngozi Patricia Buzugbe* investigate the moderating influence of institutional quality on the relationship between the financial structure (FS) and economic growth in 33 Sub-Saharan African (SSA) economies from 2006 to 2022. Classifying the mentioned economies by the amounts of their respective income,

the coauthors apply the two-step fixed-effects generalized method of moments. The results indicate that, among the low-income countries, the bank-oriented countries record lower rates of economic growth, whereas higher rates of economic growth are present in the market-oriented countries. Among the middle-income economies, the financial structures of the bank-(market-) oriented countries are associated with a higher (lower) level of economic growth. A fact is established in the paper that institutional quality does not spur the positive influence of the financial structure on economic growth. Simultaneously, institutional quality mitigates the growth effects of the financial structures in the middle-income economies and significantly exacerbates the already low economic growth of the low-income economies. The paper recommends that institutional quality strengthening policies should be adopted and that the synergy between the banking sector and the capital market should be increased.

Starting with the attitude that stable energy supply is significant for all economies, the coauthors *Selim Gungor* and *Muge Saglam Bezzin* investigate the influence of energy uncertainty on the volatility of the share markets of the 18 developed and developing countries that are ranked among the wealthiest according to the amount of their respective gross domestic product (GDP). The paper examines how the Energy Uncertainty Index influences the market dynamics and volatility patterns across different economies. The analysis of the market indices in the period from January 2023 to October 2022 was being carried out using the GARCH-MIDAS approach. The research results are indicative of the fact that the Energy Uncertainty Index does influence all share market indices. The Energy Uncertainty Index influences the least the volatility of the Canadian market, whereas the highest MIDAS component weights are perceived in the Chinese market and the United Kingdom's market. The Energy Uncertainty Index influences the most the volatility of the Indian and Chinese markets, whereas that influence is minimal when Brazil's and Canada's markets are concerned.

Pursuant to the attitude that modern customer loyalty programs are increasingly based on new technologies and forms of rewards, the coauthors *Svetlana Sokolov*

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Mladenović, Suzana Đukić and Jelena Stanković investigate the influence of mobile applications on consumer trust and loyalty in omnichannel retail. The research draws on Self-Determination Theory to explain the influence of autonomy, competence and relatedness as consumers' key needs on their trust and loyalty. The results of the empirical research conducted using the survey method and applying the structural equation modeling indicate that mobile applications significantly influence consumer loyalty, and moderators such as years of age and membership duration in the loyalty program play a significant role in this process. The research results suggest that consumers value more the mobile applications that provide them with a sense of control over the purchasing process, strengthen their existing competences and enable them to acquire new ones, simultaneously enabling them to connect with the other members of the program and establish friendships with them.

Analyzing transfer prices as a strategic tool for the optimization of the business performances and reduction in the tax burden of related entities in the Republic of Srpska, the coauthors *Ljiljana Ž. Tanasić, Srđan M. Lalić, Željana Jovičić and Teodor M. Petrović* endeavor to quantitatively assess the impact of these prices on the achievement of the key business goals. The goals mentioned pertain to the improvement of financial performance, the minimization of tax burden and the strategic allocation of resources. The empirical data for the research were collected from the Register of Financial Statements for the year 2023. The relationship between the application of transfer prices and the financial and tax positions of the related entities was examined using the Linear Regression Model. The research results show a significant and positive influence of transfer prices on the improvement of the financial and tax positions of the related entities, especially those doing business in several tax jurisdictions. Based on the results obtained, the coauthors recommend that the national regulatory framework should be harmonized with international guidelines.

Starting with the attitude that the ability to create

engaging and relevant content is a key success factor in digital marketing, the author *Jelena Šidanski* uses the Analytical Hierarchy Process (AHP) method to compare human performances with those of Artificial Intelligence in creating the aforementioned content. Artificial Intelligence may either assist or fully manage the content creation process, helping marketing experts to improve work processes and results. In the paper, the AHP method is applied to evaluate the alternatives, i.e. humans, artificial intelligence and a combination of the two approaches, all aimed at improving content production based on the criteria of creativity, speed, costs, content quality, adaptability and conversion. The research results indicate that marketing experts consider humans to be the most efficient in content creation, particularly in creativity, content quality, adaptability and conversion. Although a combination of humans and artificial intelligence offers advantages in cost efficiency and speed, it does not surpass the approach fully based on humans.

Issue 2 Volume 27 Year 2025 contains the Acknowledgement to the reviewers of the manuscripts submitted to the Editorial Board during 2024, of which those positively rated in the double-blind peer review process have been published in the Journal as the original scientific and review papers.

On behalf of the Editorial Board and on my own behalf, I hereby thank the authors of the contributions published in Issue 2 of the Journal. Simultaneously, our special gratitude goes to the reviewers, whose constructive and critical comments and suggestions to the authors of the submitted manuscripts have contributed to raising the level of the quality of the published papers.

The publishing of the journal *Economic Horizons* is financially supported by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia, Decision number: 451-03-4946/2024-03/2 as of 29th April 2025.

Milena Jakšić
Editor-in-Chief

Milena Jakšić is a full professor teaching at the Faculty of Economics of the University of Kragujevac. She earned her PhD degree at the Faculty of Economics of the University of Kragujevac in the narrow scientific field of general economics and economic growth. The key areas of her scientific and research interests are the financial system, financial markets, financial instruments and financial institutions.

Original scientific paper

UDC: 339.743:330.322
doi:10.5937/ekonhor2502099K

THE EXPORT PERFORMANCE OF THE CEFTA COUNTRIES - AN ARDL MODEL-BASED EMPIRICAL ANALYSIS

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The paper investigates the export performance of the CEFTA 2006 countries (Albania, Bosnia and Herzegovina - BiH, Montenegro, Kosovo* (UNMIK, according to the United Nations Security Council Resolution 1244), Moldova, North Macedonia and Serbia)), using the ARDL (Autoregressive Distributed Lag) model. By applying the F-Bound ARDL test for the period from 2000 to 2022, the existence of a long-term equilibrium relationship between the real exports of the CEFTA 2006 members and the selected variables was determined, the results indicating differences in the significance of certain variables in the long run. Export performance mainly depends on the degree of trade openness (for most members), then the real effective exchange rate (BiH, Kosovo*, Serbia), while the net inflow of FDI (except Serbia) and the domestic bank loans granted to the private sector are less important (with the exception of Kosovo*).

Keywords: export, exchange rate, foreign direct investments, ARDL, trade openness, co-integration

JEL Classification: C22, F10, F14, F21

INTRODUCTION

CEFTA 2006 (Central European Free Trade Agreement) represents a free trade zone that includes a group of countries (Albania, BiH, Montenegro, Kosovo*, Moldova, North Macedonia and Serbia) and has recorded a significant increase in the export of goods and services in recent years. The creation of

this free trade zone was intended to promote mutual trade between the members and prepare them for joining the European Union (EU). CEFTA 2006 initially included Romania, Bulgaria and Croatia, in addition to the mentioned current members. These three countries left CEFTA 2006 membership when they became EU members. Therefore, CEFTA 2006 includes the Western Balkan countries and Moldova today. Given the similarities and differences in available resources, the structure of trade reflects the structure of the economy and the availability of resources. Exports are extremely important for all CEFTA 2006 members because they all record a

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trade deficit as a prominent feature of their balance of payments. Trade deficits cause a current account deficit, which must be covered by the capital inflow either from abroad or from foreign exchange reserves. Due to the importance of exports for the balance of payments performance, all CEFTA 2006 members are interested in the growth of exports. The abolition of tariffs in mutual trade has contributed to the dynamic growth of the exports of all the members and the ongoing efforts to abolish the remaining non-tariff measures, which hinder trade, may further stimulate export growth.

Figure 1 in the Appendix shows the harmonized movement of the real exports of goods and services leaving the CEFTA 2006 members. The real growth of exports in the years before the outbreak of the COVID-19 pandemic and the coordinated decline during the crisis, as accompanied by the recovery after the crisis, are noticeable. The equalization of the economic conditions in the CEFTA 2006 members, as well as the growth of mutual trade, significantly contribute to mitigating the impact of external shocks on each member, such as the crisis caused by the COVID-19 pandemic. In addition to strengthening competition, the bigger the market within the CEFTA 2006 zone, the bigger the chances of each country to find a way out in mutual trade in the case of external difficulties. The further harmonization of the procedures and the mutual acceptance of the certificates accompanying trade can contribute to a deeper mutual integration of all CEFTA 2006 members. According to the OECD (2024), regional cooperation between the countries of the Western Balkans is essential for achieving convergence towards the EU.

Export performance is significant for each country because, through the balance of payments, it also affects economic growth and economic development. In addition, all CEFTA 2006 members are in the process of joining the EU and the abolition of the remaining restrictions on mutual trade should strengthen competition within the zone, thus facilitating integration into the EU market. Trade liberalization also encourages financial flows, which can contribute to enhancing CEFTA 2006 trade flows and intra-EU trade. Trade between CEFTA 2006

members tends to grow, and some countries (such as Serbia) have a marked trade surplus in trade with other CEFTA 2006 members. The growth of mutual trade can help a stronger convergence of the income of the Western Balkans countries and the EU, while the results in terms of convergence have been different between the countries so far (Stanišić, 2016).

Figure 2 in the Appendix shows the recent trends in merchandise trade between the CEFTA 2006 members, according to which it can be concluded that a significant jump was made in mutual trade between the CEFTA 2006 members after the outbreak of the COVID-19 pandemic. In the beginning, that was contributed to by the new circumstances. Due to the difficulties in transporting goods during the COVID-19 pandemic, the regional "Green Corridors" initiative was launched to facilitate the rapid flow of goods during the pandemic. The initiative has helped to facilitate trade. The intensification of cooperation and coordination in customs reduces trade costs and ensures continuous supply, for which reason this initiative was continued even after the end of the COVID-19 pandemic. The dependence of the less developed CEFTA 2006 members on regional supply chains promotes reciprocal trade. The euro-denominated growth in two-way trade within CEFTA in 2006 is partly due to the inflationary trends that have had an impact on the increase in trade value at relatively stable exchange rates.

The subject matter of the research conducted in this paper implies the export performance of the CEFTA 2006 members and the connection between the real export of the goods and services of these countries and the relevant macroeconomic variables. The paper aims to analyze the role and significance of the selected macroeconomic variables for the export performance of the CEFTA 2006 members, using the ARDL cointegration model. The basic research hypotheses of the paper read as follows:

- H1: Trade liberalization significantly affects the trade performance of the CEFTA 2006 members.
- H2: The impact of net FDI inflows and the real effective exchange rate on export varies between the CEFTA 2006 members.

The initial hypotheses were tested using the F-bound ARDL test for the period from 2000 to 2022. The empirical analysis carried out in this paper has confirmed the existence of a cointegration relationship between the real exports of the goods and services of all the CEFTA 2006 members and the selected macroeconomic variables. The estimated coefficients of the long-term relationship between exports and the explanatory variables reveal differences between the CEFTA 2006 members with respect to the importance of certain explanatory variables. In most member states, export performance mainly depends on trade openness, which leads to the recommendation to policymakers to increase activities to remove the remaining barriers to free trade, especially those coming from the non-tariff complex.

This study contributes to the existing literature in three ways. First, the study provides an empirical insight into the characteristics of the dynamics of the real exports of goods and services and the relevant macroeconomic factors of the CEFTA 2006 members. Second, the cointegration of the integrated variables of the orders $I(0)$ or $I(1)$ is tested using the ARDL bounds test model, which overcomes the limitation of the traditional cointegration tests assuming that all the variables in the model are integrated with the order $I(1)$. The ARDL model is additionally suitable for shorter time series, as is the case in this analysis. Third, the estimated long-term relationships between exports and the explanatory variables suggest that policymakers should act towards achieving greater trade openness since trade expansion contributes to the gross domestic product (GDP) growth and the welfare of a country.

The paper is structured into five sections. After the introduction, the second section provides a literature review. The third section refers to the description of the data used and the presentation of the applied methodology in the empirical research, the results of which are given in the fourth section. The conclusion is given in the fifth section.

LITERATURE REVIEW

The contribution of the ARDL methodology-based empirical research in the literature reflects in the identification of the direction and intensity of the influence of certain variables on the real export of a country, group of countries, or regions. To the best of the author's knowledge, the ARDL methodology has not been used in research in the export performance of the CEFTA 2006 members, so he believes that this research study makes a contribution to the current research in the export of goods and services of the CEFTA 2006 countries.

Recent studies have confirmed that the CEFTA 2006 member countries' exports have increased after the Agreement entered into force. R. Dragutinović-Mitrović and P. Bjelić (2015) applied the gravity approach to determine the extent to which CEFTA contributed to trade growth, the results of their study showing that this agreement has contributed to a 44% increase in reciprocal trade between the members.

L. Klimczak and J. Trivić (2018) analyzed the influence of various factors on mutual trade between the CEFTA 2006 members by applying an extended gravity model based on the CEFTA 2006 countries' panel data. The results of this study show that the CEFTA 2006 Agreement plays a positive and statistically significant role for mutual trade between the member countries.

M. Petreski (2018) also analyzed the impact of the 2006 CEFTA Agreement on the mutual trade between the member countries and found a big and statistically significant impact. Taking into account the endogeneity problem, the author estimates that the impact of the Agreement on trade exceeds 50%. In addition to the GDP and the proximity of the countries, the author opines that this was also influenced by the commitment of the member governments to standardize the conditions for faster EU accession.

Using the gravity model for trade, P. Kaloyanchev, I. Kusen and A. Mouzakitis (2018) showed that trade within CEFTA 2006 was determined by the level of economic activity and that non-tariff barriers

significantly reduced reciprocal trade. Contrary to expectations, geographic proximity did not prove to be a statistically significant variable influencing trade dynamics. The results of this study indicate a low level of trade openness in most countries in the region.

J. Choi and A. Minondo (2019) estimated that CEFTA 2006 had significantly contributed to the increase in the exports of Albanian companies using the gravity model, which was mainly due to the reduction in tariffs in the CEFTA 2006 Agreement.

R. Grieveson, M. Holzner and G. Vukšić (2021) found that the CEFTA 2006 Agreement had significantly contributed to the growth of intraregional trade and that the Stabilization and Association Agreements (SAAs) with the EU were important for the inflow of foreign direct investment from the EU to the CEFTA 2006 members.

F. V. Vieira and C. G. da Silva (2021) analyzed the export performance of the BRICS countries in the period from 2000 to 2017 using non-linear ARDL cointegration. The authors found that the exchange rate was not a statistically significant determinant of the exports in the long run, whereas the exchange rate volatility, global imports and commodity prices were statistically significant variables.

D. Lazarov and E. Miteva- Kacarski (2023) analyzed intraregional trade in the Western Balkans and found that it had tended to grow in those years. They analyzed the sources of export growth at the country and product levels and used the International Trade Centre (ITC) methodology to assess the unrealized export opportunities at the product level for the period from 2023 to 2027. A significant potential for the expansion of two-way trade between the CEFTA 2006 members was found in the fact that it was now focused on a small number of products.

N. Vujanović (2023) analyzed the differences between the CEFTA 2006 members in terms of the participation of the semi-finished products originating in CEFTA 2006 in their industrial exports. The research results show that the countries with a more developed industrial structure are more dependent on supply

chains within the EU, whereas smaller countries are more involved in the CEFTA 2006 supply chains.

DATA AND APPLIED METHODOLOGY

Data sources and description

This research into the export performance of the CEFTA 2006 countries rests on the annual time series relevant variables during the period from 2000 to 2022. The data were taken from the World Development Indicators - the WDI database, the BIS statistics, the national statistics and Bruegel. The description, the expected sign and the sources of those variables are given in Table 1. Mutual trade between the CEFTA 2006 members existed even before the signing of this agreement, for which reason we chose to start the period from 2000.

The data for Kosovo* for all the variables refer to the period from 2008 to 2022. The data for Montenegro for the BANKCREDIT series refer to the period from 2002 to 2022, and for EXP, they refer to the period from 2006 to 2022.

The applied methodology

In the study of the export performance of the CEFTA 2006 countries, the following regression equation was estimated for the period from 2000 to 2022:

$$\ln EXP = \beta_0 + \beta_1 \ln FDI_t + \beta_2 \ln BANKCREDIT_t + \beta_3 \ln REER_t + \beta_4 \ln TL_t + \varepsilon_t \quad (1)$$

The variables have the meaning as in Table 1.

The traditional ARDL model, in which y is the dependent variable and a x_1, \dots, x_k are the k explanatory variables, can be represented as:

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^p \psi_i y_{t-i} + \sum_{j=1}^k \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \varepsilon_t \quad (2)$$

where α_0 is the constant term, α_1 , ψ_i and $\beta_{i,j}$ are the coefficients associated with the linear trend, the lags

Table 1 The data description and the sources

Variables	Description	Expected sign	Source
LnEXP	Log of exports of goods and services (constant 2015 US\$) 2015=100 index	+	World Bank (2023)
LnFDI	Log of foreign direct investment, net inflows (% of the GDP)	+	World Bank (2023)
LnREER	Log of real effective exchange rate index (2015 = 100)	-	World Bank (2023)
LnTL	Log of trade liberalization measured as the trade (sum of exports and imports of goods and services)-to-GDP ratio at the time t	+	World Bank (2023)
LnBANKCREDIT	Log of domestic credit to the private sector by banks (% of the GDP)	+	World Bank (2023)

Note: Kosovo* - UNMIC, according to the SC Res. 1244. The data for Montenegro's LnEXP start from 2006. The data for Albania's LnREER were taken from BRUEGEL, retrieved December 24, 2023, from: <https://www.bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database>. The data for Bosnia and Herzegovina's LnREER were taken from https://data.bis.org/topics/EER/BIS,WS_EER,1.0/M.R.B.BA (retrieved December 13, 2023). The data for LnREER for Montenegro and Kosovo* are the data for LnREER for the euro, taken from https://data.bis.org/topics/EER/BIS,WS_EER,1.0/M.R.B.XM. The data for Serbia's LnREER were taken from the NBS (2024), p. 99. The data for LnSDI for Serbia for the period from 2001 to 2006 were taken from https://www.nbs.rs/sr_RS/drugi-nivo-navigacije/statistika/platni_bilans/, retrieved December 13, 2023.

Source: The author

of y_t and the lags of the k regressors $x_{j,t}$ for $j = 1, \dots, k$, respectively, and ϵ_t is the label for innovations.

Since no single variable in the empirical model is found to be I(2), the ARDL-ECM model can be estimated according to the following specification:

$$\Delta y_t = \alpha_0 + \alpha_1 t - \psi(1)y_{t-1} + \sum_{j=1}^k \beta_j(1)x_{j,t-1} + (\psi^*(L)\Delta y_{t-1} + \sum_{j=1}^k \beta_j(L)\Delta x_{j,t-1}) + \sum_{j=1}^k \beta_j(L)\Delta x_{j,t} + \epsilon_t \quad (3)$$

where the convention applied reads as follows:

$$\psi^*(L) = \sum_{i=1}^p \psi_i L^i = (\sum_{i=1}^p \psi_i L^{i-1})L = (\psi^*(1) + (1-L)\psi^*(L))L \quad (4)$$

EMPIRICAL RESULTS AND DISCUSSION

The first step in model estimation is the application of unit root tests in order to determine the level of the integration of the variables. As has already been mentioned, this is important in the case in which the estimated value of the F statistic lies between the

lower and upper critical values. In this paper, the following unit root tests are applied: the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, and the Kwiatkowski, Phillips, Schmidt and Shin test, the results of all the tests applied being given in the Appendix, Table A1, and showing that all the variables are either I(0) or I(1). The descriptive statistics of the estimated residuals by country are presented in the Appendix, Table A2.

Table 2 shows the ARDL models for each analyzed country. The lags for each variable vary between the countries. The same table contains the results of the Breusch and Godfrey (Breusch-Godfrey Serial Correlation LM test) autocorrelation test for each selected ARDL model, as well as the results of the heteroskedasticity test (Heteroskedasticity Test Breusch-Pagan-Godfrey) also for each of the selected ARDL model. All the estimated ARDL models are without the autocorrelation of the residuals at the standard level of 5% and heteroskedasticity (with the exception of Moldova, where there is less heteroskedasticity). The residuals of the estimated

Table 2 The ARDL models - The dependent variable: real exports (for each country)

Country	ARDL model	Breusch-Godfrey Serial	Breusch-Pagan-Godfrey	Jarque-Bera test
		Correlation LM test (Prob); H ₀ : No serial correlation	heteroskedasticity test (Prob) H ₀ : Homoskedasticity	(Prob) H ₀ : Normal distribution
Albania	(1, 1, 2, 0, 2) ¹	1.3276 (0.3596)	0.3743 (0.9315)	1.3231 (0.5160)
BiH	(3, 2, 2, 2, 2) ²	0.2924 (0.8384)	3.3924 (0.1232)	7.1483 (0.0280)
Montenegro	(2, 0, 2, 1, 2) ¹	0.5572 (0.7124)	1.9888 (0.1856)	0.9707 (0.6154)
Kosovo*	(1, 1, 1, 1, 0) ¹	3.0206 (0.4041)	2.9347 (0.1255)	0.2559 (0.8798)
Moldova	(2, 0, 2, 1, 2) ²	4.8023 (0.0578)	3.5132 (0.0348)	0.2727 (0.8725)
North Macedonia	(3, 0, 1, 1, 2) ¹	1.2212 (0.4256)	0.8456 (0.6120)	0.6342 (0.7282)
Serbia	(3, 2, 2, 2, 0) ¹	4.6677 (0.1841)	0.9392 (0.5693)	1.2808 (0.5270)

Note: ¹The restricted constant and no trend; ²The unrestricted constant and no trend; Kosovo* - UNMIK, according to the SC Res. 1244

Source: The author

ARDL models are normally distributed, except for BiH. The results of the CUSUM and CUSUMQ stability tests of the long-term coefficients given in the Appendix (Figures A - G) show a lesser instability of the equation parameters (the CUSUMQ test) in the case of Montenegro.

Allow us now to return to examining the existence of cointegration between the observed variables using the ARDL Bound test. The results are given in Table 3. The inferences regarding the presence or absence of cointegration are made using M. H. Pesaran, Y. Shin and R. J. Smith (2001) of the asymptotic critical values corresponding to the limiting case when all variables are I(0) (the lower bound) or I(1) (the upper bound).

Based on the obtained results presented in Table 3, the null hypothesis about the absence of cointegration (H₀: There is no cointegration between the dependent variable and the regressor.) can be rejected at the 1% level for BiH, Kosovo*, Moldova, North Macedonia, and Serbia, because the F-statistic for these countries is higher than the critical upper value at 1%. The null hypothesis can also be rejected for Albania (at the 5% level) and Montenegro (at the 10% level). As has already been pointed out, there is a lesser instability of the regression parameters in the case of Montenegro, possibly because some time series are shorter compared to the other countries. Based on

the previous results, it can be concluded that there is a long-term relationship between the observed variables for all the countries analyzed.

After conducting the ARDL F-Bounds test for all the models, the long-term (equilibrium) coefficients in the cointegration relation for each country. The results are given in Table 4.

For each country in Table 4, some time series are stable in level, others in the first difference (Appendix, Table 1). For Montenegro and Kosovo*, some time series are shorter compared to the other CEFTA 2006 members. In addition, the estimated ARDL model contains several lagged variables, which reduces the number of observations in the regression. Finally, the ARDL model requires a relatively large sample (more than 30 data). The time series used in this analysis contain less data. All these are the reasons why multicollinearity occurs for some variables in the estimated regression equation for individual countries. However, it does not affect the identification of the long-term relationship between the real exports and the observed explanatory variables.

The estimated coefficients in Table 4 show that there are differences between the countries with respect to the importance of certain variables for the exports in the long run. In the case of Albania, the analyzed long-term coefficients are not statistically significant, so it

Table 3 The cointegration test (the ARDL F-Bounds test)

Country	F-Statistics	Critical values						Long-term cointegration
		I(0) Bound			I(1) Bound			
		10%	5%	1%	10%	5%	1%	
Albania	2.8822	2.200	2.560	3.290	3.090	3.490	4.370	Yes, at 5% for I(0)
BiH	8.4427	2.450	2.860	3.740	3.520	4.010	5.060	Yes
Montenegro	2.2852	2.200	2.560	3.290	3.090	3.490	4.370	Yes, at 10% for I(0)
Kosovo*	115.87	2.200	2.560	3.290	3.090	3.490	4.370	Yes
Moldova	5.2255	2.450	2.860	3.740	3.520	4.010	5.060	Yes
North Macedonia	5.8171	2.200	2.560	3.290	3.090	3.490	4.370	Yes
Serbia	83.132	2.200	2.560	3.290	3.090	3.490	4.370	Yes

Note: ¹The restricted constant and no trend; ²The unrestricted constant and no trend; Kosovo* - UNMIK, according to the SC Res. 1244

Source: The author

Table 4 The ARDL models: the long-term coefficients of the cointegration equation (the dependent variable: log real exports)

Variables	FDI, net inflows	Domestic credit to the private sector by banks	Real Effective Exchange Rate	Trade liberalization	Constant
Country (Lags)	Coefficient (Prob)	Coefficient (Prob)	Coefficient (Prob)	Coefficient (Prob)	Coefficient (Prob)
Albania (1, 1, 2, 0, 2)	-0.0516 (0.7053)	0.0795 (0.4983)	-0.2319** (0.5552)	-0.2007 (0.7720)	2.1642 (0.5676)
BiH (3, 2, 2, 2, 2)	-0.04149 (0.5257)	0.3149 (0.3154)	-1.5387 (0.0391)	0.8227 (0.0355)	5.0791 (0.3164)
Montenegro (2, 0, 2, 1, 2)	-0.0393** (0.5804)	-0.0865 (0.5084)	0.7347 (0.4018)	0.8862 (0.3136)	-4.5281 (0.2245)
Kosovo* (1, 1, 1, 1, 0)	-0.4604 (0.0003)	0.4656 (0.0362)	-2.0412 (0.0014)	2.3425** (0.0000)	2.9185 (0.1185)
Moldova (2, 0, 2, 1, 2)	0.0513 (0.1490)	0.0111** (0.8515)	0.00082 (0.9595)	-0.5399 (0.0337)	4.0473 (0.0236)
North Macedonia (3, 0, 1, 1, 2)	0.0076** (0.5359)	-0.1303 (0.2320)	1.3654 (0.3002)	0.3143 (0.0139)	-6.8416 (0.2218)
Serbia (3, 2, 2, 2, 0)	0.0778 (0.0497)	-0.0099 (0.8650)	-0.9850 (0.0109)	0.9864** (0.0000)	2.3116 (0.0893)

Note: Kosovo* - UNMIK, according to the SC Res. 1244. ** The variable without a lag.

Source: The author

is not possible to reliably assess which of them has the greatest significance for the export performance of this country. The coefficient with bank loans has a high value, although it is not statistically significant. However, it indicates that the internal loans granted

to domestic companies have a positive effect on Albania's export performance. However, in 2020, the credit granted to the domestic private sector accounted for 39% of the GDP, which is below the average of the Western Balkan countries, which is 50% of the GDP

(World Bank Group, 2022, p. 55). Nevertheless, it should be noted that the 2006 CEFTA Agreement has significantly contributed to the increase in Albania's real exports (Choi & Minondo, 2019).

In Bosnia and Herzegovina's exports, the real effective exchange rate and trade openness play a significant role. The estimated coefficients of these variables are statistically significant at the 5% level and have the expected sign and a high value. Considering the exchange rate regime in BiH (the currency board), price growth leads to the appreciation of the convertible mark, which discourages exports. This result is in line with the findings of D. Jović (2024), who noted the significant role of the exchange rate for BiH's export performance. On the other hand, trade facilitation through the abolition of customs duties inside the CEFTA 2006 countries and with the EU countries within the framework of joining this integration significantly boosts the real exports of Bosnia and Herzegovina. This result is in line with the results of the OECD (2024).

The estimated coefficients for Montenegro are not statistically significant, although the value of the trade openness coefficient indicates that this factor plays a significant role in real exports. At the same time, trade with the other CEFTA 2006 members plays an important role in total trade. This result is in line with the results of previous studies (Klimczak & Trivić, 2018; Grieveson *et al*, 2021). Previously, the estimated regression parameters for Montenegro were found to be less unstable. It should be noted that some of the time series were shorter in the case of Montenegro compared to the other countries analyzed.

For the export performance of Kosovo*, trade openness and the real effective exchange rate are of utmost importance. The real effective exchange rate coefficient has the expected sign and a big impact on the real exports. However, the FDI estimated coefficient does not have the expected sign, although it is statistically significant at the 1% level. Although FDI inflows to Kosovo* more than tripled in the period from 2019 to 2022, they are largely concentrated in the non-tradable sectors (80% of the FDI stocks are those in construction and real estate), so FDI makes only

a modest contribution to the exports (OECD, 2024). However, trade openness plays an important role for the exports, as in the case of BiH. The role of bank loans is also important for the export of Kosovo*, because a 1% increase in these loans causes an increase in real exports by 0.5%.

Moldova's real exports mainly rely on the net FDI inflow, although the estimated coefficient of this regressor is not statistically significant. The estimated coefficients of the other variables are not statistically significant, either, except for trade openness. However, in the case of trade openness, no positive impact of this variable on exports was identified. This result is in line with the earlier results obtained by Z. Toaca and V. Fala (2022).

North Macedonia's export performance is mainly based on trade liberalization (the estimated coefficient is statistically significant at the level of 5% and has a high value), whereas the other variables are less important, and the estimated coefficients are not statistically significant. The estimated real effective exchange rate coefficient has a high value, but not the expected sign. North Macedonia digitizes its customs procedures and significantly simplifies its export and import processes by introducing green customs declarations (OECD, 2024). Other export promotion measures also lead to an improvement in export performance. These findings are consistent with the results of earlier studies (Grieveson *et al*, 2021).

Serbia's export performance depends on the degree of trade openness (the estimated coefficient has a high value and is statistically significant at the 1% level), the real effective exchange rate, and the net inflow of FDI. Serbia's companies' exports depend on the productivity level (Čupić & Vržina, 2024). Although the European Union is Serbia's most important trading partner, trade with the CEFTA 2006 members brings Serbia a considerable surplus. Therefore, the finding in this study that trade openness plays a significant role in the development of export performance is not surprising. These findings are in line with the previous work that found the formation of CEFTA in 2006 had been accompanied by a significant increase in mutual trade between the members (Dragutinović-

Mitrović & Bjelić, 2015; Petreski, 2018; Lazarov & Miteva-Kacarski, 2023). The exports of finished products are growing at a faster rate, whereas the exports of semi-finished products are less dynamic (Reiter & Stehrer, 2021). However, high-tech products are hardly represented in the exports of the CEFTA members in 2006 (Vujanović, 2023).

Trade openness in the CEFTA 2006 region is significant for all the countries (this result is consistent with the previous research by N. Vujanović (2023)), although in the case of Montenegro and Albania, the estimated long-term coefficients of this variable are not statistically significant. Further trade liberalization under the CEFTA 2006 Agreement (the abolition of non-tariff measures) may contribute to the dynamics of the reciprocal trade of all the members of this agreement. The most common non-tariff measures applied under the CEFTA 2006 Agreement are the formalities related to import, export and transit, customs clearance, intellectual property rights, technical barriers to trade, sanitary and phytosanitary measures, and so on (GIZ, 2022). The findings on the positive long-term relationship between trade liberalization and exports are consistent with earlier research (Kaloyanchev *et al*, 2018). In some cases, however, an unexpected positive long-term relationship between the real effective exchange rate and exports was found, with the coefficients that were not statistically significant (Montenegro, Moldova, North Macedonia). This finding is in line with the results of F. V. Vieira and C. G. da Silva (2021). Although, with the exception of Serbia, no stronger long-term positive relationship between FDI and the exports was found in this research, it should be noted that a significant part of FDI in CEFTA 2006 was channeled into the services sector (Vujanović, 2023), which could be one of the reasons for the result achieved. In addition, the inflow of FDI in a country depends on the quality of its institutions (Arsov & Naumoski, 2024).

The empirical results of this study confirm the initial hypothesis H1 that trade liberalization significantly affects the trade performance of the CEFTA members in 2006. The estimated long-term coefficients of this variable confirm that further trade liberalization

is an important factor for the real growth of the CEFTA members' exports in 2006. The removal of the remaining non-tariff measures for these countries can make an additional contribution to the growth of their mutual trade and their real exports as well. The empirical results obtained herein also confirm the hypothesis H2 that the effects of net FDI inflows and the real effective exchange rate on the CEFTA members' exports in 2006 were different. The results show that FDI has a positive effect on the real exports of Moldova, North Macedonia and Serbia, although the long-term relationship was only significant in the case of Serbia. For the other countries, no long-term positive relationship between real exports and foreign direct investment was found. The development of the real effective exchange rate is significant for the exports of Bosnia and Herzegovina, Kosovo* and Serbia, where the real effective appreciation has a negative effect on real exports. Although the exchange rate is also a significant variable for Albanian exports, it is not statistically significant. In the case of Montenegro, Moldova and North Macedonia, the theoretically expected relationship between the real effective exchange rate and exports was not found, which confirms the second research hypothesis.

CONCLUSION

The main goal of this paper was to investigate the export performance of the CEFTA 2006 members in the period from 2000 to 2022, using the ARDL cointegration model. For all the countries, the presence of the long-term equilibrium relationship between the real exports and the explanatory variables used in the empirical analysis was demonstrated, noting that the estimated long-term coefficients were not statistically significant in the cases of Albania and Montenegro. For most CEFTA 2006 countries, trade openness plays an important role in shaping long-run export performance, which is then followed by the real effective exchange rate playing a significant role as well. In the empirical analysis, it has not been determined that FDI affects the export performance of the CEFTA 2006 members (the estimated coefficients of this variable were not statistically significant),

except for Serbia, where a positive relationship was identified and the coefficient was statistically significant at the 5% level. It has not been confirmed, either, that export performance depends on the domestic bank loans granted to the private sector (the estimated coefficients of this variable are not statistically significant), except for Kosovo*, where the estimated coefficient is statistically significant at the level of 5% and shows a significant impact of this variable on exports.

The results obtained have both theoretical and practical significance. The theoretical contribution is to combine the effects of the selected factors on the CEFTA members' real exports in 2006 with a theoretical approach to the export competitiveness of the economy. The practical contribution of the results obtained is that they show the liberalization of mutual trade within CEFTA in 2006 and trade liberalization with the EU had a significant and positive impact on the export performance of all the members of this free trade area, which leads to the recommendation to policy-makers to continue liberalization, particularly by removing the remaining non-tariff measures that could influence a further increase in real exports. The results regarding the importance of net FDI inflows and exports suggest that there is a need to channel more of new FDI into export sectors with a higher share of value added, which would increase their contribution to the increase in real exports.

The empirical results of this study confirm the research hypotheses. Further trade liberalization, particularly by removing the remaining non-tariff measures, can significantly accelerate trade in goods and services and lead to further growth in the real exports of CEFTA members in 2006. In addition, the conditions must be created for FDI to make a greater contribution to exports. It should be borne in mind that the increase in the stock of FDI also increases the dividends from FDI that can be repatriated to the countries of origin, which can lead to pressure on the exchange rate. Even though this research has not shown that the domestic bank loans granted to the private sector have a stronger impact on real exports, it is precisely these financial-support loans that small and medium-sized enterprises seek.

It should be noted that the time series of the analyzed variables for the individual CEFTA 2006 members are shorter than the time sample in the applied research, which could influence the statistical significance of the estimated parameters. This is a limitation of this research.

Given the proven positive effects of trade liberalization on the export performance of the CEFTA 2006 members, the effects of the non-tariff measures on the export performance of these countries should be investigated in future research. In addition, the potential effects of geostrategic shifts in FDI flows on the export performance of the CEFTA 2006 members should be assessed.

ENDNOTE

In this paper, Kosovo* implies the following note: UNMIK, according to the SC Res. 1244.

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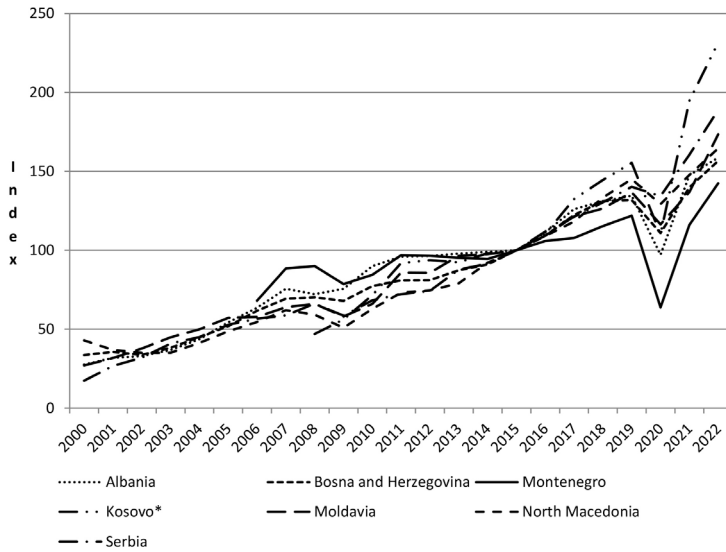
Received on 9th September 2024,
after revision,

accepted for publication on 10th July 2025.

Published online on 8th August 2025.

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APPENDIX



Note: Kosovo* - UNMIK, according to the SC Res. 1244

Figure 1 The export of goods and services of the CEFTA 2006 members in constant dollars 2015, indices 2015=100

Source: World Bank (2023), <https://datatopics.worldbank.org/world-development-indicators/>, accessed on 15th Aug. 2024

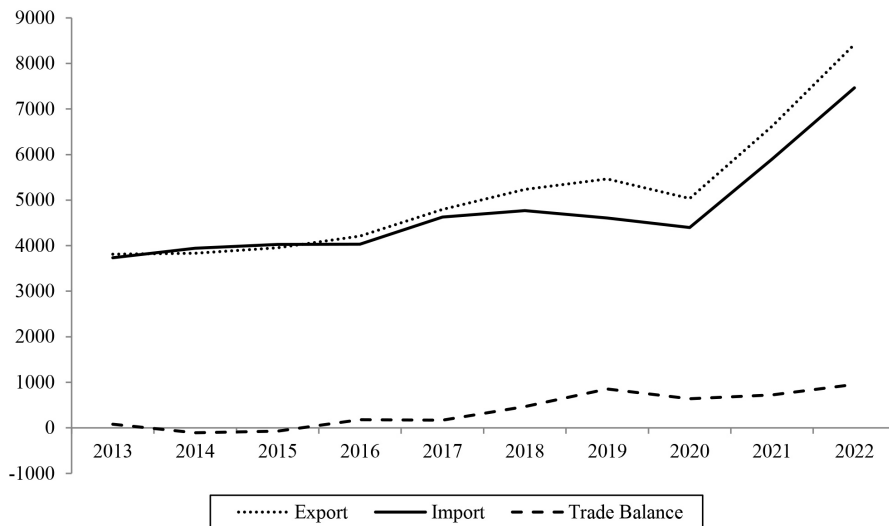


Figure 2 Intra-CEFTA trade of goods - CEFTA 2023 (in millions of euros)

Source: <https://transparency.cefta.int/TradeStatistics/TradeInGoods>, accessed on 16th Aug. 2024

Table A1 The unit root tests

	Level						The first difference						INFERENCE		
	ADF			PP			ADF			PP				KPSS	
	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept		Intercept	Trend and intercept
LnEXP	Albania	-2.43	-2.23	-2.94**	-2.13	0.65*	0.16*	-5.53*	-5.62*	-5.58*	-6.66*	0.25*	0.15*	(0)	
	BiH	-0.79	-2.10	-0.85	-2.20	0.67*	0.14*	-4.32*	-4.21*	-4.33*	-4.55*	0.09*	0.09*	(1)	
	Moldova	-1.41	-3.69**	-1.82	-4.44*	0.69*	0.13*	-3.75*	-3.65*	-4.28*	-4.16**	0.19*	0.17*	(0)	
	N. Macedonia	0.33	-4.26**	0.63	-4.15**	0.66*	0.08*	-4.55*	-4.35*	-8.85*	-8.25*	0.22*	0.11*	(0)	
	Montenegro	-3.20**	-4.37**	-3.14**	-8.07*	0.54*	0.50	-5.34*	-5.12*	-10.44*	-10.76*	0.50*	0.50	(0)	
	Serbia	-2.84**	-2.23	-2.75**	-5.22*	0.69*	0.13*	-5.59*	-5.27*	-5.59*	-5.27*	-32*	0.17*	(0)	
Kosovo*	-1.03	-3.52**	-0.80	-4.23**	0.61*	0.11*	-2.79**	-2.26	-5.06*	-4.73**	0.19*	0.19	(0)		
LnFDI	Albania	-1.72	-1.84	-1.67	-1.88	0.40*	0.16*	-4.55*	-2.58	-4.58*	-4.42**	0.18*	0.18*	(1)	
	BiH	-2.70**	-3.10	-2.66**	-3.02	0.31*	0.09*	-4.88*	-4.73*	-8.07*	-7.95*	0.50*	0.50*	(0)	
	Moldova	-2.28	-3.34**	-2.23	-2.57	0.49*	0.09*	-4.65*	-4.52*	-7.38*	-7.69*	0.50*	0.50	(1)	
	N. Macedonia	-4.69*	-4.79*	-4.84*	-10.9*	0.41*	0.50*	-5.32*	-5.18	-14.29*	-17.86*	0.39*	0.38*	(0)	
	Montenegro	-1.76	-3.23	-2.84**	-3.23	0.18*	0.15*	-6.25*	-6.93*	-6.86*	-6.93*	0.20*	0.15*	(1)	
	Serbia	-4.33*	-4.04*	-4.45*	-4.81*	0.19*	0.10*	-6.32*	-6.27*	-6.78*	-6.71*	0.23*	0.13*	(0)	
Kosovo*	-2.21	0.33	2.18	-1.26	0.28*	0.16*	-1.58	-3.34	-5.51*	-7.90*	0.38*	0.10*	(1)		
LnREER	Albania	-0.35	-1.77	-0.49	-1.91	0.59*	0.09*	-3.17**	-3.16	-3.21**	-3.20*	0.13*	0.12*	(1)	
	BiH	-1.47	-1.86	-1.57	-1.74	0.49*	0.11*	-3.37**	-3.28**	-3.28**	-3.28**	0.12*	0.12*	(1)	
	Moldova	0.05	-2.01	0.26	-2.14	0.65*	0.08*	-3.73*	-3.69*	-3.56**	-3.55*	0.14*	0.10*	(1)	
	N. Macedonia	-2.76**	-2.29	-2.76**	-2.29	-2.76**	-2.29	-4.23*	-4.36**	-4.24*	-4.42**	0.33*	0.17*	(0)	
	Montenegro	-2.21	-3.05	-2.21	-3.50**	0.24*	0.13*	-4.12*	-4.25*	-4.10*	-4.24**	0.23*	0.15*	(1)	
	Serbia	-2.43	-2.42	-2.76**	-2.35	0.45*	0.14*	-4.52*	-4.46**	-4.61*	-4.74*	0.24*	0.14*	(1)	
Kosovo*	-2.21	-3.05	-2.22	-3.51**	0.25*	0.13*	-4.13*	-4.26**	-4.12*	-4.26**	0.22*	0.15*	(1)		
LnTL	Albania	-2.93**	-3.11	-2.68**	-2.97	0.38*	0.15*	-4.16*	-4.12*	-6.32*	-5.96*	0.19*	0.19*	(1)	
	BiH	-0.51	-4.57*	-1.47	-3.49**	0.70*	0.15*	-5.61*	-5.56*	-6.06*	-10.1*	0.50*	0.43	(0)	
	Moldova	-1.26	-1.18	-1.26	-1.18	0.53*	0.11*	-3.05**	-2.99	-3.07**	-2.91	0.17*	0.15*	(1)	
	N. Macedonia	-0.29	-3.59**	1.35	-3.26**	0.66*	0.07*	-5.07*	-4.92*	-8.13*	-8.27*	0.50*	0.50*	(0)	
	Montenegro	-2.80*	-2.89	-2.62	-2.76	0.18*	0.11*	-4.62*	-4.46**	-5.22*	-4.75*	0.21*	0.21*	(1)	
	Serbia	-5.10*	-11.78*	-4.67*	-10.97*	0.67*	0.12*	-12.41*	-11.22*	-12.40*	-11.23*	0.28*	0.14*	(0)	
Kosovo*	-0.63	-1.19	-0.45	-0.94	0.38*	0.20*	-3.38**	-3.08	-3.37*	-5.31*	0.29*	0.36	(1)		
LnBANK CREDIT	Albania	-2.14	-1.49	-2.89**	-1.09	0.48*	0.17*	-1.55	-2.12	-1.64	-2.24	0.44*	0.09*	(0)	
	BiH	-1.37	-0.91	-1.37	-0.92	0.44*	0.17*	-6.59*	-12.09*	-5.78*	-12.09*	0.22*	0.11*	(1)	
	Moldova	-2.38	-2.32	-2.47	-2.16	0.18*	0.16*	-2.74**	-3.00	-2.79**	-3.00	0.34*	0.11*	(1)	
	N. Macedonia	-1.92	-0.36	-1.66	-0.76	0.58*	0.16*	-2.22	-3.03	-2.24	-3.02	0.29*	0.09*	(1)	
	Montenegro	-7.35*	-6.94*	-3.09**	-2.12	0.31*	0.14*	-2.13	-2.40	-2.05	-2.44	0.37*	0.11	(0)	
	Serbia	-1.46	-2.85	-1.79	-3.02	0.41*	0.10*	-7.84*	-3.12	-3.34**	-3.11	0.13*	0.12*	(1)	
Kosovo*	0.40	-4.65**	0.37	-1.01	0.52*	0.15*	-2.19	-3.75**	-3.18**	-3.77**	0.20*	0.10*	(0)		

Note: Kosovo* - UNMIK, according to the SC Res. 1244. * Indicates significance at the 1% level (for the ADF and PP tests), * denotes null rejection, H_0 - the unit root; for KPSS, * means that the null hypothesis cannot be rejected, H_0 - stationarity); ** Indicates significance at the 5% level; *** Indicates significance at the 10% level.

Source: The author

Table A2 The descriptive statistics of the estimated residuals of the export equation by country

	Albania	BiH	Montenegro	Kosovo*	Moldova	North Macedonia	Serbia
Mean	-6.35e-16	4.00e-16	-2.33e-16	3.62e-15	-1.23e-15	8.88e-16	-2.66e-16
Median	0.005554	-0.001536	0.002601	-0.003522	0.001931	-0.004512	-0.001221
Maximum	0.052176	0.035220	0.068244	0.033882	0.055137	0.042183	0.011443
Minimum	-0.088655	-0.040523	-0.065014	-0.031609	-0.045047	-0.038107	-0.011190
St. Dev.	0.039868	0.014255	0.039854	0.017525	0.028348	0.021788	0.007134
Skewness	-0.513282	-0.353134	-0.005544	0.135677	0.108481	0.305947	0.115063
Kurtosis	2.322996	5.842395	1.892692	2.395745	2.485612	2.378176	1.781799
Jarque-Bera	1.323147	7.148352	0.970784	0.255941	0.272709	0.634234	1.280809
Probability	0.516039	0.028039	0.615456	0.879879	0.872533	0.728246	0.527079

Note: *UNMIK, according to the SC Res. 1244

Source: The author

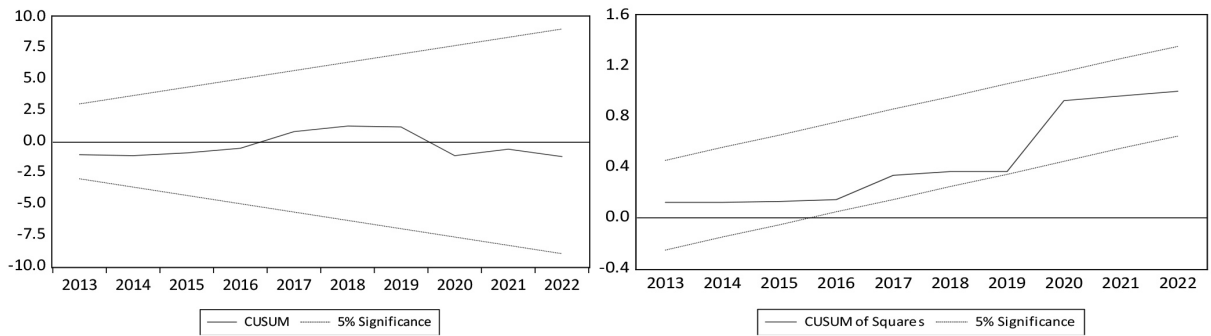


Figure A Albania - CUSUM and CUSUMQ

Source: The author

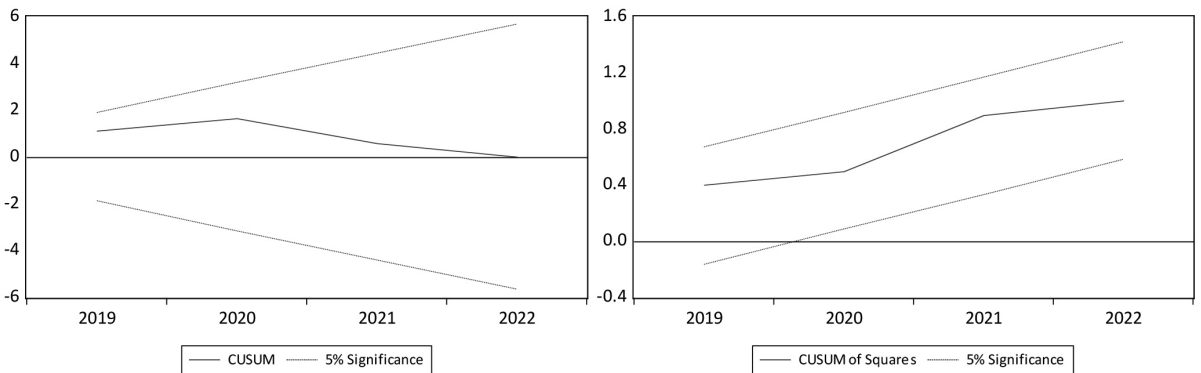


Figure B BiH - CUSUM and CUSUMQ

Source: The author

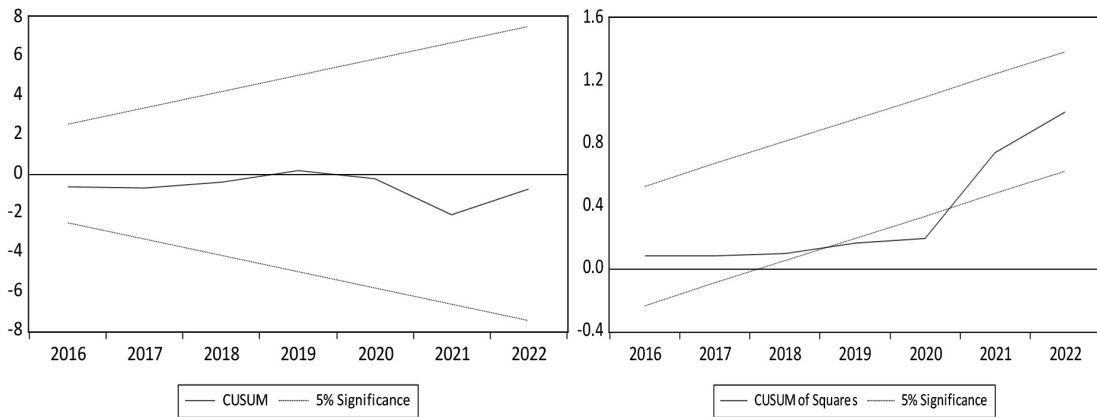
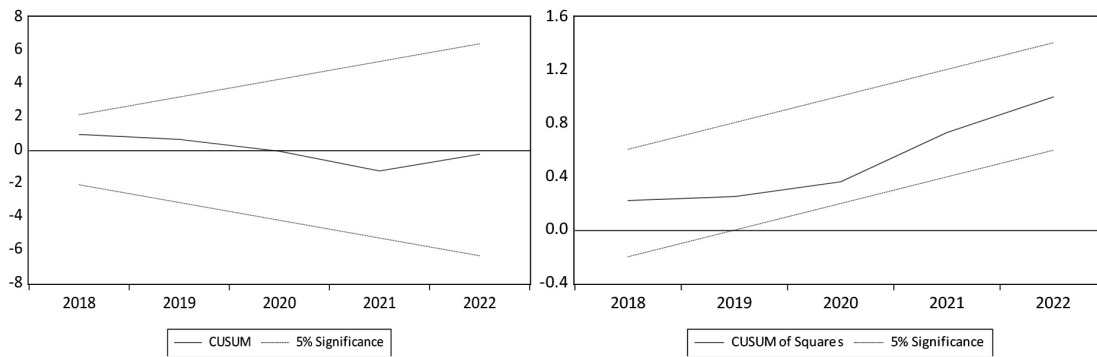


Figure C Montenegro - CUSUM and CUSUMQ

Source: The author



Kosovo* (UNMIK, according to the UN SC Res. 1244)

Figure D Kosovo* - CUSUM and CUSUMQ

Source: The author

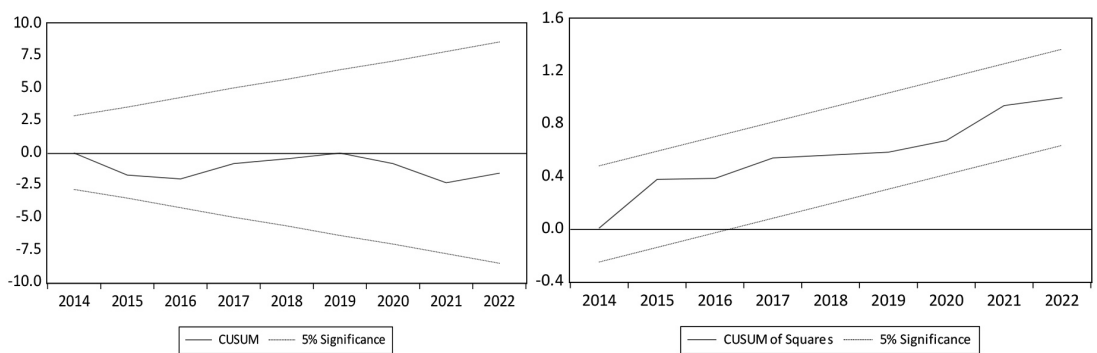


Figure E Moldova - CUSUM and CUSUMQ

Source: The author

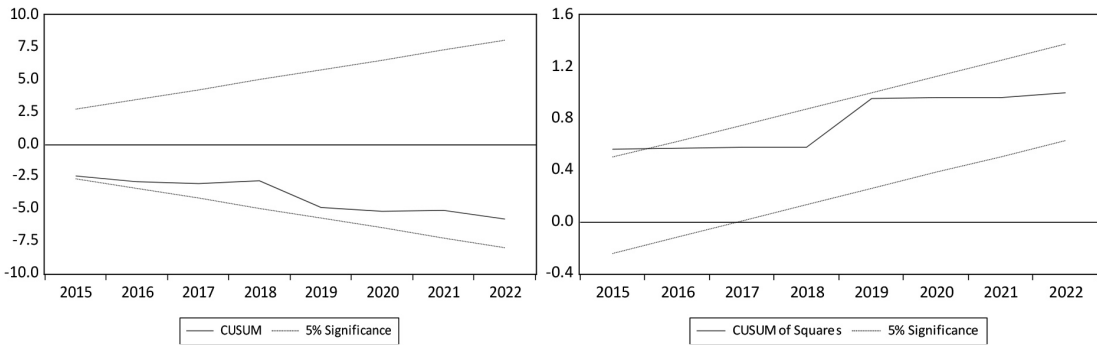


Figure F North Macedonia - CUSUM and CUSUMQ

Source: The author

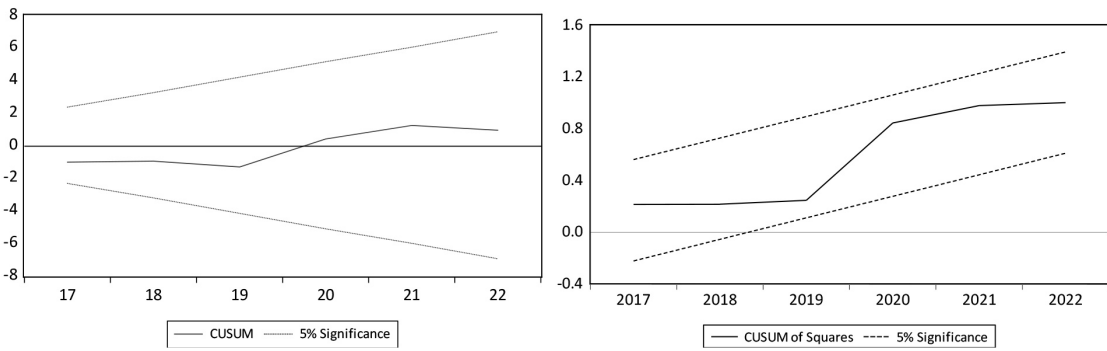


Figure G Serbia - CUSUM and CUSUMQ

Source: The author

Original scientific paper

UDC: 336.7:330(6)

doi:10.5937/ekonhor2502117E

DEBATE ON THE FINANCIAL STRUCTURE OF AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA: THE MODERATING EFFECT OF INSTITUTIONAL QUALITY IN AN INCOME-BASED PANEL

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This study x-rays the moderating influence of institutional quality on the relationship between the financial structure (FS) and economic growth in 33 Sub-Saharan African (SSA) economies from 2006 to 2022, based on income classification. Aptly utilizing the two-step fixed-effects generalized method of moments, the investigation found that, among the low-income countries, those bank- and market-oriented were associated with the lower and higher levels of economic growth, respectively, whereas among the middle-income countries, those bank- and market-oriented financial structures were associated with the higher and lower levels of economic growth, respectively. Notably, the study establishes that institutional quality does not substantially spur the financial structure to positively contribute to economic growth. The disaggregated outcomes show that prevailing institutional quality mitigates the growth effects of the financial structures of the middle-income economies, whereas it does significantly exacerbate decelerating economic growth among the low-income ones. The study recommends the adoption of policies to strengthen institutional quality, as well as the enhancement of the synergy between the banking sector and the capital market.

Keywords: financial, growth, income, institutions

JEL Classification: E44, E46, O16

INTRODUCTION

As financial integration among economies advances globally, the financial structure (FS) among economies

globally is evolving, simultaneously causing contagious impacts on economic performance. The financial structure refers to the ratio of financial instruments and intermediaries within a nation (Demirgüç-Kunt & Levine, 2001; Luintel, Khan, Arestis & Theodoridis, 2008; Yeh, Huang & Lin, 2013). Market- and bank-oriented FS broadly segment the financial structure. Market- and bank-oriented

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FS differ in the capital allocation mechanism, price risk absorption, savings mobilization, and shocks absorption. Banks often depend on robust client connections to enable financial intermediation and risk assumption on their balance sheets. Markets serve as venues for the pricing, distribution, and trading of shares and debt instruments, facilitating direct resource allocation from savers to borrowers (Atanda & Osemene, 2019). Explicitly, bank-oriented systems highlight the central role of banks in capital allocation, savings mobilization, the coordination of corporate executives' portfolio decisions, and the supervision of risk management instruments (Chu, 2020; Bats & Houben, 2020). Securities markets play an important aspect alongside banks in channeling societal savings to firms, executing corporate control, and stimulating risk management in market-oriented systems (Demirgüç-Kunt & Levine, 2001; Levine, 2002; Hamdaoui & Maktouf, 2020).

The relative economic benefits of market-oriented vs. bank-oriented FS have been the subject matter of extensive discussion due to their unique characteristics, particularly after the decades of the insignificant influence of FS on economic growth outcomes (Demirguc-Kunt & Maksimovic, 2002; Beck & Levine, 2002; Levine, 2002; Ndikumana, 2005). However, market-oriented methods are typically preferred in the most empirical studies of the post-2008 global financial crisis (Demirgüç-Kunt, Feyen & Levine, 2013; Yeh *et al*, 2013; Castro, Kalatzis & Martins-Filho, 2015; Sakarya, Zeren & Akkuş, 2018; Chu, 2020; Liu & Zhang, 2020; Oro & Ekpo, 2020; Arsov & Naumoski, 2024), possibly because bank-oriented financial institutions are more economically vulnerable to a financial crisis than market-oriented financial structures are, as the global financial crisis had demonstrated. However, given the typical free-rider problem permeating the market-oriented FSs, the raging debate over market-oriented FSs outperforming bank-oriented FSs is inconclusive. Furthermore, F. Allen and D. Gale (2000) assume that the market-oriented FS exposes households to more risk than the bank-oriented FS. Nonetheless, the bank-oriented FS exerts benefits, which include the stimulation of innovative and profitable projects, the provision of standardized risk management

services, and ensuring flexibility in financial resource accessibility (Morck & Nakamura, 1999; Levine, 2002; Kevser & Elitas, 2019).

A plethora of empirical studies on the FS and economic growth have left a wide gap in the situation in SSA. The region includes economies across several income classifications. The World Bank's classification categorizes the SSA economies into middle-income countries (MICs) and lower-income countries (LICs). There are limited studies investigating the nexus between the financial architecture and the economic growth trajectory in such nations. Most empirical studies in the region revolved around financial development and economic growth (Puatwoe & Piabuo, 2017; Ibrahim & Alagidede, 2018; Ayadi, 2019; Ustarz & Fanta, 2021; Mbuyi & Mulumba, 2022; Asante, Takyi & Mensah, 2023). In the studies that examined the FS-economic growth nexus, there are several shortcomings in terms of the scope and variable selection. For instance, N. Mathenge and E. Nikolaidou (2018) concentrated on analyzing the short- and long-term impacts of the FS on economic growth, whereas A. D. Ahmed and A. N. Wahid (2011) limited their study to only seven African developing countries, and N. Mahonye and K. Ojah (2014) failed to effectively categorize the various types of the FS. The closest to the present study is that of S. Ouedraogo and H. Sawadogo (2022), in which a financial development index was employed during the examination of the FS-growth nexus among the SSA countries between 1980 and 2017. However, the study simply identified the degree of reliance on the financial system, the financial market, or the banking industry.

There is limited research seeking to incorporate institutional integrity into the nexus between the FS and the economic growth trajectory. Notably, most studies look at how institutional quality affects countries' financial development (Kombo & Koumou, 2021; Khan, Khan, Khan, Haddad, Al-Ramahi & Sherfudeen, 2023), the influence of institutional quality on the financial development-economic growth nexus (Olaniyi & Oladeji, 2021; Bayraktar, Ozyilmaz, Toprak, Olgun & Isik, 2023), or the potential of institutional quality to influence financial inclusion (Chinoda &

Kwenda, 2019; Ha & Nguyen, 2023), which has created a void in the research investigating the moderating influence of institutional quality on the FS-economic growth nexus.

Therefore, this study x-rays the economic effects of the FS on the countries with different levels of income in SSA, and also investigates how institutional quality affects this relationship, since it is institutional quality that exerts a unique role in all economic, political, and financial activities. The paper specifically investigates the nexus between the FS and the economic growth trajectory, along with any potential moderating influence that institutional quality may exert on the FS-growth nexus. This study is novel with respect to the methodology and the context in that it differentiates the economic impacts of the FSs among the MICs and LICs in SSA. This procedure ensures the proper capturing of income-related characteristics and also analyzes any potential moderating influence of institutional quality on the FS-economic growth nexus.

Specifically, the investigation builds on the previous studies that have x-rayed the nexus existing between the FS and prevailing economic growth through the incorporation of the institutional quality moderating variable. This approach underscores the ways in which differences in governance, regulatory effectiveness, and institutional stability may affect the nexus between the FS and economic growth in SSA. The holistic approach offers a new viewpoint regarding the influence of institutions on economic results. This study specifically concentrates on the SSA region, in contrast to most existing studies that generalize findings across developing or global economies. This emphasis highlights distinct social, economic, political, and institutional circumstances in the region, which frequently receive insufficient attention in the existing literature.

In addition, sophisticated econometric methods are used in this study so as to adequately appraise the FS-economic growth-institutional quality nexus. The study effectively incorporates interaction effects in order to tackle endogeneity issues, simultaneously leading to a more precise estimation of how the

institutional quality trajectory influences the association between the FS and economic growth. The systematic approach improves the dependability of the results. The outcomes of the investigation have significant and comprehensive implications for policy formulation. The evidence shows that improved institutional quality spurs the beneficial impacts of the FS on economic growth performance, thereby forming a foundation for policy recommendations. The SSA countries have the opportunity to focus on the institutional reforms that can enhance the advantages of financial development, thereby ultimately promoting sustainable growth.

Consequently, in actualizing the study's empirical drive, a panel of 33 SSA economies, consisting of 17 MICs and 16 LICs, was examined in the period from 2006 to 2022. Due to the limited data available, the fixed-effects generalized method of moments panel method (FE-GMM) was applied so as to evaluate the obtained data. Consequently, this research reveals two significant findings - firstly, the bank-oriented FS adversely affects economic growth, with a more pronounced impact in the LICs compared to the MICs, and secondly, the market-oriented FS significantly influences economic growth, with a more apparent effect perceived in the MICs than in the LICs of SSA. The study reiterates the need to adopt a diversified FS in SSA, regardless of the income category and has also established the loss-absorbing mechanism of the stock market, which ensures economic growth through the business cycle. This study extends the extant studies in SSA by analyzing the economic growth effects of the market-oriented FS and the bank-oriented FS. It is comprehensive because it disaggregates the FS into its broad components and examines their impact across different income categories.

The paper organizes the subsequent sections as follows: Section 2 defines the literature review. Section 3 delineates the research methodology used. Section 4 describes the analysis' findings and provides in-depth discussion of these findings. The study concludes in Section 5.

LITERATURE REVIEW

An exposition of previous investigations of the FS-economic growth nexus has shown contrasting and varying outcomes, depending on several factors which range from methodological techniques, a choice of FS instruments, and the financial development level, among others. For instance, P. Liu, Y. Peng, Y. Shi and J. Yang (2022) present new empirical evidence regarding the relevance of the FS for economic growth, based on a panel of 113 countries in the period from 1990 to 2013. The study evaluates the impact of political risk and the development stage, as well as their interplay, on the FS and also that, on average, an advanced market-oriented FS correlates with growth performance levels. Moreover, banks assume a more pivotal role in the growth trajectory within the market-oriented FS, whereas equity markets exhibit a greater sensitivity to economic growth in the bank-oriented FS.

M. J. Houshaimi (2020) examines the FS-economic growth dynamic nexus relationship utilizing three indicators related to the FS across 11 countries in the Middle East and North African regions. This study utilizes unbalanced data from 11 MENA countries spanning from 1995 to 2018, and seeks to conduct a thorough empirical appraisal, employing the fixed-effect technique. The outcomes indicate that the FS influences economic growth specifically through the banking system in an S-ACT framework.

G. Liu and C. Zhang (2020) analyze the importance of the FS for economic growth using a panel data study of 29 provinces throughout eastern, western, and central China in the period from 1996 to 2013. The empirical evidence demonstrates that the FS greatly impacts the growth trajectory. The impact of the FS on the regional growth trajectory is inconsistent and demonstrates an inverted U-shaped correlation. The results confirm the dynamic impact of the FS on economic growth performance in varying phases of the economic growth trajectory. Additionally, studies such as D. Asteriou and K. Spanos (2019) and L. Slesman, A. Z. Baharumshah and W. N. W. Azman-Saini (2019) opine that a financial crisis and institutional quality, alongside the income level and time, influence the FS-economic growth relationship.

L. K. Chu (2020) examines the FS-economic growth nexus utilizing the GMM technique for 99 countries, taking into account the repercussions of the banking crises, economic volatility, the financial development level, and inequality in the FS. The primary finding supports the market-oriented perspective; however, the unbalanced FS significantly reduces the beneficial impacts of an expanding securities market expansion *vis-à-vis* the bank-oriented system. Furthermore, A. Ujunwa, O. P. Salami, I. Nwakoby and A. H. Umar (2012) analyze the effects of various FS perspectives on Nigeria's economic growth trajectory. The study employs the annual data covering a period of 17 years (from 1992 to 2008). The investigation uses the ordinary least squares regression technique to estimate the constructed models in alignment with the FS theories. The results demonstrate that the coefficients linked to bank- and legal-based theories stimulate the economic growth trajectory.

E. Nkoro and A. K. Uko (2019) examine the influence of the FS on Nigeria's economic growth dynamics, utilizing the annual time data from 1981 to 2017 and the vector error correction model (VECM) for analysis. The findings indicate that both market- and bank-oriented FSs significantly influence economic growth. These findings contrasted those of A. C. Maduka and K. O. Onwuka (2013), who opine that the FS exerts a negative, yet significant, influence on economic growth. L. Gambacorta, J. Yang and K. Tsatsaronis (2014) and P. Arestis, A. D. Luintel and K. B. Luintel (2010) reached a similar conclusion.

M. O. Saibu, K. E. I. Bowale and A. E. Akinlo (2009) employ a vector error correction model so as to examine the nexus between fluctuations in Nigeria's overall FS and economic growth in the period between 1970 and 2004, and the findings indicate that alterations in Nigeria's FS do not significantly influence its economic growth. The results indicate that, although the FS negatively influences economic growth, it positively influences the stock market development. K. B. Luintel *et al* (2008) investigate the FS-economic growth nexus through the annual data, utilizing a panel technique which is both dynamic and heterogeneous in nature. The population of the study includes 14 countries. The findings indicate that

the FS substantially accounts for the output levels in most countries and the study finds the positive influence of the FS on economic growth.

Additional research provides support for a market-oriented FS utilizing advanced econometric methodologies. For instance, C. C. Yeh *et al* (2013) establish a correlation among the FS, economic growth, and growth volatility. This study employs a panel of 40 economies spanning between 1960 and 2009 in order to illustrate that a market-oriented FS promotes economic growth, albeit with increased long-term volatility. A study by K. B. Luintel, M. Khan, R. Leon-Gonzalez and G. Li (2016) contradicts the financial service perspective while simultaneously supporting the market-oriented view. The study analyzes a group of 33 high-income countries and 36 middle- and low-income countries from 1989 to 2011, employing a Bayesian framework. In contrast to the bank-oriented system, the market-oriented FS promotes the economic growth trajectory in the high-income countries. The FS does not significantly influence the economic growth trajectory in the middle- and low-income economies. F. Castro *et al* (2015) found that the FS significantly affected the investment behavior of the financially constrained firms, even when accounting for the degree of financial development among the Brazilian firms between 1998 and 2006.

An analysis of prior empirical studies identified significant knowledge gaps, particularly in African research, which the current study seeks to address. Notably, most previous investigations focused on financial development and growth trajectories. For instance, R. Dabi, M. Sari, N. Nugraha, D. Disman and E. Alghifari (2024) use an unbalanced panel dataset of 29 middle-income African countries from 1990 to 2019 in order to demonstrate the operation of the dynamic panel model in the economic growth-finance perspective nexus. Their findings demonstrate that any prevailing financial development significantly and positively influences growth performance, highlighting the importance of comprehensive advancements in the financial system for enhancing economic outcomes. Additional studies produce similar outcomes (see Bandura & Dzingirai, 2019; Asante *et al*, 2023; Fengju & Wubishet, 2024; Adu-

Darko, 2024). Furthermore, several studies examined the influence of the stock market development and institutional quality on economic growth (Mohammed, 2023; Eshun & Tweneboah, 2024; Mbulawa & Chingoiro, 2024).

Few studies have x-rayed the moderating impact of institutional quality on the FS-economic growth nexus in the context of the SSA economies. The investigation largely contributes to the existing literature by analyzing the moderating influence of institutional quality on the nexus between the FS and economic growth in the SSA countries.

METHODOLOGY

Model specification

The GMM panel estimation was utilized to model the effect of the FS systems on economic growth. The technique helps address the potential issue of the endogeneity of the explanatory variables. This model can categorically be expressed as follows:

$$GDPG_{i,t} = \alpha_{i,t} + FS_{i,t} + FS * IV_{i,t} + \sum_{i=1}^n Z_{i,t} + u_i + \lambda_i + \varepsilon_{it} \quad (1)$$

where *GDPG* denotes the GDP growth; *FS* denotes the financial structure; *IV* is the institutional variable; *FS*IV* captures the moderating effect; *Z* is the vector of the control variables (*TRADE*, *FDI*, *INE*, *FI*); and ε is the error term. The variables λ and u represent the time and country fixed effects, respectively. The subscripts t and i refer to the period and the economy, respectively. Following J. V. Bats and A. C. Houben (2020), the FS was proxied as the bank credit ratio divided by the sum of the stock market capitalization and the non-financial sector debt. The bank credit ratio was derived as the ratio of the bank credit to the private sector/GDP.

Following previous studies (see Butkiewicz & Yanikkaya, 2011; Madni & Chaudhary, 2017; Babajić,

Nurikić, Karabegović & Nuhanović, 2024; Efayena & Olele, 2024), the institutional quality variable (IV) was constructed from the six governance indicators (namely the absence of violence/terrorism, corruption control, the rule of law, political stability and voice and accountability, governance effectiveness, and regulatory quality), applying the principal component analysis (PCA) technique. Specifically, if the overall correlation among these variables is adequate to utilize the PCA was first examined. The Bartlett test of sphericity was used for that purpose. The test has the null hypothesis of no intercorrelation among the existing variables. The null hypothesis was accepted due to the results outlined in Table 1 (Panel A) at the 1% significance level. Furthermore, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was employed to see if the variables were adequate to construct an index. The KMO value of 0.874 exceeded the threshold of 0.6 (rule of thumb), indicating that the variables were adequate.

Thereafter, a factor analysis was carried out and the results revealed that only the factor 1 had an eigenvalue exceeding 1. Thus, the factor 1 accounting for 79.63% of the total variance was used in the construction of the IV index. In addition, the control variables include *FDI* (the foreign direct investment/GDP ratio), *FI* (the fixed investment/GDP ratio), *INF* (the log of inflation), and *TRADE* (the total trade/GDP ratio). Similar control variables were adopted by O. U. Oro and A. H. Ekpo (2020).

Furthermore, in order to address the potential issue of the reverse effects among the explanatory and dependent variables that may give rise to a simultaneity bias, the two-step fixed-effects GMM panel following

M. Arellano (2003) was applied. The proposed fixed-effects instrumental variable (FE-IV) model was aptly captured in the model generalization. Specifically, the model hinges on the premise that the instruments are exogenous, which can be expressed as:

$$E[Y'\epsilon] = 0 \tag{2}$$

where *Y* represents the vector of the instrumental variables. For the internal instruments, the fourth and fifth lags of the *FS* variable and the control variables are included. These internal instruments omit both shorter and longer lags, as the former may be correlated with current *gdpg* values and the latter may lead to a finite sample bias due to the overfitting of the instruments. To achieve the estimations consistent in the presence of heteroscedasticity, the study's weighting matrix employs White GMM weights. To assess the validity of the instruments, the Sargan test for overidentifying restrictions was used.

Data

This study employs the data sourced from the *World Governance Indicators* and the *World Development Indicators*, concentrating on a sample of 33 SSA economies. The dataset covers the period from 2006 to 2022. The study classified the SSA economies into two groups, following the World Bank's classifications - 'middle-income countries' (MICs) and 'low-income countries' (LICs), as delineated in Table 2. The length of the coverage period and the countries incorporated in the analysis are contingent upon data availability.

Table 1 The test for the intercorrelation of the variables

Index	Panel A		Panel B
	Bartlett test of sphericity		Kaiser-Meyer-Olkin test
	Chi-sq.	p-value	Stat.
Institutional quality (IV)	2071.39***	0.0000	0.874

Note: freedom degree = 32

Source: Authors

RESULTS AND DISCUSSION

Descriptive analysis

The descriptive statistics of the used datasets are explicitly delineated in Table 3.

The results show that the SSA region experienced mean growth of 3.86% during the period under consideration, this growth rate being relatively dismal given the region's enormous human and financial resources. Foreign direct investment (FDI) for the period is 3.65% of the GDP of the economy, whereas the maximum FDI is 160.11% of the GDP in SSA. The

outcomes show that trade for the region performed poorly, averaging 4% of the GDP during the period. The mean for the FS was recorded at 2.51.

To establish the skewness/direction of the association, a correlation analysis was carried out in the study, whose outcomes are presented in Table 4.

The correlation matrix (Table 4) indicates that the financial structure shows an adverse association with inflation, whereas it shows a positive nexus with FDI, fixed investment, and trade. The relatively low coefficients indicate that the issue of multicollinearity does not constitute a problem in the dataset.

Table 2 Classification of Countries

Middle-income countries (MICs)	Botswana, Cameroon, Nigeria, Gabon, Congo Rep, Sudan, Mauritius, Angola, Comoros, Kenya, Cote D'Ivoire, South Africa, Namibia, Ghana, Equatorial Guinea, Senegal, Seychelles,
Lower-income countries (LICs)	Niger, Congo Dem Rep, Burkina Faso, Mozambique, Ethiopia, Malawi, Tanzania, Benin, Rwanda, Sierra Leone, CAR, Guinea, Chad, Togo, Burundi, Uganda

Source: The World Bank (2020)

Table 3 Descriptive statistics

	χ	St. dev.	Min.	Max.
GDP growth (GDPG)	3.87	8.49	-51.05	69.32
Financial structure (FS)	2.51	5.77	-27.19	33.63
Foreign direct investment/GDP (FDI)	3.65	9.51	-81.05	160.11
Inflation (INF)	5.89	7.73	-3.58	51.73
Fixed investment/GDP (FI)	4.59	22.67	37.88	67.18
Trade/GDP (TRADE)	4.04	11.07	10.99	33.68

Note: min., max., st. dev., and χ , denote the minimum, the maximum, the standard deviation, and the mean, respectively.

Source: Authors

Table 4 The correlation matrix

Variable	GDPG	FS	FDI	INF	FI	TRADE
GDP growth (GDPG)	1.000					
Financial structure (FS)	-0.102	1.000				
Foreign direct investment/GDP (FDI)	0.043	0.042	1.000			
Inflation (INF)	-0.204	-0.210	-0.075	1.000		
Fixed investment/GDP (FI)	-0.113	0.131	0.212	-0.200	1.000	
Trade/GDP (TRADE)	0.077	0.103	0.066	-0.110	0.146	1.000

Source: Authors

Cross-sectional dependence (C-D) test

Prior to examining the unit root test of the variables used, it is essential to estimate or conduct a panel C-D test in order to determine the potential interdependence between the economies over time. C-D may emanate from country-specific dynamics

and ignoring such C-D in panel estimations may culminate in the size distortions and a substantial bias. To tackle the issue, the Pesaran-scaled LM, Breusch-Pagan LM, bias-corrected scaled LM, and Pesaran C-D tests were employed. Table 5 outlines the outcomes of the mentioned tests.

Table 5 The cross-section dependence tests

	Breusch-Pagan LM	Pesaran-scaled LM	Bias-corrected scaled LM	Pesaran C-D
Overall sample				
GDPG	632.13 ^{***} (0.0000)	81.33 ^{***} (0.0000)	79.09 ^{***} (0.0000)	14.27 ^{***} (0.0000)
FS	528.61 ^{***} (0.0000)	37.14 ^{***} (0.0000)	35.25 ^{***} (0.0000)	13.49 ^{***} (0.0000)
TRADE	238.62 ^{***} (0.0000)	20.05 ^{***} (0.0000)	18.63 ^{***} (0.0000)	9.17 ^{***} (0.0000)
FDI	204.19 ^{***} (0.0000)	22.65 ^{***} (0.0000)	19.09 ^{***} (0.0000)	9.61 ^{***} (0.0000)
FI	201.06 ^{***} (0.0000)	22.17 ^{***} (0.0000)	19.00 ^{***} (0.0000)	9.24 ^{***} (0.0000)
INF	196.43 ^{***} (0.0000)	20.32 ^{***} (0.0000)	18.81 ^{***} (0.0000)	8.12 ^{***} (0.0000)
Low-income countries (LICs)				
GDPG	218.09 ^{***} (0.0000)	36.14 ^{***} (0.0000)	34.07 ^{***} (0.0000)	12.54 ^{***} (0.0000)
FS	207.13 ^{***} (0.0000)	33.71 ^{***} (0.0000)	33.06 ^{***} (0.0000)	12.81 ^{***} (0.0000)
TRADE	135.01 ^{***} (0.0000)	28.65 ^{***} (0.0000)	28.02 ^{***} (0.0000)	7.91 ^{***} (0.0000)
FDI	108.05 ^{***} (0.0000)	27.82 ^{***} (0.0000)	26.09 ^{***} (0.0000)	7.13 ^{***} (0.0000)
FI	106.11 ^{***} (0.0000)	25.79 ^{***} (0.0000)	24.09 ^{***} (0.0000)	7.02 ^{***} (0.0000)
INF	103.49 ^{***} (0.0000)	22.09 ^{***} (0.0000)	20.65 ^{***} (0.0000)	5.52 ^{***} (0.0000)
Middle-income countries (MICs)				
GDPG	464.22 ^{***} (0.0000)	49.16 ^{***} (0.0000)	46.05 ^{***} (0.0000)	15.71 ^{***} (0.0000)
FS	451.35 ^{***} (0.0000)	45.60 ^{***} (0.0000)	44.13 ^{***} (0.0000)	14.09 ^{***} (0.0000)
TRADE	150.09 ^{***} (0.0000)	38.27 ^{***} (0.0000)	36.42 ^{***} (0.0000)	9.07 ^{***} (0.0000)
FDI	139.05 ^{***} (0.0000)	36.61 ^{***} (0.0000)	36.04 ^{***} (0.0000)	8.99 ^{***} (0.0000)
FI	121.76 ^{***} (0.0000)	34.08 ^{***} (0.0000)	33.91 ^{***} (0.0000)	8.07 ^{***} (0.0000)
INF	103.92 ^{***} (0.0000)	31.74 ^{***} (0.0000)	30.48 ^{***} (0.0000)	6.26 ^{***} (0.0000)

Note: (***) (**)(*) denote significance at the 1%, 5% and 10% significance levels, respectively.

Source: Authors

Table 5 shows the output for the whole sample, as well as LICs and MICs. The output shows that the null hypothesis of no C-D in both LICs and MICs was predominantly rejected by the four C-D tests, which implies the presence of C-D in the data. Consequently, these findings suggest employing the second-generation unit root tests specifically designed to adequately capture the potential effects of cross-sectional dependence.

Panel unit root tests

The identification of the presence of the cross-sectional dependence among the variables propels the use of the panel unit root tests (the second-generation type) for conducting unit root analyses. Table 6 presents the results of the stationarity tests.

The outcomes of the second-generation unit root tests delineated in Table 6 indicate the integration of the order-one variables [I(1)]. These findings reject stationarity at the levels, simultaneously supporting stationarity in their first difference.

Panel cointegration tests

The identification of all the variables under investigation as I(1) necessitates a critical assessment of their cointegration. Three tests were used to achieve this objective: the Kao test (Kao, 1999), the Pedroni tests, and the Westerlund test (Westerlund, 2005). Table 7 displays the findings of these tests, specifically in Panels A, B, and C.

The results of the Pedroni cointegration test accounted for in Table 7 (Panel A) show that all the variables

Table 6 The stationarity tests

	Bai and Ng - PANIC		Pesaran-CIPS	
	Level	First Diff.	Level	First Diff.
Overall sample of SSA				
GDPG	-0.2318	-3.6825***	-0.4307	-4.5504***
FS	-0.6121	-3.3741***	-0.3361	-5.5169***
TRADE	-0.4502	-3.6984***	-0.4781	-2.5412**
FDI	-0.3821	-3.7811***	-0.3068	-2.5714**
FI	-0.2508	-3.7251***	-0.4414	-4.5672
INF	-0.3881	-3.7985***	-0.3170	-2.6483
Low-income countries (LICs)				
GDPG	-0.1603	-3.3561***	-0.2417	-6.2054***
FS	-0.2799	-2.0296**	-0.3820	-3.8514***
TRADE	-0.7437	-3.3518***	-0.3305	-2.6811**
FDI	-0.4163	-2.5033**	-0.2045	-2.5789**
FI	-0.4008	-2.5009**	-0.2118	-2.7094**
INF	-0.1611	-3.3578***	-0.2462	-6.3127***
Middle-income countries (MICs)				
GDPG	-0.2791	-2.3164**	-0.5821	-4.4314***
FS	-0.1605	-3.8373***	-0.3811	-4.7045***
TRADE	-0.2691	-3.1892***	-0.5104	-4.6206***
FDI	-0.1187	-3.0477***	-0.3507	-3.1043***
FI	-0.1628	-3.8419***	-0.3821	-4.7106***
INF	-0.1136	-3.0365***	-0.3513	-3.1164***

Note: The null hypothesis rejected at the 1% (***) and 5% (**) significance levels.

Source: Authors

Table 7 The panel cointegration outcomes

Panel A. Panel cointegration tests						
	Full sample		LICs		MICs	
	stat.	prob.	stat.	prob.	stat.	prob.
<i>Pedroni panel test ('within dimension')</i>						
'Panel v-statistic'	-1.8103	0.8043	-1.9262	0.8001	-1.9199	0.9652
'Panel rho-statistic'	-0.7031	0.8541	-0.6571	0.7106	-0.5704	0.5117
'Panel PP-statistic'	-11.2184	0.0000	-6.2714	0.0000	-9.6108	0.0000
'Panel ADF-statistic'	-8.5032	0.0000	-4.5401	0.0000	-5.4351	0.0000
<i>Pedroni panel ('between dimension')</i>						
'Group rho-statistic'	1.0773	0.7651	0.3931	0.5307	0.6399	0.5032
'Group PP-statistic'	-18.6035	0.0000	-12.2950	0.0000	-14.0308	0.0000
'Group ADF-statistic'	-8.2048	0.0000	-4.7006	0.0000	-4.2052	0.0000
Panel B. Kao residual cointegration test						
	Full sample		LICs		MICs	
	stat.	p-value	stat.	p-value	stat.	p-value
ADF	-6.5022	0.0000	-4.7352	0.0002	-6.0144	0.0000
Panel C. Westerlund (2005) cointegration test						
	Full sample		LICs		MICs	
	stat.	p-value	stat.	p-value	stat.	p-value
Variance ratio	-5.6132	0.0000	-3.7705	0.0002	-5.0317	0.0000

Source: Authors

included in the model for the full sample, along with LICs and MICs, demonstrate cointegration. The significant values of the Panel ADF-Statistic, Panel PP-Statistic, Group ADF-Statistic, and Group PP Statistic are all significant at the 1% level. The outcomes of the Kao test (Kao, 1999) [see Panel B] and the Westerlund test (Westerlund, 2005) [see Panel C] further confirm the cointegration of the variables across both the full sample and the income groups. These statistically significant statistics provide the evidence for this assertion.

Empirical estimation

Table 8 presents the FE-GMM panel results. As is previously mentioned, the results are heteroscedastic-consistent. The outcomes of the Sargan test of over-identification restrictions are also presented in Table 8.

Notably, Sargan test demonstrates that each estimation accepted the null hypothesis of the valid instruments. The estimates imply that in the LICs, the bank- and

market-oriented FSs are associated with lower and higher economic growth, respectively. This variation is possibly caused by the fact that in the LICs, the market-oriented financial structures often facilitate greater economic growth by fostering competition, promoting innovation, and ensuring efficient capital allocation. The bank-oriented systems typically display a higher level of risk aversion and rigidity, potentially leading to inefficiencies and impeding economic growth, especially in the dynamic or emerging sectors that require flexible and diverse financial sources (Oro & Ekpo, 2020). Regionally, the results suggest that the bank- and market-oriented FSs are associated with lower and higher economic growth, respectively.

Conversely, the estimates suggest that, in the MICs, the bank- and market-oriented FSs are associated with higher and lower economic growth, respectively, which is so for several possible reasons. For instance, in such economies, the bank-oriented financial systems offer stability, relationship-orientated

Table 8 The fixed effect GMM estimations

Dependent variable: GDPC			
Variable	Full Sample	LICs	MICs
FS	-0.2703 ^{***} (0.0000)	-0.3191 ^{**} (0.0038)	0.0740 ^{***} (0.0001)
FS*IV	-0.0401 ^{***} (0.0000)	-0.0169 [*] (0.0052)	-0.0310 ^{***} (0.000)
FDI	-0.8006 (0.0913)	-0.1772 ^{**} (0.0015)	-0.2616 (0.1301)
TRADE	0.1688 (0.0710)	0.0519 (0.1042)	0.0349 (0.1335)
FI	0.0682 ^{***} (0.0000)	0.1057 ^{***} (0.0000)	0.1953 ^{**} (0.0031)
INF	-0.1073 (0.0001)	-0.3107 ^{**} (0.0028)	-0.1572 ^{***} (0.0000)
'Country fixed effects'	Yes	Yes	Yes
'Time fixed effects'	Yes	Yes	Yes
Sargan test	0.43	0.38	0.40

Note: (***), (**) and (*) denote significance at the 1%, 5% and 10% significance levels, respectively.

Source: Authors

lending, and long-term financing essential to business growth, especially in the contexts characterized by underdeveloped capital markets and information asymmetries. These elements enhance the capacity of the banks to foster growth within these economies (Demirgüç-Kunt & Levine, 2001; Bats & Houben, 2020; Liu & Zhang, 2020). However, these nations' financial systems characterized by the market-oriented approach frequently show underdevelopment, susceptibility to volatility, and inefficiencies in directing resources to their most critical applications, potentially leading to diminished economic growth relative to bank-centric systems (Demirguc-Kunt & Maksimovic, 2002; Dabi *et al*, 2024). Explicitly, the results suggest the need to expand credit by financial institutions in SSA, especially in the LICs. In such economies, capital markets stimulate the economic growth trajectory more than the banking sector, which supports the findings of L. Gambacorta *et al* (2014), who suggested that banks slowed the reversal of the downward business cycles and took longer to reach equilibrium than the capital markets did.

The variable encapsulating the interactive impact(s) of FSs and institutional quality (FS*IV) on growth

presents several policy implications. According to Table 6, the variable shows a statistically significant negative effect for the region (SSA) and among the LICs, while showing a positive effect for the MICs. Regionally, the results indicate that institutional quality does not significantly enhance the positive contribution the financial structure makes to economic growth in SSA. Instead, institutional quality diminishes the growth effects of the FS, especially in the MICs. The finding further indicates that institutional quality significantly exacerbates the decelerating economic growth within SSA, particularly in the LICs.

A possible reason for the foregoing outcome lies in institutional corruption widespread in many SSA economies, which serves as a catalyst for resource misallocation away from their intended productive purposes, hindering investment and undermining public confidence in governmental institutions. Such corruption may hinder economic growth because of its negative influence on the efficacy of resource allocation and its discouraging effect on both international and domestic investments. Moreover, the SSA countries often encounter political instability,

marked by the recurring cycle of governmental transitions and intermittent conflicts (Efayena, Olele & Buzugbe, 2024). Political instability may foster an environment of uncertainty, potentially impeding the progress of economic development. Investors often demonstrate hesitance in committing themselves to long-term investments in the areas characterized by instability. The existence of cumbersome and ineffective bureaucratic processes exacerbates the circumstances, dissuading entrepreneurial endeavours and hindering economic growth. Establishing and overseeing a business often involves the complex and laborious task of manoeuvring various protocols, which may dissuade prospective investors from both domestic and foreign entities.

The results also show that, although trade positively impacts economic growth in both groups of countries in SSA, irrespective of their income classification, the effect is not statistically significant. In addition, FDI had a negative effect, which was statistically insignificant across the panels. These findings reiterate the need to stimulate both FDI and trade in the region.

CONCLUSION

In this study, the moderating effect of institutional quality on the FS-economic growth nexus in 33 SSA economies classified by income between 2006 and 2022 is assessed. Despite the importance or essence of institutional variables, there is a lack of studies investigating the moderating influence of institutional quality on the FS and economic growth relationship in the SSA economies. The study utilized the two-step fixed-effects generalized method of moments (GMM) to address endogeneity and other econometric concerns. The empirical findings indicate that, in the LICs, the bank-oriented FSs are associated with lower economic growth, whereas the market-oriented FSs are associated with enhanced economic growth. Conversely, in the middle-income economies, the bank-oriented FSs are associated with high economic growth, whereas the market-oriented FSs are associated with reduced economic growth.

Furthermore, the study demonstrates that the quality of institutions does not significantly enhance the FS growth effect in SSA. The disaggregated findings indicate that institutional quality alleviates the growth impacts of the FSs in the MICs, whereas it markedly intensifies the decline in economic growth in the LICs. The results reveal considerable policy ramifications and economic drives. The SSA economies should undertake a thorough assessment of their existing institutional framework with the aim of uncovering any flaws or inadequacies that hinder the potential of the financial framework to promote the growth trajectory. It is essential to advance the current capital markets by improving their capital structure, particularly among the LICs. The study shows that the non-banking and stock markets exhibit greater activity and efficiency than the banks in the context of the MICs compared to the LICs. Moreover, the stock markets in these countries exhibit greater efficiency and activity compared to their banking systems. In those countries, there is a propensity to adopt a more market-orientated approach as their wealth increases. The study suggests that the economies characterized by high institutional quality are generally market-orientated, whereas those with low institutional quality often exhibit underdeveloped financial systems. Therefore, a synergy between the banking systems and the capital markets in SSA is highly essential. Public-private partnership arrangements in SSA can help achieve this goal. The SSA economies should diligently implement contextual policy reforms tailored to improve their banking and capital markets.

Despite its policy significance, the study has several limitations. For instance, the analysis excluded financial development due to the availability of adequate proxies among the SSA nations. Financial development may affect the degree of the influence that institutional quality has on the nexus between the FS and the economic growth trajectory. Given these limitations, subsequent studies should meticulously incorporate financial development in their assessments of the nexus between the FS and economic growth. The moderating effect of the institutional quality indicators on the financial services-economic growth nexus also needs to be

evaluated sector-by-sector so as to ensure a holistic investigation.

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Received on 9th December 2024,
after revision,
accepted for publication on 10th July 2025.
Published online on 8th August 2025.

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Original scientific paper

UDC: 336.76

doi:10.5937/ekonhor2502135G

ENERGY-RELATED UNCERTAINTY AND STOCK MARKET VOLATILITY: EVIDENCE FROM THE WEALTHIEST ECONOMIES IN THE WORLD THROUGH THE GARCH-MIDAS APPROACH

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This study aims to analyze the effect energy-related uncertainty has on the volatility of the stock markets of 18 developed and developing countries ranking among the wealthiest according to their GDP. The study focuses on understanding how EUI influences market dynamics and volatility patterns across different economies. Using the GARCH-MIDAS approach, this research examines stock market indices from January 2003 to October 2022. The analysis reveals that all stock market indices are influenced by EUI. Notably, the S&P-TSX index exhibits the lowest MIDAS weight, indicating that Canada's market volatility is the least affected by EUI. Conversely, the highest MIDAS component weights are observed in the markets of China and the United Kingdom. The EUI shows the greatest influence on the volatility of the Indian and Chinese markets, whereas its influence is minimal on the Brazilian and Canadian markets.

Keywords: energy uncertainty, realized volatility, risk management, GARCH-MIDAS

JEL Classification: C58, G32, K32, Q43

INTRODUCTION

The growth of global economies has helped nations to develop new infrastructures, reduce scarcity, and improve the living standards of their citizens. These high exploitation ratios raise serious environmental concerns, namely biodiversity loss, land degradation and increasing water and air pollution levels. Failure to achieve the sustainable society and pollution

reduction goals envisioned by the United Nations Sustainable Development Goal can lead to enormous environmental shortfalls (Langnel & Amegavi, 2020; Alvarado, Ortiz, Jiménez, Ochoa-Jiménez & Tillaguango, 2021; Hussain, Mir, Usman, Ye & Mansoor, 2022). Therefore, states must develop new energy policies aligning with the world's changes and developments.

Energy policy encompasses strategies for energy consumption, production, and supply, serving as a crucial tool for governments to address energy

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challenges and economic development. Governments often adjust these policies in response to changing national and international conditions, leading to policy uncertainty. Recent examples include Germany, Austria, and Italy restarting coal-fired power plants despite committing to zero carbon targets, and the Netherlands lifting restrictions on coal plants to secure clean energy by 2030. Similarly, thanks to its energy policy, China has made significant progress in the energy market over the past 40 years. However, the clash of multiple objectives in the Chinese energy market may lead to uncertainty in energy policy by changing the scope of macro regulation in different periods (He & Xu, 2024).

Recent global turmoil, including political polarization, trade frictions, the COVID-19 pandemic, and the Russian-Ukrainian and Israeli-Palestinian conflicts, has heightened concerns about rising uncertainty. Researchers have begun to utilize various indices, such as the economic policy uncertainty index and the climate policy uncertainty index so as to assess different forms of uncertainty. In this context, the energy uncertainty index (EUI) has gained importance in financial markets, particularly amid fluctuations in global energy markets and deepening economic globalization. While many studies have analyzed the influence of specific energy prices, particularly crude oil, on financial markets, focusing solely on these prices limits a comprehensive understanding of the energy market. A holistic view can help regulators develop effective safeguards and provide traders with better insights into energy market risks. To address this, T. H. N. Dang, C. P. Nguyen, G. S. Lee, B. Q. Nguyen and T. T. Le (2023) introduced the EUI, which captures uncertainty in the energy market through various measures, including exports, imports, supply, demand, policies, and prices. Unlike traditional financial uncertainty proxies, the EUI is tailored to reflect energy market-related uncertainties, making it a better indicator of risks associated with oil and geopolitical crises.

According to the current value model of asset prices, market volatility is linked to the time-varying nature of cash flows and discount factors, suggesting a connection between uncertainty and

asset market volatility regarding expected cash flows (Shiller, 1981; Bernanke, 1983). Economic conditions primarily influence expected cash flows and interest rates; thus, ambiguity about future macroeconomic circumstances can shift asset return volatility (Schwert, 1989). This research aims to explore the influence of EUI on stock market volatility in the world's wealthiest economies.

There are three primary motivations for this current research. Firstly, the EUI developed by T. H. N. Dang *et al* (2023) hinders economic action and outcomes at the national and sectoral levels. The connection between stock return volatility and the EUI becomes clearer, providing valuable insights for investors into portfolio selection and risk management. The findings are also significant for the policymakers focused on market volatility drivers and the stability of the global financial system. Daily volatility estimation is essential for accurately measuring fluctuations and generating out-of-sample high-frequency forecasts. This approach aids traders in making timely investment decisions and enhances the quality of daily forecasts related to the expected shortfall and value-at-risk estimates.

Volatility in equity returns, representing financial market uncertainty, poses a significant policy constraint that can negatively affect economic activities. Thus, the high-frequency forecastability of equity market uncertainty enables policymakers to use MIDAS-based models to predict low-frequency indicators, helping to avoid potential stagnation. Thirdly, the previous literature has generally emphasized the effects of the EUI on equity returns (Imbet, 2022; Li, Pei, Yang & Zhang, 2024; Kayani, Sheikh, Khalifaoui, Roubaud & Hammoudeh, 2024; Wang, Huang & Huang, 2024; Zhang, 2024), so the number of the studies measuring the response of stock return volatility (Salisu, Ogbonna, Gupta & Cepni, 2024b; Salisu, Ogbonna, Gupta & Bouri, 2024c) remains entirely restricted. In addition, to the best of our knowledge, research needs to be done in the world's wealthiest countries. Due to the foregoing points, this research study will contribute to the literature.

The rest of the research paper is structured into the following sections: Section 2 summarizes the existing literature on the topic, Section 3 introduces the dataset and the methodology, Section 4 presents the empirical evidence and the last, section 5, concludes the paper and draws policy implications.

LITERATURE REVIEW

While many scholars have examined the influence of trade, geopolitical, and climate policy uncertainty on the global economy, the added complexity of energy-related uncertainty (EUI) and its interplay with other uncertainties presents the challenge that needs careful attention. As a result, economic stakeholders and policymakers have increasingly focused on the EUI as a vital concern for global financial conditions. This section summarizes the studies exploring the relationship between the EUI and macroeconomic factors and financial market indicators.

Among these research studies, M. Chiah, D. H. B. Phan, V. T. Tran and A. Zhong (2022) suggested that the value premium was significantly more pronounced when the EUI was high. T. H. N. Dang *et al* (2023) reported through VAR models that the EUI strongly responded to oil shocks, including sharp declines in oil prices and rises during the global financial crisis, the European debt crises, the COVID-19 pandemic, and the Russian invasion of Ukraine. Employing panel regression models, H. Ali, S. Kumar, M. Asim and W. Sajjad (2024) revealed a statistically significant inverse relationship between the EUI and institutional investment. X. He and C. Xu (2024) argued that EUI had a positive influence on energy efficiency using the basic panel regression analysis based on the panel data from provincial-level cities in China. M. Shahbaz, M. S. Meo, H. W. Kamran and M. S. ul Islam (2024) observed that the EUI positively affected CO₂ emissions from the power generation and transport sectors, analyzed using a time-varying bootstrap rolling window causality test.

Applying the GARCH-MIDAS approach, A. A. Salisu, A. E. Ogbonna, R. Gupta and Q. Ji (2024a) found that

country-specific EUIs significantly outperformed the benchmark for at least 14 currencies at short-, medium- and long-term forecast horizons. H. Xu, Y. Wang, J. Chen, H. Lin and P. Yu (2024) concluded that there was an asymmetric relationship between the EUI and Bitcoin volatility. X. Zhang and Q. Guo (2024) reported that positive or negative changes in the EUI contained information about oil price volatility. O. Usman, O. Ozkan, A. Koy and T. S. Adebayo (2024) employed quantile-on-quantile regression models to examine the impact of EUI shocks on US inflation and concluded that EUI shocks acted as cost-push shocks and raised inflation.

Several studies have explored the relationship between energy-related uncertainty index (EUI) and stock markets. J. F. Imbet (2022) found that EUI had a positive influence on stock returns on the NYSE AMEX and Nasdaq, as companies increased investments to hedge against future energy costs. U. Kayani *et al* (2024) reported that adverse global EUI shocks boosted stock returns in the consumer services, financials, healthcare, and industrial sectors, while positive shocks decreased returns in the materials and technology sectors. H. Li *et al* (2024) used the R² connectedness approach to show that the EUI uniquely influenced market shock transmission in G20 countries. Additionally, A. A. Salisu *et al* (2024b) demonstrated that the GARCH-MIDAS model incorporating the EUI outperformed the traditional GARCH-MIDAS realized volatility in 37 out of 50 US states. In a related study, A. A. Salisu *et al* (2024c) found that increases in both global and country-specific energy-related uncertainty indices (EUI) raised stock market return volatility in 28 developed and emerging economies. Y. Wang *et al* (2024) used an out-of-sample R² test to show that the EUI outperformed both global and US EUIs in predicting Chinese stock returns. Lastly, X. Zhang (2024) employed a supervised dimensionality reduction technique to argue that the country-specific EUI held predictive value for stock market returns in the US and China.

The literature review reveals that the EUI concept is either defined by individual indices, created within the framework of the sample of the study (Chiah *et al*, 2022; Imbet, 2022; He & Xu, 2024) or by the

EUI introduced by T. H. N. Dang *et al* (2023) (Ali *et al*, 2024; Kayani *et al*, 2024; Li *et al*, 2024; Salisu *et al*, 2024a; Salisu *et al*, 2024b; Salisu *et al*, 2024c; Shahbaz *et al*, 2024; Wang *et al*, 2024; Xu *et al*, 2024; Zhang, 2024; Zhang & Guo, 2024). Moreover, the evaluation of country-specific research in the relationship between the EUI and stock markets reveals that the research focus is on the US and China (Imbet, 2022; Kayani *et al*, 2024; Salisu *et al*, 2024b; Wang *et al*, 2024; Zhang, 2024), G20 countries (Li *et al*, 2024) and 28 developed and developing countries (the MSCI indices of countries) (Salisu *et al*, 2024c). These points highlight that the current research will contribute to the world of science.

DATA SET AND METHODOLOGY

The data set and preliminary analysis

In this research study, the relationship between the EUI and stock market volatility is analyzed, focusing on 18 of the 25 wealthiest economies in the world according to the GDP weighted by purchasing power parity and their benchmark stock market data. The review covers the USA, China, Germany, Japan, India, United Kingdom, France, Brazil, Italy, Canada, Russia, Mexico, Australia, South Korea, Spain, Netherlands, Belgium and Sweden. The data on the stock markets consist of the daily data for the period between January 2003 and October 2022, while the index data on the EUI includes the monthly data for the same period. The data on the countries' energy-related uncertainties were obtained from *policyuncertainty.com*, and the data on the major stock indices were obtained from *investing.com*. The stock market return series with the formula $r_t = \ln(p_t) - \ln(p_{t-1})$ were obtained, and the series of changes in the EUI with the formula $EUC_t = \ln(Y_t) - \ln(Y_{t-1})$ were calculated. Tables 1 and 2 present the descriptive statistics of the stock market returns and the series of changes in the EUI, respectively.

Table 1 shows that the null hypothesis saying that the stock market return series are not normally distributed is accepted, based on the J-B statistics of

all the variables. According to the standard deviation values of the variables, Russia has the highest deviation value, which strengthens this argument. The fact that the skewness values of all the series are negative means that there are more negative than positive returns in the series, and the series exhibit a left-weighted structure. Moreover, the kurtosis values of the return series are positive and far from 3, suggesting that the series exhibit a leptokurtic distribution.

Table 2 displays the descriptive statistics of the countries' EUIs. According to Table 2, Germany's EUI, Belgium's EUI and the Netherlands' EUI have the highest standard deviation among all the variables. Therefore, there is a significant variation in energy use in these countries. The kurtosis coefficients of all the variables indicate that the series have a pointed distribution, and the positive skewness values signal a positive asymmetry. The null hypothesis saying that not all EUI series are normally distributed based on the J-B statistic values is also accepted. This fact reflects occasional abnormal increases or decreases in energy use.

Additionally, the ARCH-LM test benefits the preliminary examination of whether the data are suitable for modelling with ARCH group models or not. Table 3 contains the heteroskedasticity status of the stock market indices returns. Since EUIs constitute the MIDAS component of the GARCH-MIDAS approach, no case of heteroskedasticity is examined.

The ARCH-LM-F statistics of the series presented in Table 3 are the proof of a very strong heteroskedasticity in all the return series, and the F test results are statistically significant. All the stock return series are suitable for modelling with the ARCH group. More precisely, the results reveal that the return variance varies over time, and that heteroskedasticity should be taken into consideration in financial models.

Moreover, the ARCH group models assume that the series are stationary and perform better in stationary series, for which reason the stationarity of the series is examined applying the ADF and PP unit root tests, and the results of the unit root tests are given in Table 4.

Table 1 The descriptive statistics of the stock market return series

Indices	Median	Std. Dev.	Skew	Kurt.	J-B Stat
Australia-S&P ASX 200R	0.000924	0.012315	-0.650239	11.64456	11224.14 (0.000)
Belgium-BEL 20R	0.000511	0.014601	-0.673863	13.64478	16909.38 (0.000)
Brazil-BOVESPAR	0.001044	0.020186	-0.491159	11.94317	11888.84 (0.000)
Canada-S&P TSXR	0.000868	0.012661	-1488431	28.53260	97051.38 (0.000)
China-Shanghai CompositeR	0.000385	0.017987	-0.347449	7.859676	35395.90 (0.000)
France-CAC 40R	0.000794	0.015992	-0.315777	11.88688	11658.27 (0.000)
Germany-DAXR	0.001003	0.016065	-0.281612	11.19076	99002.30 (0.000)
India-Nifty 50R	0.001221	0.016781	-0.295909	14.91002	20885.46 (0.000)
Italy-FTSE MIBR	0.000795	0.017972	-0.893351	15.02027	21690.38 (0.000)
Japan-Nikkei 225R	0.000697	0.016513	-0.456755	10.43208	82353.19 (0.000)
Mexico-S&P BMV IPCR	0.000898	0.014022	-0.390167	14.05117	18027.02 (0.000)
Netherlands-AEXR	0.000809	0.015392	-0.416854	12.67066	13838.10 (0.000)
Russia-MOEXR	0.001031	0.025035	-2.711112	52.54823	364900.2 (0.000)
South Korea-KOSPI CompositeR	0.000717	0.014977	-0.364287	11.21204	99828.65 (0.000)
Spain-IBEX35R	0.000769	0.016697	-0.618457	13.14377	15337.58 (0.000)
Sweden-OMX StockholmR	0.001209	0.014861	-0.464126	10.75073	89499.05 (0.000)
United Kingdom-FTSE 100R	0.000601	0.013323	-0.444395	14.03463	17999.97 (0.000)
United States-S&P 500R	0.001000	0.013784	-0.566982	14.87402	20897.10 (0.000)

Source: Authors

According to the ADF and PP unit root test results, all the series are stationary at the same level, for which reason the analyses continue with the level values of the series. As a result, due to the different data frequencies, the GARCH-MIDAS approach is preferred, which allows the analysis of the high- and low-frequency data in the same model.

Methodology - the GARCH-MIDAS approach

The GARCH-MIDAS model is the approach that allows the examination of the low- and high-frequency data together. In other words, the model allows combining data at different frequencies. The model consists of the MIDAS and GARCH components.

Table 2 The descriptive statistics of the EUIs

EUI	Median	Std. Dev.	Skew.	Kurt.	J-B Stat
AUSTRALIA_EUI	-0.032899	0.629900	2.410080	13.03357	1223.576
BELGIUM_EUI	-0.013579	1.775903	11.47654	156.6938	238467.8
BRAZIL_EUI	-0.009946	0.512095	2.329233	12.46525	1099.011
CANADA_EUI	0.007923	0.882412	4.045437	30.63148	8185.991
CHINA_EUI	0.010431	0.941082	3.647672	23.61911	4723.903
FRANCE_EUI	-0.009946	0.512095	2.329233	12.46525	1099.011
GERMANY_EUI	-0.015919	1.137762	7.745261	84.21153	67498.28
INDIA_EUI	-0.005771	0.648815	1.514469	5.397004	147.3360
ITALY_EUI	0.005883	0.532913	1.828630	9.339375	528.9369
JAPAN_EUI	-0.027112	0.619586	1.736086	7.372009	307.8082
MEXICO_EUI	-0.020979	0.458390	1.520524	6.477787	210.7619
NETHER_EUI	0.007650	1.074568	5.812537	53.03923	26060.78
RUSSIA_EUI	-0.023487	0.485089	1.318556	5.178122	115.5234
S. KOREA_EUI	-0.009648	0.525511	1.958862	9.439631	561.0720
SPAIN_EUI	-0.019628	0.753895	2.620134	13.38654	1336.488
SWEDEN_EUI	-0.020971	0.803585	2.531535	11.82132	1021.572
UK_EUI	0.007358	0.410758	1.300376	5.642251	135.7359
USA_EUI	-0.009914	0.685486	1.891441	8.630056	454.3263

Source: Authors

The short-term component follows the standard GARCH process, whereas the long-term component incorporates the low-frequency variables through the MIDAS approach (Wu, Mei & Ding, 2022).

The MIDAS component includes the low-frequency data. The model analyzes the effect of the low-frequency data on the volatility of the high-frequency data. The GARCH component is the first stage of this two-component model. For the returns with a constant conditional mean and conditional volatility, the model is specified as expressed in Equation 1:

$$r_{i,t} = \mu + \sqrt{\tau_t \times g_{i,t}} \times \varepsilon_{i,t}, \forall i = 1, \dots, N_t \tag{1}$$

and

$$\varepsilon_{i,t} | \phi_{i-1,t} \sim N(0,1) \tag{2}$$

where $\phi_{i-1,t}$ denotes the information available on the day $i-1$ of the period t . The second item on the

right-hand side of Equation (1), the conditional variance part, is decomposed into two parts. The first component is the short-term component $g_{i,t}$ with a higher frequency, assumed to follow the traditional GARCH(1,1) process. The second component is the long-term volatility captured by i in the rolling window framework. The conditional variance is stated in Equation 3:

$$g_{i,t} = (1 - \alpha - \beta) + \alpha \frac{(r_{i-1,t} - \mu)^2}{\tau_i} + \beta g_{i-1,t} \tag{3}$$

The parameter μ in Equation 3 is the unconditional mean return, α and β being the ARCH and GARCH terms, where $\alpha > 0$, $\beta \geq 0$ and $\alpha + \beta < 1$ are required. τ_i is defined as the realized volatility adjusted following the MIDAS regression, expressed as in Equation 4 (Asgharian, Hou & Javed, 2013):

Table 3 The ARCH-LM test results

Variables	ARCH-LM F Test
United States- S&P 500R	487.4448***
China- Shanghai CompositeR	57.34925***
Germany- DAXR	273.1774***
Japan-Nikkei 225R	296.5299***
India-Nifty 50R	91.50384***
United Kingdom-FTSE 100R	553.0609***
France-CAC 40R	355.6342***
Brazil-BOVESPAR	493.8389***
Italy-FTSE MIBR	314.5327***
Canada-S&P TSXR	636.8492***
Russia-MOEXR	360.6114***
Mexico-S&P BMV IPCR	49.11086***
Australia-S&P ASX 200R	482.2495***
South Korea-KOSPI CompositeR	184.9784***
Spain-IBEX35R	316.1572***
Netherlands-AEXR	324.7613***
Belgium-BEL 20R	241.1024***
Sweden-OMX StockholmR	230.1203***

Source: Authors

$$\tau_i = m + \theta \sum_{k=1}^K \varphi_k(w_1, w_2)RV_{t-k}$$

$$RV_t = \sum_{i=1}^{N_t} r_{i,t}^2 \tag{4}$$

where K is the number of the volatility-smoothed periods. This equation can be further modified to include economic variables along with RV in order to examine the effect of the variables on the long-term return variance, as in Equation 5:

$$\tau_t = m + \theta_1 \sum_{k=1}^K \varphi_k(w_1, w_2)RV_{t-k}$$

$$+ \theta_2 \sum_{k=1}^K \varphi_k(w_1, w_2)X_{t-k}^l$$

$$+ \theta_3 \sum_{k=1}^K \varphi_k(w_1, w_2)X_{t-k}^v \tag{5}$$

where X_{t-k}^l indicates the level of the macroeconomic variable and X_{t-k}^v refers to the variance of the macroeconomic variable, i.e. the variance of the low-frequency data. As a result, the total conditional variance is shown in Equation 6:

$$\sigma_{it}^2 = \tau_t \cdot g_{i,t} \tag{6}$$

The beta lag polynomial describes the weighting scheme used in the equations 4 and 5, as in Equation (7):

$$\varphi_k(w) = \frac{\left(\frac{k}{K}\right)^{w_1-1} \left(1 - \frac{k}{K}\right)^{w_2-1}}{\sum_{j=1}^K \left(\frac{j}{K}\right)^{w_1-1} \left(1 - \frac{j}{K}\right)^{w_2-1}} \tag{7}$$

In the empirical implementation of this research, the constraint $w=1$ is used, which implies that the weights are monotonically decreasing. However, R. F. Engle, E. Ghysels and B. Sohn (2013) estimate the GARCH-MIDAS model using the maximum likelihood estimation and construct the heteroskedasticity and autocorrelation consistent (HAC) standard errors.

RESULTS AND DISCUSSION

The parameters of the GARCH model are significant for all the variables and reveal volatility persistence in the stock market return series. In addition, the MIDAS parameters are also significant for all the variables. Separate models are constructed for each variable and the parameter estimates for all the models are given in Table 5.

The parameter μ in Table 5 represents the average return, the parameter α reflects the short-term shocks and the parameter β indicates the long-term shocks. Furthermore, the GARCH model condition is $\alpha + \beta < 1$. The MIDAS parameters are θ , ω and m . Secondly, in estimating the GARCH-MIDAS model, m in the equation τ_t which is the long-run component of total volatility, represents the initial value of the log-likelihood function. ω indicates the weight required for the MIDAS regression, and θ shows the total effect the low-frequency variable has on the volatility of the

Table 4 The unit root test results

Stock Market Variables	ADF		PP		EUI Variables	ADF		PP	
United States-S&P 500R	t-stat	-65.7062 (0.000)	t-stat	-65.9334 (0.000)	USA	t-stat	-14.4277 (0.000)	t-stat	-21.22396 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.4581	1% level	-3.457984
China-Shanghai CompositeR	t-stat	-58.8534 (0.000)	t-stat	-58.8725 (0.000)	China	t-stat	-11.0169 (0.000)	t-stat	-20.30462 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.4581	1% level	-3.457984
Germany-DAXR	t-stat	-59.1051 (0.000)	t-stat	-59.16 (0.000)	Germany	t-stat	-16.9883 (0.000)	t-stat	-17.08122 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Japan-Nikkei 225R	t-stat	-59.8494 (0.000)	t-stat	-59.9208 (0.000)	Japan	t-stat	-20.8883 (0.000)	t-stat	-26.53216 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
India-Nifty 50R	t-stat	-58.6481 (0.000)	t-stat	-58.6674 (0.000)	India	t-stat	-15.3271 (0.000)	t-stat	-23.67243 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.4581	1% level	-3.457984
United Kingdom-FTSE 100R	t-stat	-46.0307 (0.000)	t-stat	-62.1113 (0.000)	UK	t-stat	-23.7453 (0.000)	t-stat	-27.71046 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
France-CAC 40R	t-stat	-45.092 (0.000)	t-stat	-61.0011 (0.000)	France	t-stat	-22.7023 (0.000)	t-stat	-22.78833 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Brazil-BOVESPAR	t-stat	-61.3442 (0.000)	t-stat	-61.3759 (0.000)	Brazil	t-stat	-22.7023 (0.000)	t-stat	-22.78833 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Italy-FTSE MIBR	t-stat	-61.2807 (0.000)	t-stat	-61.3023 (0.000)	Italy	t-stat	-22.6937 (0.000)	t-stat	-24.41467 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Canada-S&P TSXR	t-stat	-61.1039 (0.000)	t-stat	-61.1699 (0.000)	Canada	t-stat	-71.5633 (0.000)	t-stat	-18.2151 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45823	1% level	-3.457984
Russia-MOEXR	t-stat	-44.1351 (0.000)	t-stat	-58.2605 (0.000)	Russia	t-stat	-16.9038 (0.000)	t-stat	-24.33895 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.4581	1% level	-3.457984
Mexico-S&P BMV IPCR	t-stat	-44.6862 (0.000)	t-stat	-55.9337 (0.000)	Mexico	t-stat	-16.2038 (0.000)	t-stat	-24.60454 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.4581	1% level	-3.457984
Australia-S&P ASX 200R	t-stat	-61.3892 (0.000)	t-stat	-61.4533 (0.000)	Australia	t-stat	-21.4626 (0.000)	t-stat	-22.46272 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
South Korea-KOSPI CompositeR	t-stat	-56.8221 (0.000)	t-stat	-56.7699 (0.000)	South Korea	t-stat	-20.6698 (0.000)	t-stat	-25.47752 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Spain-IBEX35R	t-stat	-44.1133 (0.000)	t-stat	-59.0318 (0.000)	Spain	t-stat	-22.1984 (0.000)	t-stat	-22.68461 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Netherlands-AEXR	t-stat	-43.7076 (0.000)	t-stat	-58.2936 (0.000)	Netherlands	t-stat	-19.3992 (0.000)	t-stat	-19.0053 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Belgium-BEL 20R	t-stat	-56.7179 (0.000)	t-stat	-56.7197 (0.000)	Belgium	t-stat	-17.0084 (0.000)	t-stat	-17.02712 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984
Sweden-OMX StockholmR	t-stat	-60.684 (0.000)	t-stat	-60.8141 (0.000)	Sweden	t-stat	-22.1993 (0.000)	t-stat	-21.48863 (0.000)
	1% level	-3.43202	1% level	-3.43202		1% level	-3.45798	1% level	-3.457984

The values in parentheses represent the p-value. Furthermore, "X has a unit root" is the null hypothesis.

Source: Authors

high-frequency variable. The positive and statistically significant θ parameter means that the independent variable will cause high volatility on the dependent variable in the long run.

The USA-S&P 500 index model indicates that both short- and long-term volatility values are statistically significant, suggesting persistent volatility with a mean reversion. The θ parameter shows that the EUI significantly affects long-term volatility. Additionally, the constant term parameter (ω) is significant, confirming the importance of the S&P 500's volatility level. The positive and significant parameter m indicates that the short-term fluctuations in the EUI may influence long-term volatility trends.

All the parameters for the China-Shanghai Composite index are statistically significant. While the mean return (μ) is positive, it is relatively low, indicating modest daily returns. Both short- and long-term shocks significantly affect current volatility, confirming volatility persistence. Overall, changes in the EUI significantly influence volatility both in the short run and in the long run, thus indicating high persistence in the volatility of the Chinese market.

The model parameters of the DAX index are statistically significant. Based on the GARCH parameter results in the DAX series, it can be concluded that previous volatility is effective on current volatility, and volatility is clustering in the series. In addition, the EUI also affects the volatility of the DAX series. According to the parameter θ , long-term changes in the EUI can increase the volatility of DAX. According to the results, volatility persistence is also high in this index, and the EUI significantly increases the overall volatility level of the DAX index. This result suggests that the EUI significantly influences DAX.

The short- and long-term volatility values of the Japan-Nikkei 225 are statistically significant, from which point of view it can be assumed that volatility in the Nikkei 225 is permanent. According to the MIDAS parameters, the EUI significantly influences the Nikkei 225 volatility. Therefore, long-term changes in the EUI may increase the volatility of the Nikkei 225 index.

According to the model parameters of Nifty50, all the parameters are statistically significant, so it can be concluded that the short-term shocks are significant in the volatility of the index, there is volatility persistence in the index, and long-term changes in the EUI are effective in the volatility of the Nifty 50 based on the MIDAS parameters. The evidence from the model suggests that volatility persistence in the Nifty50 is significantly high.

The analysis results for the FTSE100 show that all the parameters of the model are statistically significant. Moreover, the GARCH parameters prove that the short-term shocks affect the volatility of the index and that the volatility of the previous periods exerts a significant influence on current volatility. According to the parameter θ , the hypothesis saying that long-term changes in the EUI affect the FTSE volatility is accepted.

For the CAC40, all the parameters of the model are statistically significant. The positive mean return indicates that daily returns are generally positive. The sum of the α and β values is less than 1, confirming the stability of the GARCH model. The results show that both short- and long-term shocks exert an influence on volatility with significant persistence. The notable θ parameter suggests that the EUI raises volatility in the long run, affecting the CAC40 both in the short run and in the long run. Overall, the EUI significantly increases the volatility of the index.

The BOVESPA model shows that the ω parameter is not statistically significant, thus indicating that the volatility level of the series is not essential. However, the GARCH parameters reveal that the short-term shocks significantly affect volatility, and past volatility exerts a strong influence on current volatility. The significance of the θ parameter indicates that the EUI affects BOVESPA, though the influence appears to be relatively limited compared to the other markets.

According to the results of the FTSE-MIB model, the short-term shocks have an influence on volatility and past volatility has an influence on current volatility. In addition, volatility persistence is present in the series, and the daily average return of the index is positive. However, the MIDAS parameters show that

Table 5 The GARCH-MIDAS results

Variable	μ	α	β	ϑ	ω	m	LLF	AIC	BIC
United States-S&P 500R	0.00089279 [4.872] 1.1048e-06***	0.14161 [12.746] 0.0000***	0.81743 [65.05] 0.0000***	0.11712 [8.8054] 0.0000***	2.9735 [3.0566] 0.00223***	0.010874 [14.781] 0.0000***	9228.81	-18445.6	-18408.6
China-Shanghai CompositeR	0.00042097 [1.6703] 0.094869*	0.076468 [11.684] 0.0000***	0.88487 [64.168] 0.0000***	0.18332 [20.159] 0.0000***	11.001 [3.6271] 0.0000***	0.0094538 [11.045] 0.0000***	8178.38	-16344.8	-16307.8
Germany-DAXR	0.0009949 [4.6313] 3.6344e-06***	0.13124 [9.7179] 0.0000***	0.81503 [41.273] 0.0000***	0.12875 [8.3413] 0.0000***	13.871 [2.4604] 0.013879*	0.012394 [16.731] 0.0000***	8598.06	-17184.1	-17147.1
Japan-Nikkei 225R	0.00082304 [3.4334] 0.00059615***	0.13319 [11.786] 0.0000***	0.79736 [50.737] 0.0000***	0.13072 [10.443] 0.0000***	9.9903 [3.2537] 0.0011392***	0.013166 [18.564] 0.0000***	8341.75	-16671.5	-16634.5
India-Nifty 50R	0.0011098 [4.8371] 1.3178e-06***	0.11192 [10.606] 0.0000***	0.80422 [45.459] 0.0000***	0.19671 [28.51] 0.0000***	2.2644 [7.3328] 0.0000***	0.006234 [7.6713] 0.0000***	8492.67	-16973.3	-16936.3
United Kingdom-FTSE 100R	0.00041605 [2.2482] 0.024566**	0.15262 [11.074] 0.0000***	0.7562 [36.143] 0.0000***	0.14937 [14.831] 0.0000***	11.16 [4.6755] 2.9331e-0***	0.0088146 [18.359] 0.0000***	9176.82	-18341.6	-18304.6
France-CAC 40R	0.00076944 [3.3901] 0.000698***	0.14584 [10.615] 0.0000***	0.80082 [39.39] 0.0000***	0.13298 [8.4817] 0.0000***	9.7257 [2.4346] 0.014911*	0.01248 [14.082] 0.0000***	8587.96	-17163.9	-17126.9
Brazil-BOVESPAR	0.00085433 [2.8125] 0.0049166***	0.10082 [10.492] 0.0000***	0.84301 [50.385] 0.0000***	0.070816 [3.2537] 0.0011***	3.516 [1.207] 0.22743	0.017687 [19.248] 0.0000***	7839.84	-15667.7	-15630.7
Italy-FTSE MIBR	0.00066559 [2.6603] 0.007807**	0.14641 [13.755] 0.0000***	0.82375 [62.308] 0.0000***	0.1647 [9.9301] 0.0000***	1.7394 [2.7615] 0.005753***	0.014131 [9.9749] 0.0000***	8130.23	-16248.5	-16211.5
Canada-S&P TSXR	0.0004983 [3.1365] 0.00171	0.12253 [15.558] 0.0000***	0.85057 [90.544] 0.0000***	0.090865 [7.0278] 0.0000***	1.0493 [2.7378] 0.0061851***	0.010529 [16.432] 0.0000***	9613.28	-19214.6	-19177.5
Russia-MOEXR	0.0011737 [4.672] 2.9837e-06***	0.17361 [25.637] 0.0000***	0.75998 [62.634] 0.0000***	0.15119 [19.378] 0.0000***	7.5746 [5.4563] 0.0000***	0.014461 [22.13] 0.0000***	7956.24	-15900.5	-15863.5
Mexico-S&P BMV IPCR	0.00046836 [2.3493] 0.018809***	0.077206 [13.62] 0.0000***	0.90428 [123.31] 0.0000***	0.12834 [6.8406] 0.0000***	1.0673 [2.7679] 0.0056416***	0.011935 [12.816] 0.0000***	8901.09	-17790.2	-17753.2
Australia-S&P ASX 200R	0.00050528 [2.7114] 0.0067011***	0.091311 [10.341] 0.0000***	0.86268 [49.509] 0.0000***	0.11701 [6.7632] 0.0000***	7.9339 [2.2043] 0.027506**	0.0097832 [15.369] 0.0000***	9244.93	-18477.9	-18440.9
South Korea-KOSPI CompositeR	0.00044484 [2.1825] 0.029074**	0.10758 [9.3657] 0.0000***	0.81563 [43.172] 0.0000***	0.16898 [21.6] 0.0000***	5.8372 [7.5964] 0.0000***	0.007604 [14.718] 0.0000***	8956.52	-17901	-17864
Spain-IBEX35R	0.00047398 [2.0172] 0.043672**	0.15508 [12.525] 0.0000***	0.78378 [45.066] 0.0000***	0.1463 [11.823] 0.0000***	9.1872 [2.7563] 0.0058456***	0.012747 [15.397] 0.0000***	8359.16	-16706.3	-16669.3
Netherlands-AEXR	0.00074787 [3.6885] 0.000225***	0.1414 [10.266] 0.0000***	0.78277 [35.85] 0.0000***	0.15603 [15.427] 0.0000***	10.132 [4.6529] 3.2738e-0***	0.0098868 [19.007] 0.0000***	8829.04	-17646.1	-17609.1
Belgium-BEL 20R	0.00061243 [2.8765] 0.0040217***	0.13904 [11.795] 0.0000***	0.79707 [47.155] 0.0000***	0.13242 [11.936] 0.0000***	9.2432 [2.6714] 0.0075531***	0.011054 [19.711] 0.0000***	8846.6	-17681.2	-17644.2
Sweden-OMX StockholmR	0.00086688 [4.2592] 2.0519e-05	0.1145 [11.245] 0.0000***	0.84755 [51.019] 0.0000***	0.11098 [4.9104] 0.0000***	10.237 [1.6365] 0.10000	0.012473 [11.92] 0.0000***	8785.4	-17558.8	-17521.8

[] represents t-statistic and ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Source: Authors

the EUI has an influence on the volatility of the FTSE-MIBR.

The S&P-TSX model results indicate that all the parameters are significant. The short-term shocks and the volatility of the previous period in the series affect current volatility. According to the parameter θ , the influence of the EUI on the volatility of the S&P-TSX is statistically significant. Therefore, the long-term movements in the EUI are among the factors with the potential to cause volatility in the S&P-TSX.

As for the Russia-MOEX, the short-term shocks are also significant in the context of volatility. Moreover, according to the MIDAS parameters, the EUI has an influence on the volatility of the Russian financial markets. Therefore, an increase in the EUI is likely to lead to an increase in the volatility of the Russian MOEX index.

The model for the Mexico-S&P-BMV-IPC shows that all the parameters are statistically significant and the short-term shocks and past volatility are perceived to influence current volatility in this index, accompanied by volatility continuity. The results of the MIDAS parameters prove that the effect of the EUI on the volatility of the Mexican markets is positive and significant, i.e. an increase in the EUI may cause volatility in the Mexican financial markets.

A fact can be established that all the parameters are meaningful in the Australia-S&P ASX 200 index, as is the case for all the other markets. Based on the GARCH parameters, it is possible to infer that the short-term shocks affect the volatility of this market and past volatility also affects current volatility. According to the θ parameter, the effect of the EUI on the relevant market volatility is both positive and significant.

According to the model parameters for South Korea's KOSPI Composite Index, the daily average return is positive and significant, as is the case for all the other markets. Additionally, according to the GARCH parameters, the short-term shocks have an influence on the volatility of this market. In addition, past volatility also affects current volatility. The MIDAS parameters imply that the weighting of the MIDAS

model is substantial enough to enable that an increase in the EUI may lead to an increase in the volatility of the South Korean financial markets.

Spain's IBEX35 results demonstrate that the uncertainty of the energy market is practical regarding market volatility. In addition, the short-term shocks and past volatility in the GARCH component parameters are adequate for current volatility.

The model parameters of the Netherlands' AEX index reveal that all the parameters are statistically significant. According to the GARCH parameters, both short-term shocks and past volatility are perceived to have an influence on current volatility. The EUI positively and significantly affects the volatility of the AEX index, based on which an increase in the EUI may cause an increase in the volatility of the AEX.

All the parameters are significant in the GARCH-MIDAS model of the Belgium BEL20 index, which shows a significant influence of the short-term shocks and past volatility on current volatility. According to the parameters of the EUI, an increase in the EUI may cause an increase in the volatility of the BEL20 index.

The Sweden OMX index is the last variable included in the analysis. The parameters of the model derived using this index are also statistically significant. The GARCH parameters prove that the short-term shocks affect volatility. In addition, past volatility in the series affects current volatility. The fact that the MIDAS parameters are positive and significant implies that the EUI influences the volatility of the OMX index and increasing uncertainty will increase volatility.

Comparatively, the Canada-S&P TSX model performs best according to the AIC and BIC criteria, but it also has the lowest MIDAS weight. In contrast, the Chinese and UK indices exhibit high MIDAS component weights, indicating significant long-term volatility effects. The EUI exerts the greatest effect on the volatility of the Indian and Chinese markets, while its impact is least pronounced in the Brazilian and Canadian markets. Among the GARCH components, the Chinese and German markets show the highest volatility persistence, whereas the UK and Russian markets show lower persistence.

Overall, the analysis indicates that EUIs significantly influence stock market volatility. Increased energy-related uncertainty may lead to the risk-averse investors exiting the market, causing sudden price fluctuations and undermining investors' confidence. This decline may affect market stability and firms' profitability, potentially leading to crises. Therefore, investors should adopt proactive investment strategies, anticipate market changes and adjust their portfolios accordingly. Incorporating the EUI as a forecasting factor and implementing risk management strategies, such as insurance and stop-loss orders, can help minimize potential losses.

CONCLUSION

This research study investigates the influence of energy-related uncertainty on stock market volatilities in 18 of the 25 wealthiest countries, using the GARCH-MIDAS technique due to the differing frequencies of the EUI (monthly) and stock market data (daily). The analysis shows that all the model parameters are statistically positive and significant across all the countries, indicating that the EUI positively affects market volatilities. These findings align with the previous studies of J. F. Imbet (2022) and U. Kayani *et al* (2024).

When examined on a market-by-market basis, the Chinese and German stock markets are most influenced by the EUI, probably due to China's significant role in global energy production and consumption. The EUI may cause fluctuations in energy prices (e.g. oil and natural gas prices), which may increase production costs and reduce companies' profits, thus simultaneously leading to lower stock indices and heightened volatility. The EUI may also encourage China to boost investments in renewable energy, positively influencing the stock performance of renewable companies, thus having both negative and positive implications for the Chinese stock markets. A similar scenario applies to Germany, where the EUI may increase production costs in the energy-intensive sectors, such as the automotive and chemicals sectors, potentially harming companies'

profits and stock prices. Interestingly, Brazil and Canada are least exposed to the influence of the EUI on stock market volatility, which is notably due to their differences - as the market of a developed economy, the Canadian market is less influenced by external factors, whereas the Brazilian emerging market faces high volatility and political risks. The minimal effect of the EUI on Brazil's market is surprising, suggesting further research in this topic is warranted. Additionally, while the Toronto Stock Exchange includes strong energy sector companies, the research results differ from the expectations with respect to the EUI's influence. Future studies should explore these dynamics so as to provide valuable insights for financial researchers and investors in these markets.

The results suggest that high-frequency stock market uncertainty forecasts based on the EUI can help policymakers to predict low-frequency economic activity in real time through MIDAS models. This approach allows for the development of early warning systems to mitigate regional recessions. Additionally, integrating broader energy market uncertainties into risk management and investment strategies can benefit investors, particularly in the energy sector. Individual investors and portfolio managers can optimize asset allocations and hedging strategies based on enhanced EUI-based forecasts, potentially increasing risk-adjusted returns. However, it is important to note that analyzing stock market volatility with a single constraint may not provide a complete economic interpretation, which highlights the limitations of this research study. Nevertheless, from the investor's perspective, monitoring the EUI can serve as a valuable forecasting factor. Investors should take into consideration the EUI when considering external factors for portfolio optimization. Overall, this research study demonstrates the influence of the EUI on stock market volatility, analyzing it across different frequencies without data transformation, still preserving information integrity.

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Received on 24th November 2024,
after revision,
accepted for publication on 10th July 2025.
Published online on 8th August 2025.

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Original scientific paper

UDC: 339.3:004.738.5
doi:10.5937/ekonhor2502151S

THE INFLUENCE OF MOBILE APPLICATIONS ON CUSTOMER LOYALTY IN OMNICHANNEL RETAIL

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Modern customer loyalty programs are increasingly based on new technologies and forms of rewards, in which sense customer loyalty programs are increasingly implying the use of mobile applications not only as a means of collecting and realizing points, but also as a means ensuring ease of purchase, the personalization of the offer and entertainment through various types of prize games. Based on these facts, the paper explores the influence exerted by mobile applications on customer trust and loyalty in omnichannel retail. The research draws on Self-Determination Theory to explain the influence of autonomy, competence and relatedness as the key needs of people as customers on their trust and loyalty. The empirical research conducted using the survey method and carrying out SEM analysis showed that mobile applications significantly affected customer loyalty, with the moderators such as age and membership duration in the loyalty program playing a significant role in the process. The research results suggest that customers value the mobile applications that provide them with a sense of autonomy, i.e. control over the purchasing process, strengthen their existing competences and enable them to acquire new ones, making possible connectedness and friendship with other members of the program, thus generating their confidence in the quality and reliability of the mobile application and strengthening customer loyalty to the seller.

Keywords: mobile applications, customer loyalty, trust, omnichannel retail, loyalty programs, SEM analysis

JEL Classification: M31

INTRODUCTION

The digitalization process and trade digital transformation have led to significant changes in the business done by retail chains, one of these

changes being visible in sale and communication with customers, since - in addition to traditional sales channels (such as physical stores, kiosks, direct mail) - new channels (such as social networks, mobile applications, location-based services and the so-called gaming consoles) are also used in retail chains (Shi, Wang, Chen & Zhang, 2020). All said is indicative of the application of an omnichannel strategy in retail, which attracts a lot of attention from researchers in

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this field. Omnichannel retail is a comprehensive retail strategy integrating all channels across different digital technologies so as to deliver the best customer experience. This is an advancement beyond omnichannel retail, which includes offline and online channels separately, while the omnichannel approach seeks to achieve consistent goals across all channels (Verhoef, Kannan & Inman, 2015). So, full channel integration is the essence of an omnichannel strategy.

Previous research has shown that an omnichannel retail strategy can be effective in building customer loyalty (Hussein & Kais, 2020; Mainardes, Rosa & Nossa, 2020), for which reasons many companies have integrated traditional and new, i.e. offline and online, channels and all have the aim to provide a superior experience to customers (Kocić, Šapčić & Sofronijević, 2022). Customer loyalty is the result of the quality of offline and online channel integration (Quach, Barari, Moudry & Quach, 2020). The very quality of integration in an omnichannel strategy is critical to delivering a superior customer experience and is determined by how it is perceived by customers through the integrated performance of all retail channels. A customer-centric omnichannel strategy enables seamless transitions between different channels throughout the buying experience (Verhoef *et al*, 2015). Synergy effects generation is an anticipated outcome of this strategy since the retailer synchronizes various channels, therefore attaining synergies through combined use of channels (Wang & Lee, 2020).

Research indicates that the attitudes developed in the offline environment are carried over to online platforms. Trust in offline sales has a positive influence on trust in online sales (Bruneau, Swaen & Zidda, 2018) and loyalty towards offline channels is positively linked to loyalty towards online channels (Frasquet & Miquel, 2017). A. Timoumi, M. Gangwar and M. K. Mantrala (2022) point out that previous research has mainly explored the shift from offline to online channels, whereas interest in the influence of online channels on offline is growing. S. A. Neslin (2022) emphasizes that marketing actions may trigger frequent cross-channel effects. This is how the so-called transference theory was born, which is used

in marketing and links customer attitudes towards advertising with attitudes towards brands, arguing that the influence of one object can be transferred to another closely related object through a cognitive or unconscious.

The implementation of omnichannel strategies in retail has led a few researchers to identify the factors that lead to customer trust and loyalty in the mobile environment and explore the influence of mobile applications on building customer trust and stimulating repeat purchases. This research study aims to determine if the use of mobile applications enhances customer's perception of autonomy in the shopping process (McLean, 2018; Zhang, Wang, Anjum & Mu, 2022), improves the feeling of competence and information during the purchase (Molinillo, Aguilar-Illescas, Anaya-Sánchez & Carvajal-Trujillo, 2022), and fosters a sense of belonging and friendship within the framework of the loyalty program (Gwinner, Gremler & Bitner, 1998). Additionally, the research aims to examine how these factors are manifested in customer trust in the application and loyalty towards the firm. This research study is aimed at determining the potential moderating effects of age and membership tenure on the relationship between the use of a mobile application and customer trust and loyalty in loyalty programs. The empirical study was carried out based on survey methodologies, and the collected data were analyzed using a structural equation model. The anticipated findings indicate that the use of mobile applications enhances customer confidence in loyalty programs and fosters vendor loyalty. Specifically, younger customers and those with longer membership tenures are expected to exhibit higher levels of trust and loyalty.

The paper is structured into a few sections. After the introductory considerations, a literature review of the specifics and factors of customer loyalty in an omnichannel environment is given, and Self-Determination Theory as the basis for an analysis of the influence customer experience with mobile applications has on their trust and loyalty to the seller. Based on the literature review and previous empirical research, the hypotheses are defined, and the research model is presented. The results of the

empirical research and the key contributions made by the research are summarized in the final part of the paper based on the discussion, and certain limitations are identified as well.

LITERATURE REVIEW

Customer loyalty in an omnichannel environment

The existing literature provides a lot of definitions of customer loyalty. Given the growing digitalization and digital transformation, the question arises as to how customer loyalty is understood in the context of the digital environment. According to one definition, customer loyalty is their favorable behavior towards a company, which is manifested through repeat purchases from the same seller, a preference for a particular brand, and positive recommendations (Zeithaml, Berry & Parasuraman, 1996). Customer loyalty is a crucial concern for retail chains (Rokonuzzaman, Harun, Al-Emran & Prybutok, 2020) and refers to customers' inclination to make repeat purchases and support a specific retailer over an extended period (Liu-Thompkins, Khoshghadam, Attar Shoushtari & Zal, 2022) and reflects customers' readiness to regard one particular seller as their optimal choice, provide favorable reviews, and recommend them to others (Zeithaml *et al*, 1996).

The proliferation of operations in omnichannel business methodologies which facilitate customer-seller communication has added to the intricacy of the purchasing experience and influenced customer loyalty (Gao, Fan, Li & Wang, 2021). According to D. Herhausen, K. Kleinlercher, P. C. Verhoef, O. Emrich and T. Rudolph (2019), effective management of intricate customer activities requires a comprehensive understanding of customer loyalty across different online and offline channels used by customers to engage with the organization. Several studies on online customer behavior have revealed multiple variables that influence client loyalty towards online merchants. Several factors that influence customer

experience include customization, interactivity, interface design, the community, information, incentives, a product range, an overall image of the seller (Srinivasan, Anderson & Ponnnavolu, 2002), satisfaction, reputation (Gutiérrez Rodríguez, Villarreal, Cuesta Valiño & Blozis, 2020), website quality, usability, ease of use (Purani, Kumar & Sahadev, 2019), and perceived value (Molinillo *et al*, 2022). Furthermore, the study conducted by A. Bleier, C. M. Harmeling and R. W. Palmatier (2019) that investigates the influence of user experience on customer loyalty in both offline and online retail services highlights the comprehensive nature of customer experience, which encompasses customer responses to interactions with a brand or company, irrespective of the attributes of the channel itself. Nevertheless, in an omnichannel setting, the objective should be expanded beyond just considering the influence of user experience on their loyalty towards a specific retail channel (such as a physical store, website, app, social media) to encompass loyalty towards the retailer as an organization or brand.

Prior research examining the correlation between customer experience with mobile apps and their loyalty to the seller has demonstrated a favorable influence of the variables including application engagement (McLean, 2018), the application attitude (McLean, Osei-Frimpong, Al-Nabhani & Marriott, 2020), and application experience (Molinillo, Navarro-García, Anaya-Sánchez & Japutra, 2020). However, no sufficient research has been conducted in the Republic of Serbia with the focus on how the use of a mobile application affects customer trust in the application itself and their loyalty to the seller who develops such loyalty programs, starting from autonomy, competence and relatedness, as people's key needs according to Self-Determination Theory. In this sense, the paper is expected to contribute to overcoming the identified gap and be the basis for future research related to the relationship between customer experience and a mobile application, customer trust and loyalty in the omnichannel environment.

The importance of Self-Determination Theory in the analysis of the influence of mobile applications on customer trust and loyalty

The marketing literature, particularly the literature on customer loyalty research in the digital environment, shows an increasing significance of the self-determination concept pertaining to the beneficial influence on individuals' higher life satisfaction (Purohit, Arora & Paul, 2022). Self-Determination Theory (Deci & Ryan, 2000) posits that an individual's subjective well-being is attained when their fundamental psychological needs for autonomy (their perception of freedom and control over personal actions), competence (their sense of their own ability and skill), and relatedness (the need to integrate into society) are fulfilled. The utility of this theory in comprehending the subjective well-being is demonstrated by its superior predictive ability of human behavior in comparison to other behavioral models. Furthermore, the current body of literature indicates that consumption experiences can have a substantial influence on subjective well-being (Ekici, Sirgy, Lee, Yu & Bosnjak, 2018). Shopping can be characterized as a clearly favorable experience resulting in the broadening of the notion of subjective well-being to encompass the so-called "well-being". This expression of well-being pertains to the documented influence of shopping in shopping malls on contentment in the crucial aspects of life, such as customer life, social life, leisure, and community life, leading to a comprehensive evaluation that a shopping mall makes a substantial contribution to the overall quality of life (El Hedhli, Becheur, Zourrig & Chaouali, 2021). The authors suggest that shoppers' well-being is derived from subjective well-being and various shopping experiences have the potential to evoke emotional reactions enhancing the overall quality of life. The application of Self-Determination Theory can enhance our understanding of the development of *shopping well-being*, which is a distinct domain of life and a substantial outcome of subjective well-being.

The self-determination concept highlights autonomy as an inherent and fundamental need that individuals endeavor to fulfill through their experiences.

Autonomy is the conviction that people maintain the freedom to decide on their own actions in each circumstance. In the purchasing context, autonomy refers to the customer's conscious or unconscious perception of having freedom and control over the buying process (Shen, Wan & Li, 2023). Within the realm of the use of mobile applications, autonomy pertains to the way customers perceive their ability to make personal choices while engaging with an application which arises from their perceived level of control. Extending upon this hypothesis, mobile applications are seen to frequently provide customers with an enhanced perception of autonomy in managing their shopping experience. As described by M. Kleijnen, K. D. Ruyter and M. Wetzels (2007), control refers to the degree to which customers may decide on the timing, content, and order of a transaction. This attribute is the fundamental feature of mobile applications and elucidates why their use might enhance customers' sense of autonomy. The evidence indicates that retail applications, i.e. software applications, especially created to provide a positive shopping experience and streamline the buying and selling of goods or services (McLean, 2018), can promote customer independence. This hypothesis is corroborated by the study conducted by L. Zhang *et al* (2022), wherein they found that a significant degree of user pleasure within the realm of mobile payment applications leads to the augmentation of their self-assurance in terms of autonomy.

Competence is another key need according to Self-Determination Theory. It refers to the sense of effectiveness and achievement - the sense of effectiveness in interacting with the environment and support for the development of individual capacities (Deci & Ryan, 2000). It differs from autonomy, which refers to our feeling that we are the source of our actions. Competence is established by an individual's capacity to effectively utilize both environmental and personal resources, in which context mobile applications are an environmentally friendly resource customers can use to improve their competence. In retail, mobile applications allow customers to access information, thus being more informed about the store and its products, which improves their shopping experience (Molinillo *et al*, 2022).

Relatedness is the third key need according to Self-Determination Theory. People's need to connect with other people is related to their biological and cultural evolution and the result of their concern for themselves and their families. As people's environment has changed and become more complex, this need has become more intense over time and the ways of fulfilling it have changed, too. The tendency to connect shows that a social group with a higher level of cohesion provides significantly greater protection to an individual within the group than a social group with less cohesion of members does (Stevens & Fiske, 1995). However, the need for relatedness may conflict with the need for autonomy, in which sense the autonomy of a person (individual integration) and the aspiration to connect (the integration of an individual into society) can be complementary in optimal circumstances; otherwise, they can become antagonistic. In the context of the research in customer experience with mobile applications, relatedness - as a necessity means - that customers join such loyalty programs so as to create a sense of belonging and friendship with other members (Gwinner *et al*, 1998). In accordance with the foregoing, the following hypotheses were defined:

- H1: As the dimensions of a mobile application, autonomy, competence and relatedness have a positive and significant influence on customer trust in a mobile-application-based loyalty program.
- H2: As the dimensions of a mobile application, autonomy, competence and relatedness have a positive and significant influence on customer loyalty.

Customer trust is the key predictor of customer loyalty - increased customer engagement with mobile applications does not only mean collecting points and realizing them when making purchases, but also participating in creative activities, such as sweepstakes and entertainment (Danaher, Sajtos & Danaher, 2016). Participation in such activities creates a surprise effect and brings intangible rewards, such as obtaining a privileged status or travel. T. Kunkel, D. Lock and J. P. Doyle (2021) confirm that new customer

experiences within mobile applications play the key role in the development of customer loyalty. Based on the theoretical conclusions that customer trust leads to greater loyalty, the following hypothesis can be defined:

- H3: Trust in a mobile-application-based loyalty program has a positive and significant influence on customer loyalty.

Previous research has found that older customers and those with longer loyalty program memberships often exhibit different behavior patterns compared to younger customers and new members, which affects their perceptions of the benefits offered by loyalty programs, trust, and vendor loyalty (Lambert-Pandraud & Laurent, 2010; Halwani, 2021). Younger customers are more likely to embrace new trends in purchasing and consumption, especially those related to new technologies (Halwani, 2021). Younger customers are more likely to change their shopping habits, as a result of the need to adapt to a dynamic social environment. In particular, their perceptions of the utilitarian and hedonistic benefits they gain from being tied to a particular vendor are different from those of older customers. It has empirically been confirmed that members of different age groups perceive the benefits of loyalty programs differently (Zhang *et al*, 2022), especially when the acceptance of more modern forms of reward realized through mobile applications is concerned (Đukić, Sokolov Mladenović & Stanković, 2023). A survey conducted in Bosnia and Herzegovina showed that the respondents between 26 and 35 years of age expressed a more intense preference for loyalty programs in banking compared to the other age groups (Ozenis & Peštek, 2016).

The starting point for including membership duration in loyalty programs as another moderation variable is the fact that loyalty programs are essentially aimed at rewarding and encouraging the existing customers to make repeat purchases and reinforcing their attitudes towards the seller on that basis. Purchase history is an essential basis for structuring the incentives of conventional loyalty programs. It has been empirically confirmed that advertising the

benefits of loyalty programs has significantly greater effects on customers enrolled in the program for a longer period of time (Maity & Gupta, 2019). Taking into account the previous results of the research, yet another hypothesis was defined:

H4: Age and membership duration in the loyalty program play a significant moderating role on customer trust and loyalty.

Based on the literature review, the analysis of previous research and the established research hypotheses, a conceptual research model can be defined as shown in Figure 1.

RESEARCH METHODOLOGY

In order to test the defined hypotheses and the research models, a questionnaire was made, containing the questions related to *autonomy*, *competence* and *relatedness* as the three dimensions of a mobile application representing the independent variables, as well as the *trust in the loyalty program* and *customer loyalty to the seller* as the dependent variables. In addition, the research model includes age, as

the demographic characteristic of the respondents, and membership duration in the loyalty program as the moderating variables. The data used in this paper were collected with the help of an online questionnaire on a random sample. First of all, the questionnaire is structured to contain general data, such as gender, age, education, employment status, as well as the initial questions related to the use of mobile applications, such as whether they are members of the loyalty program including a mobile application and how long they have been members of such a program. The next segment of the questionnaire contains the statements related to the independent and dependent variables rated by the respondents using a five-point Likert scale. The assertions related to autonomy were taken from the paper of C. Raab, O. Berezan, A. S. Krishen and S. Tanford (2016), those related to competence were adapted according to J. Hwang and L. Choi (2020), and those pertaining to relatedness were adapted according to J. So, C. Achar, D. Han, N. Agrawal, A. Duhachek and D. Maheswaran (2015). The statements related to customer trust were taken from the authors P. Gurviez and M. Korchia (2002) and V. Swaen and C. R. Chumpitaz (2008), and the statements related to customer loyalty were taken from A. Chaudhuri and M. B. Holbrook (2001).

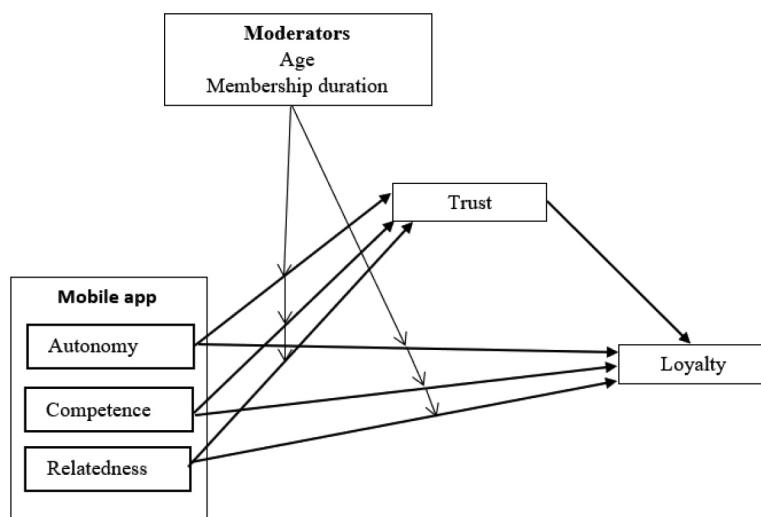


Figure 1 The conceptual research model

Once the surveys had been collected, statistical data processing was performed in the IBM SPSS and AMOS programs. Descriptive statistics, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and SEM analysis were used to test the connections in the research models. The moderating influence of age and membership duration in the loyalty program was also analyzed.

The sample characteristics

The empirical research was carried out in the territory of Serbia in the period from January 8th to November 5th, 2023. The sample contained 250 respondents included in the survey using the *Google Forms*. Based upon the analysis of the demographic characteristics of the respondents, it can be concluded that there are more female respondents (76.8%) participating in the sample than the male respondents (23.2%). Regarding

Table 1 The values of the descriptive statistics

Statements	Mean	SD	N of Items/Sorce
Autonomy			3
I feel special about being a member of the loyalty program. (1)	3.68	1.439	C. Raab et al (2016)
As a member of the loyalty program, I receive personalized offers. (2)	4.05	1.142	C. Raab et al (2016)
As a member of the loyalty program, I receive special discounts and bonuses. (3)	4.06	1.265	C. Raab et al (2016)
Competence			3
Loyalty programs allow me to participate in prize games. (1)	3.85	1.120	J. Hwang and L. Choi (2020)
Loyalty programs provide me with creative rewards. (2)	3.85	1.143	J. Hwang and L. Choi (2020)
Loyalty programs provide me with innovative rewards. (3)	4.09	1.040	J. Hwang and L. Choi (2020)
Relatedness			3
Membership in the loyalty program provides me with the same privileges as membership in a social club does. (1)	3.68	1.342	J. So et al (2015)
Membership in the loyalty program contributes to my identity. (2)	3.31	1.691	J. So et al (2015)
I share information with other loyalty program members. (3)	3.96	1.227	J. So et al (2015)
Customer trust			
I believe in the honesty (accuracy) of the information I receive through the loyalty program. (1)	4.13	1.217	V. Swaen and C. R. Chumpitaz (2008)
Loyalty purchases are reliable. (2)	4.35	1.085	V. Swaen and C. R. Chumpitaz (2008)
I have confidence in the loyalty program which I am a member of. (3)	4.28	1.073	P. Gurveyez and M. Korchia (2002)
Customer loyalty			4
I am committed to the companies which I have a loyalty program membership with. (1)	4.33	1.066	A. Chaudhuri and M. B. Holbrook (2001)
I would pay a higher price to companies which I have a loyalty program membership with. (2)	4.04	1.355	A. Chaudhuri and M. B. Holbrook (2001)
I will recommend to others the company where I have membership in the loyalty program. (3)	4.37	.976	A. Chaudhuri and M. B. Holbrook (2001)
I intend to continue to buy from companies which I have a loyalty program membership with. (4)	4.43	1.007	A. Chaudhuri and M. B. Holbrook (2001)

Notes: SD - Standard Deviation.

Source: Authors

the respondents' age structure, the largest part of the respondents belonged to the category of those between 20 and 30 years of age (47.2%), while the respondents between 31 and 40 years of age and the respondents over 40 years of age were approximately evenly represented in the sample - 26.8% and 26%, respectively. With respect to the educational structure of the sample, most respondents notably have a university degree (54%), only to be followed by the respondents with a college diploma (27.6%) and the fewest with a high-school diploma (18.4%). The majority of the respondents included in the sample were employed (80%), only to be followed by the students (18%) and the pensioners (2%).

RESEARCH RESULTS

Research tool validation

Homogeneity and heterogeneity between the respondents' attitudes were determined applying descriptive analysis; for each statement included in the research study, the values of the arithmetic mean and the standard deviation were calculated. The internal consistency of the variables, i.e. statements, was checked by calculating the values of the Cronbach alpha coefficient and the values of the factor loadings. In addition, Table 1 contains the results of the confirmatory factor analysis.

By analyzing the values of the descriptive statistics, it can be concluded that all investigated factors (the

dimensions of a mobile application, customer trust and loyalty) exert an influence on their behavior when they use mobile application services. The assertion of the *customer loyalty* variable, *I intend to continue to buy from companies which I have a loyalty program membership with.* (4.43) has the highest value of the arithmetic mean, whereas the lowest (3.31) is identified in the assertion of the *relatedness* dimension, *Membership in the loyalty program contributes to my identity.* Based on the value of the standard deviation, it can be said that the respondents' attitudes are the most homogeneous in the assertion *I will recommend to others the company where I have membership in the loyalty program* (the standard deviation .976). The greatest heterogeneity of the attitudes is perceived in the assertion of the *relatedness* dimension, *Membership in a loyalty program contributes to my identity* (the standard deviation 1.691).

The internal consistency of the variables, i.e. the assertions, was checked by calculating the values of the Cronbach alpha coefficient and the values of the factor loadings. Also, the application of exploratory factor analysis was aimed at checking the reliability and validity of the research model (Table 2).

First, the results show that the values of the Cronbach alpha coefficient for each variable in the model exceed 0.7, based on which it can be concluded that there is good internal consistency (Nunnally, 1978). The value of the KMO test for all the variables in the research model exceeds the value threshold of 0.5 and the variables have a statistically significant p value of 0.000 (Harrington, 2009). Given the fact that all the analyzed variables are explained by a single factor,

Table 2 The results of the exploratory factor analysis

Variables	Cronbach's Alpha	KMO and Bartlett's tests	Sig.	Total variance explained
Autonomy	0.862	0.646	.000	78.88
Competence	0.920	0.697	.000	86.41
Relatedness	0.912	0.700	.000	86.11
Customer trust	0.920	0.730	.000	86.61
Customer loyalty	0.908	0.778	.000	80.43

Notes: KMO Test - The Kaiser-Meyer-Olkin Test

Source: Authors

that shows the compatibility of all the findings within the variables (the explanation is shown in the *Total variance explained* column). A higher *Total variance explained* value means that the analysis results are better explained. The results obtained in this way were also confirmed by the Principal Components Method, given the fact that the value of the KMO test was statistically significant at 0.864. After the factor rotation (*oblimin*), five factors were singled out - autonomy, competence, relatedness, customer trust and customer loyalty. They are shown in Table 3. The values of the factor loadings for all the assertions in the model account for over 0.7, except for one assertion (*I receive special discounts and bonuses as a member of the loyalty program*) (Autonomy3), whose value is 0.699.

Finally, the average extracted variance (AVE) and composite reliability (CR) values were analyzed, which are only significant if the AVE value is above the level of 0.5, i.e. the CR value is above the level of 0.7 (Fornell & Larcker, 1981). It can be said that the convergent validity of the model has been achieved considering that the value of the AVE for each variable in this research model is greater than 0.5, whereas the

composite reliability value of all the variables in the analyzed model is greater than 0.7.

Measurement Model Evaluation

The research model developed based on the descriptive statistics, reliability analysis and the CFA and EFA is shown in Figure 2.

The created research model implies a validity check. Primarily, the χ^2/df indicator that should have a value lower than 5 was used (Marsh & Hocevar, 1985). Then, the NFI, IFI, TLI, CFI indicators indicate a better validity of the model the closer the value is to 1; in the research model, they have the following values: NFI (.949), IFI (.945), TLI (.925), CFI (.954). Finally, only the RMSEA indicator is not within the recommended value, but the analysis can be continued considering that deviations of one or two fall within acceptable parameter limits. Therefore, based on the given parameters whose values are within the recommended range, it can be concluded that the research model meets the acceptability level and that the validity assumptions are met.

Table 3 The rotated component matrix

	Component				
	1	2	3	4	5
Autonomy1	.997				
Autonomy2	.822				
Autonomy3	.699				
Competence1		.809			
Competence2		.955			
Competence3		.925			
Relatedness1			.825		
Relatedness2			.935		
Relatedness3			.909		
Customer trust1				.955	
Customer trust2				.964	
Customer trust3				.974	
Customer loyalty1					.944
Customer loyalty2					.893
Customer loyalty3					.971
Customer loyalty4					.956

The extraction method: Principal Component Analysis. The rotation method: Oblimin with Kaiser Normalization. Rotation converged in 9 iterations. KMO= 0.864; Sig. 0.000

Source: Authors

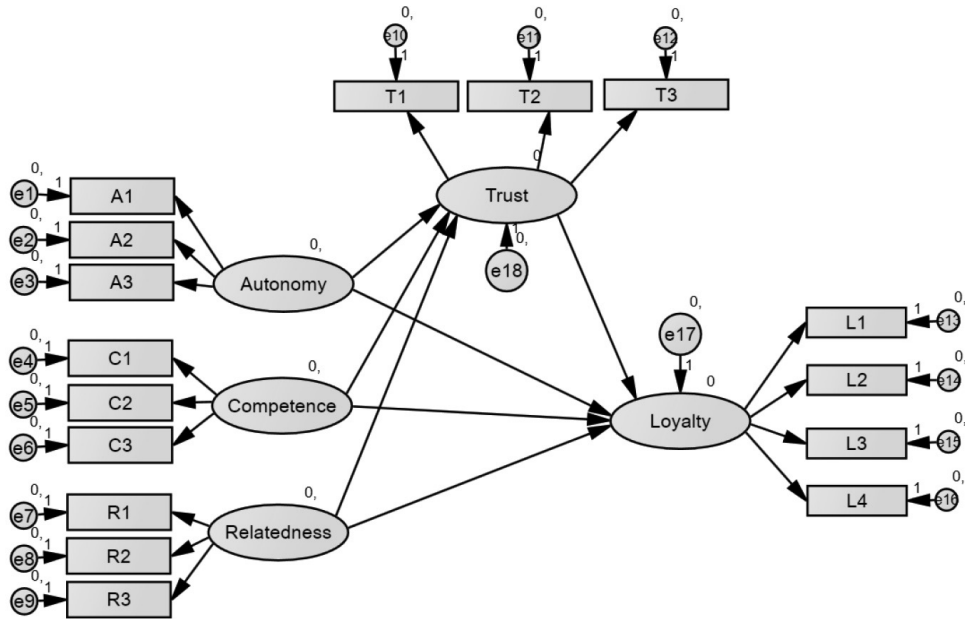


Figure 2 The research model

Source: Authors

Table 4 The results of the confirmatory factor analysis

Variables	AVE	CR
Autonomy	.720	.883
Competence	.797	.922
Relatedness	.794	.920
Customer trust	.930	.976
Customer loyalty	.886	.969

Notes: AVE - the average variance extracted; CR - composite reliability

Source: Authors

Structural model evaluation

The results of the tested connections between the researched variables in the structural equation model are shown in Table 5, based on which certain conclusions can be drawn. By testing the first hypothesis, significant values were obtained showing

that the use of a mobile application has a positive effect on customer trust, which indicates that the hypothesis H1 is confirmed. Partly observed, the dimensions of a mobile application have the following values: *autonomy* ($B = .888, p < .000$), *competence* ($B = .966, p < .000$) and *relatedness* ($B = .914, p < .000$). Furthermore, the second hypothesis was related to the research in the relationship between the use of a mobile application and customer loyalty. Based on the results obtained, it can be said that the use of a mobile application has a significant positive influence on customer loyalty, which confirms the hypothesis H2. The dimensions of a mobile application perceived in relation to customer loyalty have the following values: *autonomy* ($B = .634, p < .000$), *competence* ($B = .940, p < .000$) and *relatedness* ($B = .688, p < .000$). The third hypothesis examined the direct relationship between customer trust and loyalty. Based on the in-depth results, it can be concluded that there is a significant and positive direct relationship between customer trust and loyalty ($B = .408, p < .003$). Accordingly, the hypothesis H3 is confirmed.

The coefficient of determination R² in the given research model shows that 93.4% of the variability of the *loyalty* dependent variable is explained by the stated research model, while 6.6% is influenced by the other extreme factors not explained by the research model.

The fourth hypothesis analyzed the moderating role of age and membership duration in the loyalty program. The results shown in Table 6 show the moderating effect of age on customer trust, based on which a conclusion can be drawn that the respondents classified into the younger age category have a higher level of trust in the services provided by mobile applications. The identical results are obtained by one-way analysis of variance (ANOVA), in the SPSS statistical program. Furthermore, the moderating effect of membership duration in the loyalty program has a statistically significant effect on the respondents'

trust. Namely, if membership in the loyalty program increases by one unit (year), the respondents' trust increases by .038 units. Then, the years of age and membership in the loyalty program have a significant moderating role on customer loyalty because the p value for age is less than .001 and for membership duration, it is less than .005, based on which it can be concluded that an increase in age by one unit (i.e. a year) generates a decrease in customer loyalty towards the use of a mobile application by .512 units, whereas, if membership in a loyalty program increases by one unit (i.e. a year), customer loyalty increases by .487 units. The results are also confirmed by applying the ANOVA analysis - the younger respondents are more loyal, and membership duration proportionally affects customer loyalty. Accordingly, it can be concluded that the hypothesis H4 is confirmed.

Table 5 The SEM analysis

Hypotheses	Observed relationship	Estimate	Statistical significance (p)	Result	R ²
Hypothesis 1	A Trust	.888	.000	Accepted	0.934
	C Trust	.966	.000		
	R Trust	.914	.000		
Hypothesis 2	A Loyalty	.634	.000	Accepted	
	C Loyalty	.940	.000		
	R Loyalty	.688	.000		
Hypothesis 3	Trust Loyalty	.408	.003	Accepted	

Notes: A - Autonomy, C - Competence, R- Relatedness

Source: Authors

Table 6 Testing the relationship in the model (SEM) - the moderation effects

Dependent	Moderators	Mobile application	
		Estimate	Statistical significance (p)
Customer trust	Age	.614	.000***
	Membership duration	.038	.000***
Customer loyalty	Age	-.512	.000***
	Membership duration	.487	.003*

Notes: p < .000***, p < .001**, p < .005*

Source: Authors

DISCUSSION

The conducted empirical research allows for discussion of the obtained results based on the connections established between the analyzed variables in the model. Overall, all the three dimensions of a mobile application have a positive effect on *customer trust* in mobile applications and *customer loyalty* to the seller as the independent variables. Also, the moderating influence shows that age and membership duration in the loyalty program have a significant influence on the independent variables. Accordingly, the hypotheses H1, H2, H3 and H4 are confirmed.

The first hypothesis tested shows that the implementation of a mobile application positively affects customer trust in the loyalty program they are included in, which means that, as the key dimensions of a mobile application, autonomy, competence and relatedness create customer trust in a mobile application. The results obtained are in agreement with the previous research that confirmed the positive influence of the service quality offered by mobile applications on customer trust (Wahyoedi, Saporso, Tecolau & Winoto, 2021). Similarly to the prior research studies, the research done by C. Y. Li (2018) shows that an increasing number of customers are switching from using conventional loyalty cards to mobile applications, which confirms the assumption of customer trust in them.

The second hypothesis tested confirmed that the use of a mobile application within a loyalty program has a significant influence on customer loyalty. Thus, mobile applications provide customers with a positive experience, strengthen autonomy, increase competence and emotional and social relatedness with other members and the company and/or brand as well, in which way customers perceive the mobile application as a set of interactive and unique incentives capable of making them stay loyal in the long run. The results obtained in this way are in agreement with previous scientific research which shows that, in order for modern customer loyalty programs to succeed, it is necessary not only to have loyalty cards, but also to intensify and diversify more the engagement of customers themselves (Bruneau

et al, 2018), which is achieved through customer participation in prize and other creatively designed games (Danaher *et al*, 2016) and receiving various rewards based on their connecting with the other members of the program (Rehnen, Bartsch, Kull & Meyer, 2017).

The third hypothesis tested the direct influence of trust on customer loyalty, and the results show a significant and positive influence between these two variables, which means that trust is an important predictor of customer loyalty, which was confirmed by the research conducted (Kolte, Pawar, Sangvikar & Sawant, 2021). The authors B. Lu and Z. Chen (2021) concluded that customer trust in them and the seller itself is important for the use of mobile applications. Also, according to B. Kim, Y. Chen and D. Kim (2023), customer trust has a significant influence on customer loyalty, which means that customer trust is the key factor in the formation of customer loyalty because it enables their positive perceptions of transactions and the other pre- and post-purchase activities that can be carried out through a mobile application.

The moderating influence of age and membership duration in the loyalty program is extremely pronounced in terms of creating customer trust and loyalty. Namely, as a demographic characteristic of customers, age affects the connection between the variables in the model and that difference is evident with the increase in the respondents' age, i.e. they positively affect an increase in customer trust and negatively affect a decrease in customer loyalty. On the other hand, the results related to the moderating influence of membership duration in the loyalty program show that one more year of the membership increases customer trust by .038 units, and customer loyalty by .487 units. The results obtained in this way are in agreement with the results of the research showing that younger respondents have a greater tendency to use the incentives of modern loyalty programs than the older do (Lambert-Pandraud & Laurent, 2010; Halwani, 2021; Zhang *et al*, 2022), while membership duration in the program loyalty has an important moderating role between advertising effectiveness and customer loyalty (Maity & Gupta, 2016).

CONCLUSION

The analysis of the theoretical attitudes and the research conducted enables the elaboration of appropriate conclusions and the formulation of managerial implications for the importance of the modern loyalty programs that integrate the services provided by mobile applications. Namely, the research conducted shows that, as the dimensions of mobile applications, autonomy, competence and relatedness have a significant influence on customer trust and loyalty, thus confirming the hypotheses H1, H2 and H3. Additionally, the hypothesis H4 was confirmed by the moderation effect - age, as a demographic characteristic, and membership duration in the loyalty program exert a significant influence on customer trust and loyalty, which further means that customers perceive the service of a mobile application as reliable and valuable and that establishes a connection between them both and the company, allowing for their satisfaction of their own needs. Structuring the loyalty program through a mobile application also means adapting it to certain generational groups, bearing in mind the fact that younger respondents show a greater inclination towards innovations and novelties, which is in agreement with previous research (Halwani, 2021). On the other hand, it is necessary to differentiate the incentives based on membership duration in the loyalty program because membership determines the level of customer loyalty in retail (Maity & Gupta, 2016).

The key contribution of this research is reflected in the fact that the analysis of the influence of autonomy, competence and relatedness (as the independent variables) on customer trust and loyalty (as the dependent variables) was carried out using different statistical methods to validate the results. The main implications of the research results for omnichannel retail managers include the following assertions

- 1) The use of mobile applications has a positive effect on customer trust and loyalty.
- 2) The respondents' age and membership duration in the loyalty program show that there are differences between certain categories of customers in generating customer trust and loyalty,

- 3) Customers value the mobile applications that provide them with a sense of autonomy, competence and relatedness, which strengthens customer trust in their usefulness and leads to their increased loyalty to the retailer.

The research carried out in the paper has certain limitations. The first limitation refers to the sample size, which reduces the generalization of the conclusions and comparison with previous research. In addition to expanding the sample, recommendations for further research imply carrying out the investigation of additional factors in the analysis in order to do research in the relationships between the variables that were the subject matter of the research conducted in this paper. In that sense, future research studies should include certain incentives within mobile applications as the independent variables and the moderator variables, such as respondents' gender, education and economic power, which would enable a more complete insight into customers' perceptions of the incentive structure of mobile applications and a perception of the differences in customer reaction to them based on their relevant demographic and economic characteristics. Finally, the results of this research study provide significant insights for the managers in omnichannel retail who want to improve customer loyalty through mobile applications, as well as the academic public engaged in researching this issue.

ACKNOWLEDGEMENT

The paper is a result of the research based on the obligations under the Agreement on the Transfer of Funds for Financing NIR in 2025 (Registration Number: 451-03-137/2025-03), concluded between the Ministry of Science, Technological Development and Innovation of the Republic of Serbia and the Faculty of Economics, University of Niš.

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Received on 15th July 2024,
after revision,
accepted for publication on 10th July 2025.
Published online on 8th August 2025.

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Original scientific paper

UDC: 336.1/5 (497.6)

doi:10.5937/ekonhor2502169T

THE IMPACT OF TRANSFER PRICING ON THE OPTIMIZATION OF THE FINANCIAL AND TAX POSITIONS OF RELATED ENTITIES IN THE REPUBLIC OF SRPSKA

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This paper investigates transfer pricing as a strategic tool for optimizing business performance and reducing the tax burden of related entities in the Republic of Srpska. The goal of the research is to quantitatively assess the impact of transfer pricing on the achievement of the key business goals, including the improvement of financial performance, the minimization of tax burden and the strategic allocation of resources. The empirical data for the research were collected from the Register of Financial Statements for the year 2023. A simple linear regression model was used to determine the relationship between the application of transfer prices and the financial and tax position of related entities. Research findings show a significant and positive impact of transfer pricing on improving the financial and tax position of related entities, especially those operating in multiple tax jurisdictions. The results emphasize the importance of transfer prices as a strategic instrument for financial planning and the optimization of resources and recommend that the national regulatory framework should be harmonized with international guidelines.

Keywords: transfer pricing, related entities, financial position, tax position

JEL Classification: M41, M48, H25, F23

INTRODUCTION

Transfer pricing is central to discussions on the optimization of the business performance and fiscal position of multinational enterprises. It is especially important in the context of increasing

globalization and the complexity of the international tax environment. Related entities in different tax jurisdictions are increasingly using transfer pricing for strategic planning and profit allocation, which directly impacts operational performance and fiscal stability. With the growth of global economic integration, transfer pricing has become a critical instrument in shaping the financial strategies of multinational corporations. As related entities conduct

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their business across multiple jurisdictions, they face divergent tax rates and regulatory challenges. Transfer pricing enables efficient tax burden planning and optimization, potentially enhancing competitiveness and improving the financial position of the enterprise.

The literature highlights the dual effect of transfer pricing, aligning business strategies with tax regulations while potentially undermining fiscal stability by reducing the tax base in affected countries. S. U. Ahmed (2021) and L. M. Tănase, I. I., Drăghici and N. Popovici (2023) emphasize the importance of transfer pricing for business performance optimization and tax burden reduction, while P. K. Chugan and N. Panchal (2022) analyze its application as a mechanism used to minimize tax burden, highlighting the need for the high standards of corporate governance and transparency so as to maintain financial reporting integrity. The OECD and the G20, through the BEPS guidelines, have set global standards for transfer pricing in order to mitigate the potential for abuse (OECD, 2015; Ignat & Feleagă, 2017), while M. Ištók, V. Solilová and K. Brychta (2022) emphasize the importance of safe harbors and advance pricing agreements (APAs) as tools facilitating regulatory compliance and fostering more transparent business practices.

In the Republic of Srpska, transfer prices are regulated by the Corporate Income Tax Law and the Rulebook on Transfer Prices. The methods for their determination are based on the application of the "arm's length" principle, i.e. business conducted under the conditions that would apply between unrelated parties on the open market. Also, the legal framework stipulates that taxpayers must have documentation on transfer prices at the group level (the Master File) and at the level of an individual related entity (the Local File), which enables the harmonization of business operations with international practices, increasing fiscal stability and minimizing the possibility of tax abuses.

Transfer pricing also plays a critical role in corporate governance and transparency, as it enables companies to adapt their strategies in line with changes in the tax and economic environments, simultaneously

contributing to the maintenance of financial stability. M. Kohlbeck and B. W. Mayhew (2010) emphasize that weak corporate governance can lead to transfer pricing manipulation, undermining financial statement credibility and increasing tax abuse risk. This aspect further facilitates the use of transfer pricing in companies with complex ownership structures, where there is an increased risk of profit shifting to jurisdictions with lower tax rates (Tarmidi & Murwaningsari, 2019). Namely, as the key instrument of modern tax planning, transfer pricing influences profit allocation within the group, business models, investment decisions, and the tax base in each member country of the group (Tirau, Cozma & Pantelescu, 2022). Furthermore, taxation can significantly influence investment decisions regarding specific projects within particular tax jurisdictions, as well as the overall volume of investments. Assuming that other factors remain constant during the observed period, it can be argued that companies are more likely to invest in countries with relatively low tax burden, whereas countries with relatively high tax burden may attract less capital or even experience investment outflows (Luković, Vržina, Grbić & Pjanić, 2021).

The subject matter of this research is the analysis of transfer pricing as a mechanism for optimizing the financial and tax positions of related legal entities in the Republic of Srpska. The general goal is to perform a quantitative assessment of the impact of transfer pricing on achieving key business objectives, with a focus on improving the financial position, reducing tax burden and strategic resource allocation. The research is based on the hypothesis that transfer pricing significantly affects the financial and tax position of related entities, particularly those operating across multiple tax jurisdictions. In this context, related entities are increasingly using transfer pricing to allocate profits, which directly affects their operational efficiency and fiscal stability. To test this hypothesis, empirical data were gathered from the Register of Financial Statements for the year 2023. The data were analyzed using a simple linear regression model to determine the relationship between transfer pricing practices and the financial and tax performance of such related entities.

The paper presents an extensive overview of the complexities of transfer pricing, starting with a literature review and a summary of the legal framework in the Republic of Srpska. Then, the methodology applied to data collection and analysis, the sample, and the techniques used are explained. The results obtained indicate the impact of the application of transfer pricing to financial performance, tax burden, and competitiveness. The paper concludes with policy recommendations and suggestions for future research aimed at improving the transparency and efficiency of transfer pricing practices.

LITERATURE REVIEW

Transfer pricing is a key tool for tax burden optimization for multinational corporations by shifting profits to low-tax jurisdictions. It remains a critical strategy for the multinational corporations that aim to reduce their overall tax burden by allocating profits to countries with more favorable tax regimes, which practice is particularly prominent in the sectors with highly mobile assets and intellectual property, where profit allocation can be structured so as to achieve significant tax savings. S. U. Ahmed (2021) highlights the role of transfer pricing in reducing the tax base and enhancing competitiveness in tax competition. The author argues that the ability of multinational corporations to manipulate transfer pricing mechanisms poses a serious challenge to national tax authorities seeking to preserve fiscal revenues and ensure economic stability. Moreover, transfer pricing is seen as a strategic response to the changing tax rates and regulatory environment, thereby strengthening the competitive position of the companies engaged in cross-border business. M. Ištók *et al* (2022) explore safe harbor rules, which establish pre-determined margins for specific industries and types of transactions, as well as APAs as ways to reduce administrative costs and ensure compliance with regulations. L. M. Tănase *et al* (2023) highlight transfer pricing as a tool for tax optimization, analyzing it through the lens of tax planning in the EU and related regulatory challenges.

Complex ownership structures facilitate the use of transfer pricing to reduce tax burden, especially when companies have subsidiaries in multiple tax jurisdictions. Such structures enable internal profit reallocation, thereby decreasing the overall tax liability of the corporation (Tarmidi & Murwaningsari, 2019; Bouaziz & Ennour, 2022). In addition, intricate ownership chains and legal arrangements allow for the concealment of the true nature of transactions, making it more difficult for tax authorities to accurately assess the legitimacy of transfer pricing practices. As a result, companies often manage to reduce their effective tax rates significantly below the statutory rates in high-tax jurisdictions. In this context, multinational corporations increasingly adopt sophisticated ownership structures so as to align their tax planning strategies with favorable regulatory environments, thereby further enhancing their profitability and competitiveness.

Tax avoidance by multinational corporations is a globally significant issue. T. Tørsløv, L. Wier and G. Zucman (2022) found that 36% of multinational profits had been shifted to tax havens in 2015, thus having reduced tax revenues in high-tax countries. In this context, companies transfer profits through several main channels, each with distinct characteristics and implications:

- Transfer pricing in the trade of goods: Corporations manipulate prices in intragroup transactions related to goods in order to shift profits to jurisdictions with lower tax rates (Cristea & Nguyen, 2016; Liu, Schmidt-Eisenlohr & Guo, 2020).
- Intragroup debt shifting: By creating artificial debt structures or relocating the debt to their subsidiaries in high-tax countries, companies can reduce taxable income through interest payments (Huizinga, Laeven & Nicodeme, 2008). This strategy is particularly effective when interest payments are tax-deductible.
- Relocating intangible assets: Intellectual property, patents, trademarks, and other intangible assets are often relocated to countries with favorable tax regimes (Karkinsky & Riedel, 2012). The mobility

of intangible assets makes this channel especially attractive for tax avoidance.

- Intragroup trade of services: The provision of services (e.g. managerial, consulting, and technical services) between related entities can be manipulated in order to shift profits, especially when pricing is based on non-market terms (Sebele-Mpofu, Mashiri & Schwartz, 2021). This channel is less transparent and harder to regulate, making it a preferred method for multinational corporations engaging in profit shifting.

D. Syromyatnikov, M. Dolgova and S. Demin (2020) emphasize that transfer pricing in developing countries primarily serves as a tool for tax optimization. Transactions between related parties represent a significant risk factor for financial fraud, particularly in jurisdictions with weak or inadequate legal frameworks and limited supervisory capacities, which are characteristic of developing countries (Cabello, Watrin & Moraes, 2022; Nindito, Afianti, Koeswayo & Dewi Tanzil, 2024). For this reason, B. Güvemli, H. İ. Alpaslan and M. E. Şuşoğlu (2017) and D. H. Septiani, I. F. A. Prawira and M. Kusniawan, (2021) highlight the importance of regulating transfer pricing through an effective legislative framework aligned with international standards, with the aim of reducing the risk of tax evasion. Transfer pricing regulation presents a major challenge for many countries, particularly those in the developing world. A. A. T. Rathke, A. J. Rezende and C. Watrin (2021) demonstrate how different countries implement varying regulatory systems, contributing to inconsistencies in practice. J. P. Choi, T. Furusawa and J. Ishikawa (2020) underscore the importance of adhering to international standards so as to prevent harmful tax competition and safeguard national tax sovereignty. Furthermore, there is a strong emphasis on the need to strengthen national regulatory frameworks in order to enhance transparency and simplify dispute resolution mechanisms, thereby ensuring a fair allocation of tax revenues and protecting national budgets (Ciubotariu & Petrescu, 2022).

A ten-year study conducted in Slovakia (Kramarova, 2021) showed the connection between transfer prices,

earnings management and tax avoidance. A similar three-year study was conducted in Romania, with an analysis of examples at the European and global levels, highlighting the increasingly sophisticated methods used by multinational companies in shaping the financial result and the tax base through transfer pricing (Sava & Tureatcă, 2017), for which reason, the authors R. Maxim and F. Moisescu (2017) emphasize the importance of strengthening international coordination and transparency, as well as a better control and regulation of transfer prices. V. Todorović, J. Bogićević and S. Vržina (2019) investigated the management of corporate income tax in banks in the Republic of Serbia, emphasizing that tax management includes a set of activities aimed at the legal minimization of tax liabilities. The obtained results indicated that tax policy had a significant impact on the financial position of related entities and their operations across multiple jurisdictions. Based on the research also conducted in the Republic of Serbia on a sample of 52 medium-sized and big companies operating in various industries, a fact was determined that transfer prices were more dominantly treated as a tax instrument than as a tool for managing business performance (Demko-Richter, Sekerez, Spasić & Conić, 2019).

The literature review suggests that the effective application of transfer pricing strategies enables multinational corporations to strategically allocate profits, thereby optimizing their tax burden and enhancing overall financial performance. However, it is important to emphasize that, while transfer pricing can serve as an effective tool for tax optimization, it may also obscure the accurate representation of the assets and income of related parties, which in turn poses challenges to the reliability of financial disclosures, particularly in the context of regulatory compliance and reporting transparency. Moreover, the strategic use of transfer pricing directly influences the way the actual tax base is reported, ultimately exerting an impact on both fiscal liabilities and corporate strategies concerning profitability and resource allocation - particularly in the case of multinational enterprises operating across multiple tax jurisdictions.

In line with the foregoing, the following research hypothesis was tested in the paper:

H1: Transfer pricing significantly affects the financial and tax position of related entities, particularly those operating across multiple tax jurisdictions.

LEGAL FRAMEWORK

Transfer prices are the prices at which related entities conduct transactions, such as goods sales, services, or financial arrangements. In the Republic of Srpska, regulations ensure that these transactions comply with the “arm’s length principle”, meaning conditions like those between unrelated parties in an open market. Accordingly, in the Republic of Srpska, transfer pricing is regulated by the Corporate Income Tax Law and the Rulebook on Transfer Pricing. These regulations define the methods for determining transfer prices, required documentation, and substantiation procedures. Related entities are entities connected through ownership, management, or in any other manner that could influence business decisions.

The Rulebook defines the following methods for determining transfer prices:

1. **Comparable Uncontrolled Price Method:** A comparison of prices in transactions between related entities with prices in similar transactions between unrelated entities.
2. **Cost Plus Method:** Adding a standard markup to the costs of production or service provision.
3. **Resale Price Method:** Deducting the standard distributor margin from the sales price of a product or service.
4. **Transactional Net Margin Method:** Analyzing the net profit margin achieved in transactions with related entities compared to margins in similar transactions between unrelated entities.
5. **Profit Split Method:** Allocating the total profit or loss between related entities in an economically justified manner.

The taxpayers involved in related transactions must maintain detailed transfer pricing documentation, which includes:

- **Master File:** The group-level documentation that provides an overview of business operations, the organizational structure, and transfer pricing policies.
- **Local File:** The entity-level documentation that provides detailed descriptions of transactions with related entities, comparability analysis, and the chosen method for determining transfer prices.

Taxpayers must have transfer pricing documentation available when submitting a tax return (March 31st in the current year for the previous year). Additionally, if total controlled transactions exceed BAM 700,000 in the tax year, the taxpayer must submit an annual report to the Tax Administration (offsetting income and expenses is not allowed). The documentation must be made available within 30 days if requested by the Tax Administration. Penalties for late submission range from BAM 20,000 to BAM 60,000 for the entity, and from BAM 5,000 to BAM 15,000 for the responsible individual.

International options for resolving transfer pricing disputes are not legally regulated, but internal options are. For adjustments following a tax audit, the taxpayer may appeal to the Ministry of Finance of the Republic of Srpska. In the event of an unfavorable decision rendered by the Ministry, the taxpayer may initiate administrative proceedings before the competent District Court and subsequently appeal to the Supreme Court of the Republic of Srpska. However, filing an appeal does not suspend the execution of the tax audit results.

There are 37 active international double taxation avoidance agreements in the Republic of Srpska (Tanasić, 2019). In the Republic of Srpska, APAs are not used, and there is no dedicated department for transfer pricing control, nor any customized databases for verifying transaction terms (Tanasić, Lalić & Petrović, 2024).

DATA AND METHODOLOGY

According to the data extracted from the Financial Statements Registry of the Agency for Intermediary, IT, and Financial Services (APIF) for the year 2023, a total of 1,644 related entities operated in the Republic of Srpska, including both the parent and subsidiary entities. This population reflects the entities engaging in inter-company transactions subject to transfer pricing regulations. To assess the specific impact of transfer pricing practices on the financial and tax positions of these entities, a sample of 57 related entities, representing 3.5% of the overall population, was used in the research. The sample size reflects the number of the entities that responded to the survey request rather than a predetermined optimal sample size. Significant challenges arose during the initial sampling phase. Overall, 80.05% of the entities either lacked publicly available email addresses or had incorrect/inactive email addresses, which limited our ability to effectively reach potential respondents. For those entities with functional email addresses, a formal invitation to participate in the survey, including a link to the electronic questionnaire, was sent to 328 companies. However, 82.62% of these entities did not respond, resulting in only 57 filled-out questionnaires. Although the response rate was relatively low, the findings still provide valuable insights into transfer pricing practices and their effects on the financial and tax positions of the related entities within the jurisdiction. The low response rate underscores broader challenges in engaging the business community in the research, likely stemming from a limited awareness of the value of scientific research for improving community outcomes. Another limitation to consider is the possibility that, as the representatives of their respective entities, the survey participants may not occupy roles directly related to the application of transfer pricing. Consequently, there is a risk that they may have been insufficiently familiar with the subject matter of the questionnaire, or the terminology used in it, which may potentially have affected the accuracy and reliability of their responses. Nevertheless, the insights gained from the entities included in the survey remain valuable for understanding the trends

and the potential implications of transfer pricing practices.

In this study, a simple linear regression model was used to demonstrate the degree of the impact of transfer pricing (the independent variable) on the financial and tax positions (the dependent variables) of the related entities. The financial and tax positions were measured based on the respondents' assessments of their own satisfaction with the current financial and tax situations, given the application of the transfer pricing policies. As a dependent variable, the financial position was evaluated through subjective assessments performed by the respondents, who were asked to rate their own satisfaction with the financial outcomes of their respective entities, following the application of transfer pricing, which included their perceptions of overall profitability, liquidity, and financial stability. The respondents used a Likert scale (ranging from 1 to 5) to indicate the extent to which they believed that transfer pricing had contributed to improving their financial position, including the aspects such as increased cash flow, better resource allocation, and enhanced market competitiveness. Similarly, the tax position was assessed through the respondents' respective evaluations of their own satisfaction with their current tax burden in relation to the application of transfer pricing. The survey captured the perceptions of the effectiveness of transfer pricing in optimizing tax burden, including the ability to effectively utilize tax reliefs, deductions, and exemptions. The respondents were asked to indicate, on the Likert scale (from 1 to 5), how satisfied they were with the extent to which transfer pricing had led to the reduction in their tax burden and improved compliance with the existing tax regulations. These subjective evaluations provided a unique insight into how transfer pricing was perceived to influence both financial performance and tax efficiency at the entity level, allowing for a nuanced interpretation of its impact beyond purely quantitative financial metrics.

Considering that Bosnia and Herzegovina has a unique organizational structure characterized by fragmented and conflicting accounting and tax regulations, this study identifies and presents the differences in the impact of transfer pricing on the

financial and tax performance of the related entities, which on their part are categorized into three groups: (1) those operating exclusively within the Republic of Srpska, i.e. within a single tax jurisdiction; (2) those operating across multiple tax jurisdictions within Bosnia and Herzegovina (two or three); and (3) those engaged in transactions with related entities operating abroad. Based on this classification, the results are presented in three distinct segments. Specifically, 35.1% of the total number of the respondents indicated that they did not have related legal entities within the Republic of Srpska. Therefore, they were excluded from the assessment of the goal achievement related to the application of transfer pricing in transactions with the related entities within the same jurisdiction. For this category, a sample of 37 respondents was used. To assess the achievement level of the goals related to the application of transfer pricing in transactions with the related legal entities within Bosnia and Herzegovina, a sample of 43 respondents was used, which is because 24.6% of the respondents indicated that they did not have related legal entities in other jurisdictions within Bosnia and Herzegovina, for which reason they were excluded from the assessment of the set goals. A sample of 34 respondents was used to evaluate the level of the achievement of certain goals related to the application of transfer pricing in transactions with the related legal entities abroad. This sample size reflects that 40.3% of the respondents reported they did not have related entities abroad.

RESEARCH RESULTS

The organizational status of the entities included in the survey concerning their affiliated structures was as follows: 26.3% of the respondents identified themselves as the parent entities, whereas the remaining 73.7% of them classified themselves as subsidiaries. Of the total number of the related legal entities participating in the survey, 10.5% stated that they operated only within the Republic of Srpska, thus indicating their focus on localized operations without involvement in other tax jurisdictions. Furthermore,

28.1% operate in two or all three jurisdictions within Bosnia and Herzegovina, which reflects a regional business approach that necessitates compliance with multiple regulatory frameworks. As many as 42.1% of the companies operate within the territory of the Republic of Srpska and abroad, which highlights their engagement in cross-border activities, which involves navigating different fiscal and regulatory environments. Finally, only 19.3% indicated that they carried out their business activities within the territory of Bosnia and Herzegovina (in two or all three jurisdictions), as well as abroad, thus pointing to the complex operational structure that requires sophisticated management of diverse legal and fiscal obligations (Table 1).

Table 1 The territorial structure of the business operations of the related entities registered in the Republic of Srpska

Area of operation	Number of the respondents	Share
Republic of Srpska	6	10.5%
Bosnia and Herzegovina (two or three jurisdictions)	16	28.1%
Republic of Srpska and abroad	24	42.1%
Bosnia and Herzegovina and abroad	11	19.3%
Total	57	100.0%

Source: The authors

In Bosnia and Herzegovina, the existence of three distinct and independent corporate income tax systems creates a foundation for a certain level of tax competition. While corporate income tax rates across the entities and Brčko District are relatively low and harmonized, tax incentives and reliefs

emerge as the primary drivers of these competitive dynamics. According to the research study, 42% of the respondents reported significant discrepancies in the tax reliefs between the jurisdictions within Bosnia and Herzegovina, 40% noted partial discrepancies, and 18% were unfamiliar with the prescribed tax reliefs in the other jurisdictions. None of the respondents indicated that tax regulations were fully harmonized across all the jurisdictions in Bosnia and Herzegovina, which points to the fragmented tax policy landscape that complicates compliance for entities operating in multiple areas.

The following charts present the objectives of the transactional activities involving transfer pricing and the tables with the goal fulfillment ratings using the Likert scale (1 - completely unfulfilled, 5 - completely fulfilled). It is important to note that, when collecting data on tax practices, particularly in transition countries, the potential for respondent bias must be carefully considered. In her 2007 study, K. Gërzhani (2007) underscores the challenges involved and provides guidelines for potentially overcoming them when gathering data on tax evasion. She emphasizes

that respondents often hesitate to admit to certain activities due to fears of sanctions or social stigma.

Improving the financial position is cited as the primary objective of transactional activities with related entities within the Republic of Srpska. Increasing the market share is also a significant goal, followed by improving business operations, while reducing tax burden is the least cited objective in applying transfer pricing within the same jurisdiction

For transactions with related entities in other jurisdictions within Bosnia and Herzegovina (Figure 2), improving the financial position remains the primary objective, followed by increasing market share, improving business operations, and, to a somewhat lesser extent, reducing tax burden.

Regarding transfer pricing with the related entities abroad (Figure 3), the entities in the Republic of Srpska identified the increase in the market share and reduction in tax burden as the primary objectives. Additionally, they also mentioned reduction in the impact of the economic constraints and, to a lesser extent, the improvement of the financial position of the entity.

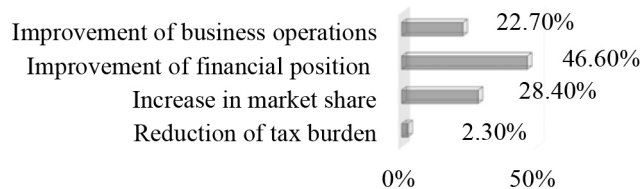


Figure 1 The objectives of the transfer pricing applications in business with the related entities within the same jurisdiction

Source: The authors

Table 2 The rating of the degree of the fulfillment of the objectives through the transfer pricing applications in business with the related entities within the same jurisdiction

Primary objectives	Number of the respondents	Actual range		Median	Arithmetic mean	Standard deviation
		Min. score	Max. score			
The improvement of business operations	37	3	5	4.00	4.11	0.568
The improvement of the financial position	37	3	5	4.00	4.33	0.321
An increase in the market share	37	3	5	4.00	4.28	0.522
Reduction in tax burden	37	2	4	4.00	3.31	0.261

Source: The authors

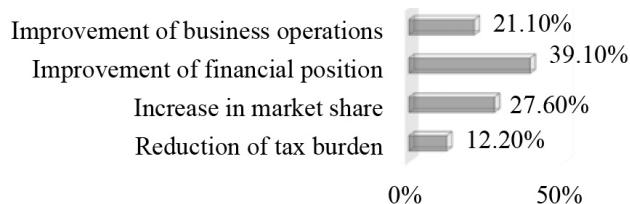


Figure 2 The objectives of the transfer pricing applications in business with the related entities in Bosnia and Herzegovina

Source: The authors

Table 3 The rating of the degree of the fulfillment of the objectives through the transfer pricing applications in business with the related entities in Bosnia and Herzegovina

Primary objectives	Number of the respondents	Actual range		Median	Arithmetic mean	Standard deviation
		Min. score	Max. score			
The improvement of business operations	43	3	5	4.00	4.17	0.541
The improvement of the financial position	43	3	5	4.00	4.57	0.689
An increase in the market share	43	3	5	4.00	4.11	0.728
Reduction in tax burden	43	2	5	4.00	3.67	0.612

Source: The authors

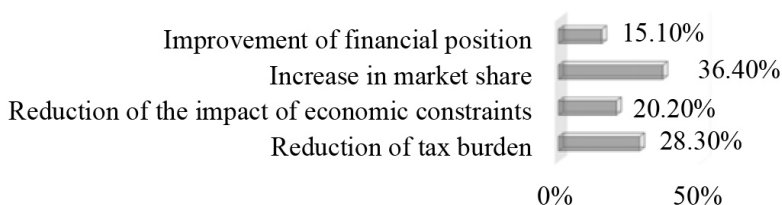


Figure 3 The objectives of the transfer pricing applications in business with the related entities abroad

Source: The authors

Table 4 The rating of the degree of the fulfillment of the objectives through the transfer pricing applications in business with the related entities abroad

Primary objectives	Number of the respondents	Actual range		Median	Arithmetic mean	Standard deviation
		Min. score	Max. score			
The improvement of the financial position	34	3	5	4.00	4.10	0.786
An increase in the market share	34	3	5	4.00	4.15	0.702
Reduction in the impact of the economic constraints	34	4	5	4.00	4.21	0.553
Reduction in tax burden	34	3	5	4.00	3.93	0.598

Source: The authors

HYPOTHESIS TESTING AND DISCUSSION

To assess the strength of the relationship between the transfer pricing application and the achievement of the specific objectives in transactions with the related entities, the Pearson Correlation Coefficient (PCC) was employed. The results of the correlation analysis are presented in the tables 5-7.

The data indicate that, at the 1% error level, a strong positive correlation exists between the degree of the transfer pricing application and the achievement of certain business objectives with the related entities (except for the reduction in tax burden in dealings within the same tax jurisdiction, i.e. in the Republic of Srpska). It is noticeable that the strength

of the correlation is the weakest in the transactional relationships with the related entities within the same tax jurisdiction, and the strongest with the related entities abroad.

In line with the conducted research, the results of the regression analysis are presented in tables 8 to 12. The established multiple correlation coefficient and the coefficient of determination (Table 8) indicate the strong relationship between transfer pricing and the financial position within the same jurisdiction, where 57% of the variability in the financial position is explained by the variations in transfer pricing. The ANOVA test ($p=0.000<0.05$) confirms that the regression model is statistically valid. The regression equation for the impact of transfer pricing on the

Table 5 PCC for the fulfillment of the objectives of the transfer pricing applications in business with the related entities within the same tax jurisdiction

	The improvement of business operations	The improvement of the financial position	An increase in the market share	Reduction in tax burden
The degree of the TP applications in the business activities of the entity	0.785**	0.802**	0.812**	*
The improvement of business operations		1.000**	0.599	*
The improvement of the financial position			0.967**	*
An increase in the market share				*
The number of the respondents	37			

** p < 0.01; * It cannot be calculated because at least one of the variables is constant.

Source: The authors

Table 6 PCC for objectives of transfer pricing applications in business with related entities across multiple tax jurisdictions in Bosnia and Herzegovina

	The improvement of business operations	The improvement of the financial position	An increase in the market share	Reduction in tax burden
The degree of the TP applications in the business activities of the entity	0.856**	0.813**	0.905**	0.652**
The improvement of business operations		0.832**	0.939**	0.723**
The improvement of the financial position			0.958**	0.626**
An increase in the market share				0.704**
The number of the respondents	43			

** p < 0.01;

Source: The authors

financial position of the related entities within the same jurisdiction is $Y = 0.897 + 0.788X$. Based on the t-test value ($t=6.285>2.0013$) and the significance level ($p=0.000<0.05$), it can be concluded that transfer pricing has a statistically significant impact on predicting the financial position. Due to the inability to calculate the correlation coefficient between the degree of the transfer pricing application and the reduction in tax burden within the same jurisdiction (owing to a small number of the respondents selecting this objective), it was determined that no significant dependency exists between these two components, which was an expected outcome given the fact that, unlike improving the financial position, increasing the market share and enhancing overall business operations, reducing tax burden is not considered the primary or dominant objective for the business

activities of the related entities within the same jurisdiction, i.e. in the Republic of Srpska.

The multiple correlation coefficient ($R=0.815$) and the coefficient of determination indicate a strong relationship between transfer pricing and the financial position of the related entities operating across multiple tax jurisdictions in Bosnia and Herzegovina (Table 9), with 66.4% of the variability in the financial position explained by the regression model. The ANOVA test ($p=0.000<0.05$) confirmed the statistical validity of the model. The regression equation for the impact of transfer pricing on the financial position of the related entities is $Y = 1.421 + 0.755X$. Based on the t-test value ($t=8.495>2.0013$) and the significance level ($p=0.000<0.05$), it can be concluded that transfer pricing has a statistically significant effect on the

Table 7 The PCC for the objectives of the transfer pricing applications in business with the related entities abroad

	The improvement of business operations	The improvement of the financial position	An increase in the market share	Reduction in tax burden
The degree of the TP applications in the business activities of the entity	0.814**	0.851**	0.912**	0.718**
The improvement of business operations		0.842*	0.841	0.988**
The improvement of the financial position			0.799**	0.668**
An increase in the market share				0.793**
The number of the respondents	34			

* $p < 0.05$; ** $p < 0.01$

Source: The authors

Table 8 The impact of the transfer pricing applications on the improvement of the financial position of the related entities within the same jurisdiction

The financial position of the model (Y)	Regression coefficients		t-test	Significance
	β	Standard error		
The constant	0.897	0.396	2.013	0.049
The degree of the TP applications in the business activities of the entity (X)	0.788	0.117	6.285	0.000
The multiple correlation coefficient	R=0.755			
The coefficient of determination	R ² =0.570			
The ANOVA test	p=0.000			
The number of the respondents	37			

Source: The authors

financial position of the entities operating across multiple tax jurisdictions in Bosnia and Herzegovina.

The correlation analysis also reveals a direct relationship between the transfer pricing application and the reduction in tax burden for the related entities across multiple jurisdictions (Table 10). The coefficient of determination shows that 39.9% of the variability in the tax position is explained by the transfer pricing application. The ANOVA test ($p=0.001<0.05$) indicated that the regression model was statistically valid. The regression equation is $Y = 1.355 + 0.612X$. Based on the t-test value ($t=3.498>2.0013$) and the significance level ($p=0.001<0.05$), it is evident that transfer pricing significantly influences the tax position of the related entities in Bosnia and Herzegovina. A strong direct relationship was also established between transfer

pricing and the improvement of the financial position of the entities conducting transactions with the related entities abroad (Table 11). In this context, 64.2% of the variability in the financial position can be explained by the regression model. The ANOVA test ($p=0.004<0.05$) confirms the statistical validity of the model. The regression equation is $Y = 0.598 + 0.887X$. The t-test value ($t=3.998>2.0013$) and the significance level ($p=0.004<0.05$) indicate that transfer pricing significantly contributes to predicting the financial position of these entities.

Moreover, the multiple correlation coefficient indicates a strong relationship between transfer pricing and the reduction in tax burden for the entities conducting transactions abroad (Table 12). The coefficient of determination shows that 52% of

Table 9 The impact of the transfer pricing applications on the improvement of the financial position of the related entities operating across multiple tax jurisdictions in Bosnia and Herzegovina

The financial position of the model (Y)	Regression coefficients		t-test	Significance
	β	Standard error		
The constant	1.421	0.425	3.650	0.012
The degree of the TP applications in the business activities of the entity (X)	0.755	0.091	8.495	0.000
The multiple correlation coefficient	R=0.815			
The coefficient of determination	R ² =0.664			
The ANOVA test	p=0.000			
The number of the respondents	43			

Source: The authors

Table 10 The impact of the transfer pricing applications on the tax position for the related entities operating across multiple tax jurisdictions in Bosnia and Herzegovina

The financial position of the model (Y)	Regression coefficients		t-test	Significance
	β	Standard error		
The constant	1.355	0.567	2.110	0.049
The degree of the TP applications in the business activities of the entity (X)	0.612	0.201	3.498	0.001
The multiple correlation coefficient	R=0.632			
The coefficient of determination	R ² =0.399			
The ANOVA test	p=0.001			
The number of the respondents	43			

Source: The authors

the variability in the tax position is determined by transfer pricing. The ANOVA test ($p=0.001<0.05$) demonstrates the statistical validity of the model. The regression equation for the tax position of the entities conducting transactions abroad is $Y = 2.110 + 0.503X$. The t-test value ($t=5.023>2.0013$) and the significance level ($p=0.001<0.05$) allow us to conclude that transfer pricing has a statistically significant impact on the tax position of the entities engaged in controlled transactions with the related entities abroad.

CONCLUSION

This study provides the empirical evidence confirming that transfer pricing is a pivotal tool for

tax burden optimization and financial performance enhancement in the Republic of Srpska, particularly in the context of global economic integration and increasingly complex international tax systems. The results of the regression analysis demonstrate a significant impact of transfer pricing on the financial and tax positions of the related entities in the sample analyzed. These findings indicate that the strategic application of transfer pricing can yield considerable competitive advantages, particularly for the entities operating across multiple tax jurisdictions. For the entities operating within a single jurisdiction transfer pricing primarily contributes to improved operational efficiency, although its impact on tax burden reduction appears to be less significant. This finding underscores the differentiated benefits derived from

Table 11 The impact of the transfer pricing applications on the improvement of the financial position of the entities conducting business with the related entities abroad

The financial position of the model (Y)	Regression coefficients		t-test	Significance
	β	Standard error		
The constant	0.598	0.812	0.725	0.501
The degree of the TP applications in the business activities of the entity (X)	0.887	0.225	3.998	0.004
The multiple correlation coefficient	R=0.801			
The coefficient of determination	R ² =0.642			
The ANOVA test	p=0.004			
The number of the respondents	34			

Source: The authors

Table 12 The impact of the transfer pricing applications on the tax position of the entities conducting business with the related entities abroad

The financial position of the model (Y)	Regression coefficients		t-test	Significance
	β	Standard error		
The constant	2.110	0.425	4.512	0.000
The degree of the TP applications in the business activities of the entity (X)	0.503	0.128	5.023	0.001
The multiple correlation coefficient	R=0.721			
The coefficient of determination	R ² =0.520			
The ANOVA test	p=0.001			
The number of the respondents	34			

Source: The authors

transfer pricing, which vary depending on the scope of operations and market complexity. Consequently, the adoption of appropriate transfer pricing strategies is essential for companies seeking to navigate both domestic and international tax environments effectively. The conducted regression analysis demonstrates that significant differences exist in the strength of the relationship between transfer pricing practices and the financial and tax performance of the related entities. Gradually observed, the impact of transfer pricing is the weakest within the same tax jurisdiction, more pronounced when the entities operate across multiple tax jurisdictions within Bosnia and Herzegovina, and the most pronounced when dealing with the related entities abroad.

However, this research study has certain limitations that must be taken into account when interpreting the results. The relatively small sample size of 57 entities limits the generalizability of the results. In addition, the possibility of respondent bias must be acknowledged as inaccuracies or intentional misrepresentations in the self-assessment of the financial and tax positions, as well as the perceived impact of transfer pricing, may compromise the reliability of the data. Although the low response rate posed methodological challenges, the data collected nevertheless offer valuable perspectives on transfer pricing patterns and their implications within the Republic of Srpska.

This research study contributes to the existing literature on transfer pricing by providing a detailed empirical analysis of its application among related entities in the Republic of Srpska and emphasizes the importance of establishing a well-structured regulatory framework aimed at maximizing positive outcomes and minimizing associated risks. Additionally, the findings highlight the need for advanced regulatory instruments such as Advance Pricing Agreements (APAs) to enhance legal certainty, reduce administrative burden, and foster a transparent business environment aligned with international standards, such as the OECD guidelines.

Effective and transparent transfer pricing practices are essential for promoting financial stability and

ensuring fairness within the tax system. Furthermore, improved corporate governance, strong internal controls, and clearly defined audit and management practices are essential for increasing accountability and mitigating the risks associated with inappropriate or abusive transfer pricing practices. Raising awareness among the business community about the importance of participating in scientific research could significantly improve the quality of data and contribute to more comprehensive and reliable future studies. Future research should focus on increasing the sample sizes, examining different transfer pricing strategies, and analyzing their effects across different tax jurisdictions and regulatory frameworks. Ensuring the respondents' expertise and encouraging a broader company participation are key to obtaining reliable results. Such efforts would provide a deeper insight into transfer pricing practices and their implications for financial and tax performance, thereby supporting economic growth, transparency, and regulatory efficiency.

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Received on 20th December 2024,
after revision,
accepted for publication on 10th July 2025.
Published online on 8th August 2025.

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Review paper

UDC: 004.8:658.8

doi:10.5937/ekonhor2502187S

COMPARISON OF HUMANS AND ARTIFICIAL INTELLIGENCE IN THE AHP METHOD-BASED CONTENT CREATION FOR DIGITAL MARKETING

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In digital marketing, the ability to create engaging and relevant content is a key success factor. Advancements in technology present new opportunities, with artificial intelligence (AI) reshaping various business sectors. AI can assist or fully manage content creation, helping marketers enhance work processes and outcomes. Using a multicriteria analysis model, it is possible to evaluate criteria and make decisions between alternatives for content creation. This paper uses the Analytical Hierarchy Process (AHP) to evaluate the alternatives, namely humans, AI, and a combination of the two, with the aim of improving content creation based on the criteria of creativity, speed, cost, content quality, adaptability, and conversion. The results of the paper indicate that marketing professionals consider humans to be most effective for content creation, particularly in creativity, content quality, adaptability, and conversion. While the combination of humans and AI offers advantages in cost efficiency and speed, it does not surpass the human-driven approach.

Keywords: humans, artificial intelligence, digital marketing, content creation, AHP method

JEL Classification: M31, C44, O33, D83, L86

INTRODUCTION

In the field of digital marketing, any organization seeking to attract potential customers, and ensure that its products remain consumers' preferred choice must continuously provide high-quality content and work diligently on its improvement and development. Given the rapid technological advancements, it is

crucial for companies to adapt to these changes in order to avoid falling behind their competitors (Yeğın, 2020).

In the 1950s, computer-generated content was mainly focused on music and visual arts. These early computer-generated pieces could be easily distinguished from human-created content. With the advancements in artificial intelligence, particularly in the realm of visual content, AI-generated works have become highly realistic, thanks to techniques such as generative adversarial networks and diffusion

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models (Ma, Liu, Yi, Cheng, Huang, Lu & Liu, 2023). Marketing professionals play a key role in integrating artificial intelligence into business operations so as to enhance the digital development of companies, create relevant content, and define strategies (Yeğin, 2020).

The subject of this paper is the comparative analysis and evaluation of humans, artificial intelligence (AI), and their combination in the content creation process for digital marketing, using the Analytical Hierarchy Process (AHP) method. This approach aims to identify the most valued criteria by marketing professionals when selecting content creation strategies and to assess how these alternatives perform in producing engaging and high-quality content.

Drawing on the existing research (Amabile, Conti, Coon, Lazenby & Herron, 1996; Gao & Chen, 2021; Chintalapati & Pandey, 2022; Deekshith, 2023; Singh, 2024), two hypotheses have been formulated, namely:

H1: Creativity and content quality are the most critical factors for marketing professionals when selecting a content creation method in digital marketing.

This hypothesis is supported by previous studies emphasizing the importance of creativity as a key component of successful content (Amabile *et al.*, 1996), as well as the role of high-quality content in achieving marketing objectives (Gao & Chen, 2021). While AI offers significant advantages in efficiency and scalability, it has been criticized for its limitations in generating content with emotional resonance and originality, traits typically associated with human creators (Chintalapati & Pandey, 2022).

H2: Combining humans and artificial intelligence in content creation for digital marketing yields superior business outcomes, striking a balance between creativity, speed, content quality, adaptability, conversion and cost efficiency, thereby outperforming the use of only human resources or AI tools alone.

This hypothesis aligns with the research suggesting that human-AI collaboration leverages the strengths of both approaches. Humans bring innovation and

emotional intelligence, while AI enhances efficiency, scalability, and speed (Deekshith, 2023; Singh, 2024). This synergy is particularly relevant in dynamic digital environments where adaptability and cost management are critical.

This multicriteria decision-making problem focuses on identifying the success criteria that marketing professionals prioritize most in digital marketing and content creation and determining which of the three approaches best supports the achievement of these goals. Accordingly, a multicriteria decision-making model was developed in the *SuperDecisions* software so as to evaluate the model's elements, criteria, and alternatives. The introduction outlines multicriteria decision-making, reviews the relevant literature, and describes the research methodology. The paper emphasizes the application of the AHP method, which has proven to be an effective and validated tool for solving complex multicriteria decision-making problems. The key aspects include the proper structuring of the decision-making problem and the selection of appropriate criteria to identify optimal alternatives. The hierarchical decomposition of the problem significantly contributes to transparency and more efficient problem solving, increasing decision-making consistency and reducing the likelihood of errors.

THE THEORETICAL FOUNDATIONS OF THE RESEARCH

Digital marketing and content creation

Digital marketing can be described as a set of activities, organizations, and processes that use digital technologies to create, communicate, and deliver value to customers and other relevant parties. It includes methods such as search engine optimization, social media, email, content marketing, and online advertising, aiming to enable more precise and personalized interaction with consumers compared to traditional marketing (Saadah, Suliyanto & Rahab, 2023).

The concept of digital content marketing refers to the promotion of products where both the products and their delivery are digital (Rowley, 2008). It includes various formats like news, videos, e-books, infographics, newsletters, blogs, and more, all aimed at attracting the target audience (Kose & Sert, 2017). Creating effective content requires time, effort and skills, such as persuasive writing and producing high-quality visuals or audio (Blank, 2013).

Criteria for success in digital marketing and content creation

To effectively assess the success of digital marketing and optimize content creation strategies, it is essential to consider the key criteria that directly impact the performance and results of marketing campaigns. These criteria include creativity, speed, cost, content quality, conversion, and adaptability. Each of these factors plays a crucial role in shaping how digital content can be optimized for the maximum impact and efficiency in the modern digital environment.

Creativity helps differentiate the brand and capture user attention. According to the research by T. M. Amabile *et al* (1996), creativity is defined as the ability to generate new and useful ideas that contribute to innovation and the improvement of business processes. Creativity in content creation can have a direct impact on the quality and effectiveness of marketing campaigns, enabling the production of unique and engaging materials that better resonate with the target audience.

The speed of content production and distribution refers to the ability of content to quickly reach the target audience and provoke rapid responses, affecting how quickly campaigns can address viral topics or trends. The speed at which content spreads through social media can significantly contribute to the success of viral marketing by allowing messages to reach a large number of users swiftly (Kaplan & Haenlein, 2011). In the context of digital marketing, efficient and rapid content distribution is increasingly important, as users expect instant information and the immediate gratification of their needs. The speed of

interactions between consumers and brands via social media directly impacts marketing outcomes, as quick responses can increase engagement and positive feedback from consumers (Rapp, Beitelspacher, Grewal & Hughes, 2013).

Costs directly influence the efficiency and sustainability of various content creation approaches in digital marketing. In the digital environment, the effective cost management of marketing campaigns can significantly enhance profitability and resource efficiency (Kannan & Li, 2017). Given the growing importance of online channels, reducing costs through digital campaign optimization is becoming increasingly relevant as companies seek to achieve the maximum impact with minimal resources (Rust, Moorman & Bhalla, 2010). Additionally, the ability to precisely quantify return on investment (ROI) across different digital channels allows for a better budget allocation, which is crucial for success in modern marketing (Wiesel, Pauwels & Arts, 2011).

Content quality is critical for long-term user loyalty and brand trust, as it reflects the ability of a material to meet user needs and expectations while simultaneously positively influencing their opinions and behaviors. According to C. Homburg, L. Ehm and M. Artz (2015), the quality of content in digital marketing significantly affects brand perception and public opinion about a company. Their research emphasizes the importance of understanding and managing user emotions in the digital age, which directly depends on the relevance, accuracy, and attractiveness of the content. High-quality content not only informs but also engages the audience, fostering loyalty and positive reactions. It is also noted that content quality significantly contributes to conversions and user engagement. Quality content generates higher engagement and increases user satisfaction.

Adaptability refers to the ability of content to dynamically adjust to changing user and market needs. According to E. Constantinides and S. J. Fountain (2008), adaptability is a crucial characteristic in the Web 2.0 era, where users expect interactivity and real-time content personalization. The authors

emphasize that flexibility and the ability to rapidly adjust content based on user preferences and feedback are essential for success in digital marketing. Adaptive content allows brands to remain relevant and engaged with their audience.

Conversion is considered a key metric of success in digital marketing and relates to the ability of content to encourage users to take desired actions, such as making a purchase, subscribing to a newsletter, or downloading content. Research by H. van der Heijden (2003) indicates that conversion success on websites depends on several factors, including user experience, information relevance, and ease of navigation. The author notes that users are more likely to convert when the content and site interface clearly communicate value and facilitate an easy execution of actions. In the context of digital marketing, conversion can be regarded as a critical indicator of content success.

Humans, artificial intelligence, and a combination of humans and artificial intelligence in content creation

In content creation, humans play an essential role due to their ability to infuse creativity and a deep understanding of the target audience. Human creativity enables the development of original ideas that capture attention and engage the audience emotionally. Content creators use artistic skills and personal experiences to produce the material that is both aesthetically appealing and aligned with the values and interests of the target group (Amabile *et al*, 1996). The importance of writing skills, understanding audience psychology, and tailoring content to user needs is emphasized. These elements support the creation of relevant, engaging, and high-quality content. Human creators bring unique perspectives and emotional depth to the process (Gao & Chen, 2021).

Artificial Intelligence (AI) significantly contributes to content creation in digital marketing. AI assists marketing professionals in analyzing consumer data, optimizing content, and targeting it accurately to specific demographic groups (Haleem, Javaid,

Qadri, Singh & Suman, 2022). The application of AI simplifies the understanding of consumer behavior through social media analysis and contributes to creating content that is better aligned with audience interests (Chintalapati & Pandey, 2022).

The focus of this study includes both the generative AI tools that can independently create content and the AI tools that assist human users in content creation. While generative AI tools offer significant efficiency and speed advantages, they still lack the emotional depth and market-specific understanding provided by human creators. However, when combined, human creativity and AI can complement each other, enhancing content quality, creativity, and cost-effectiveness, thus offering superior outcomes compared to using either approach alone.

A combination of humans and artificial intelligence provides significant advantages by merging human creativity with the analytical power of AI. Humans have the ability to understand, empathize, and think innovatively, while AI facilitates the processing of large amounts of data, pattern recognition, and content personalization to a level that would be difficult for humans alone to achieve. This synergy enables marketing professionals to create content that is not only technically optimized but also emotionally resonates with the target audience. The advantages of AI in content creation depend on the type and context of the generated content. AI-generated content may be somewhat lower in quality compared to the content produced by humans (Chintalapati & Pandey, 2022).

RESEARCH METHODOLOGY

T. L. Saaty (2008) developed the Analytic Hierarchy Process (AHP) as a decision support tool for multicriteria decision-making and for analyzing the decision-making process itself. The AHP uses decision-makers' subjective judgments such as input data, while the output values are the quantified weights of each alternative. This approach allows both objective issues to be easily quantified and subjective issues, which lack theoretical values, to

be assessed. Due to these characteristics, the AHP is broadly applied in various decision-making contexts, such as economic issues, policy evaluation, and urban planning (Sato, 2005).

The AHP addresses decision problems through a hierarchical structure that includes the overall goal, a set of alternatives, and a set of criteria that link alternatives to the goal. T. L. Saaty (2008) distinguishes between two types of measurement in the AHP method: absolute and relative measurement. In absolute measurement, each alternative is compared to an ideal alternative that is known or imaginable. In contrast, relative measurement involves comparing alternatives with each other individually, a process known as pairwise comparison. Pairwise comparisons are typically conducted by asking the decision-maker to evaluate the extent to which one criterion is more important compared to another criterion relative to the overall goal. Similarly, alternatives can be compared with each other, asking the decision-maker to assess the alternative A in comparison to the alternative B according to a specific criterion. Based on the assessments given by decision-makers during pairwise comparisons, a pairwise comparison

matrix is formed. While the diagonal elements of the matrix equal 1, the other elements differ in the values specified in Table 1 and in their inverse values. To evaluate the consistency of the subjective judgments provided by the decision-maker, T. L. Saaty (2008) introduces the Consistency Index (CI). If the obtained consistency index is less than 10%, the priorities are considered acceptable; otherwise, decision-makers are called to revise their comparisons (Oztaysi, 2014).

The AHP can be applied to solve multicriteria decision-making (MCDM) problems. Once criteria are defined and their weights calculated using a pairwise comparison matrix, the same procedure is used to calculate the weights of the alternatives. A pairwise comparison matrix for alternatives is formed for each individual criterion, resulting in a reciprocal square matrix with its corresponding eigenvector. This process is repeated for all criteria to calculate the values of each alternative and criterion. The value of each alternative is then multiplied by the weight of the corresponding criterion, and the overall score for each alternative is obtained by summing all the values, allowing for the ranking of alternatives based on the computed values (Oztaysi, 2014).

Table 1 The comparison scale from 1 to 9

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the goal.
3	Moderate importance	Experience and assessment slightly favor one criterion or alternative over another.
5	Strong importance	Experience and assessment strongly favor one criterion or alternative over another.
7	Very strong or demonstrated importance	One criterion or alternative is very strongly favored over another.
9	Extreme importance	Evidence strongly supports one criterion or alternative over another at the highest level of confirmation.
2, 4, 6, 8	Intermediate values between two judgments	A compromise is needed between the judgments.
Reciprocal values of the above intensity of importance	If the criterion or alternative i is assigned one of the non-zero numbers above when compared to another criterion or alternative j , then j has the reciprocal value of i .	

The structure of the AHP research model

Based on previous research and the literature, the key criteria for evaluating different content creation approaches have been defined, focusing on the business aspects: creativity, speed, cost, content quality, adaptability, and conversion. S. Mayahi and M. Vidrih (2022), emphasize that creativity, content quality, and adaptability (or personalization) are the key elements in content creation. Creativity plays a crucial role in producing distinctive and engaging content, while content quality ensures alignment with marketing goals and audience engagement. Adaptability, or personalization, highlights the need to tailor content to specific audience preferences, enhancing relevance and user experience. In addition, the importance of speed, cost, and conversion are essential for achieving economic success in a dynamic business environment (Deekshith, 2023; Singh, 2024). Speed enables a timely market response, cost efficiency supports sustainable resource management, and conversion measures content effectiveness in achieving business objectives. These criteria form a comprehensive framework for evaluating content creation approaches. To examine and validate Hypothesis 1 and Hypothesis 2, an AHP model was developed in order to evaluate the importance of these criteria and compare the performance of human, AI, and combined content creation methods.

In the AHP model, creativity is assessed as a critical criterion for comparing human labor, artificial intelligence, and their combination, because it evaluates how each approach contributes to innovation and originality in content creation. The content quality criterion assesses how well each alternative creates the content that delivers an effective message and achieves digital marketing goals. The conversion criterion is used to evaluate how different content creation alternatives contribute to achieving high conversion rates through optimized presentation and content relevance. The adaptability criterion evaluates how effectively different content creation alternatives can respond to these demands, ensuring that content remains relevant and tailored to users. The speed criterion assesses how quickly different alternatives in content creation can deliver

effective content that meets the dynamic nature of the digital marketing environment. The cost criterion evaluates how cost-effective different alternatives are in the context of creating high-quality content.

Figure 1 illustrates the hierarchical structure of a multicriteria decision-making problem developed using the AHP software. This structure facilitates the evaluation and ranking of the three content creation approaches, with the criteria deemed essential for business operations.

The research was focused on marketing employees as the target population in July 2024. The data were collected through an online questionnaire. The link to the online questionnaire was distributed to the employees via LinkedIn and email. Having agreed to participate, the employees were instructed to compare the relative importance of each pair of the six criteria at the second level of the AHP hierarchy, resulting in 15 pairwise comparisons. Subsequent comparisons were made at the third hierarchical level for the alternatives within each criterion, each comparison involving three pairwise evaluations. In total, each respondent provided 33 comparisons during the study. The standard Saaty scale ranging from 1 to 9 was employed, where 1 denotes "equal importance" and 9 indicates the "extreme importance" of one element over another (Saaty, 2008). The AHP analysis was conducted using the SuperDecisions and Excel pieces of software.

The AHP applications in digital marketing and content creation

Similar studies applying the AHP model include research into the adoption of AI-generated news articles (Kim & Kim, 2020), the analysis of the quality of AI-generated articles and publications on decision support systems (Forgionne, Kohli & Jennings, 2002), the evaluation of the role of AI-based smart sensors in smart cities (Khan & Nazir, 2023), the prioritization of the impact of AI-based visual communication for long-term learning (Liu, Al-Atawi, Khan, Gohar & Zaman, 2023), the selection of information technologies (Oztaysi, 2014), and others. The Analytic

Hierarchy Process has broadly been applied in digital marketing and content marketing research to address various challenges and optimize decision-making processes. K. H. Leung and D. Y. Mo (2019) proposed a fuzzy-AHP framework for evaluating and selecting digital marketing tools, streamlining internal processes and enhancing strategic alignment with marketing objectives. Ü. Şengül and M. Eren (2016) employed a combination of the fuzzy AHP and TOPSIS to prioritize digital marketing tools, with a focus on balancing cost-efficiency and performance. Similarly, M. S. Şalvarlı (2025) applied the AHP method to evaluate social media marketing tools, emphasizing factors like cost, effectiveness, and audience relevance, and providing practical guidelines for maximizing ROI. S. Wiwatkajornsak and C. Phuaksaman (2024) integrated the fuzzy AHP to assess the key success factors in digital marketing for the food retail industry, addressing complexities like content relevance and campaign performance. B. T. Mukhsinov and S. D. Ergashodjayeva (2022) used the AHP in selecting appropriate digital marketing communication technologies, offering actionable insights for businesses in tailoring strategies to their target markets. These studies collectively demonstrate the versatility and effectiveness of the

AHP in evaluating and optimizing digital marketing strategies across diverse industries and contexts.

The application of the AHP in this research provides a systematic and robust framework for evaluating and comparing the contributions of humans, artificial intelligence, and their combination in the content creation process for digital marketing. The AHP is particularly suitable for this study because it enables the decomposition of complex decision-making problems into a structured hierarchy of criteria, allowing for pairwise comparisons and the calculation of relative weights. This methodology is crucial for addressing the multifaceted nature of content creation, where criteria like creativity, speed, cost, content quality, adaptability, and conversion must be balanced so as to achieve optimal outcomes. Unlike the prior studies that applied the AHP to tool selection or marketing strategies, this research uniquely focuses on comparing the performance of humans, AI, and their synergy, filling a critical gap in the literature. By leveraging the AHP, the study provides actionable insights into how marketing professionals can optimize their content creation approaches, offering a valuable contribution to both academic discourse and practical applications in the dynamic field of digital marketing.

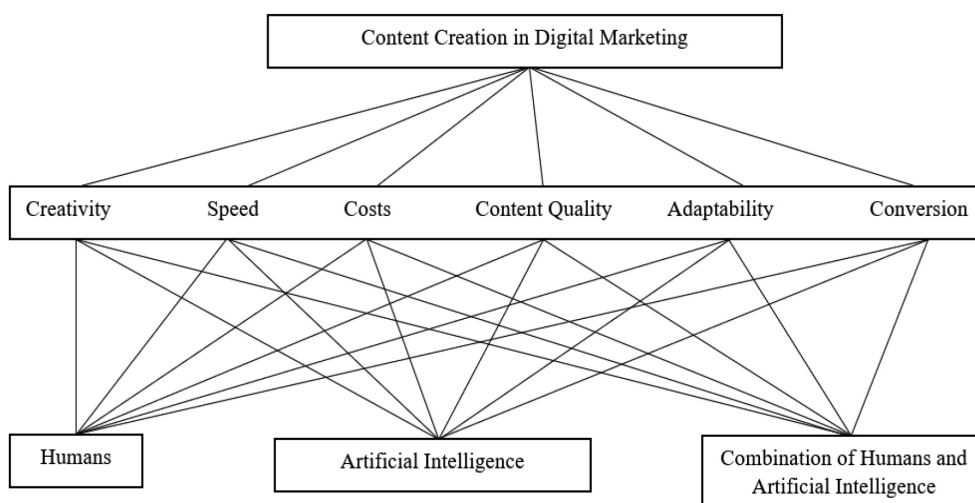


Figure 1 The AHP model for evaluating human and AI contributions to content creation for digital marketing

Source: The author

RESULTS AND DISCUSSION

The sample consists of 80 respondents, whose demographic characteristics are summarized in Table 2. The majority are female (77.5%), and most hold undergraduate (50%) or master's degrees (40%). Regarding employment, most work in companies with 51-250 employees (33.8%), only to be followed by those working in companies with 10-50 employees (26.3%). Most respondents are employed in companies operating for over 10 years (62.5%). Geographically, the largest proportion is from Novi Sad (38.8%), only to be followed by Belgrade (28.3%).

A higher proportion of the respondents use AI for content creation in digital marketing (56.25%) compared to those who do not (43.75%).

The respondents who use AI (56.25%) cited several reasons for its adoption, which can be categorized as follows:

- **Efficiency:** Speed, process facilitation, content checking (e.g. grammar, readability).
- **Creativity and idea development:** Generating additional ideas and inspiration, trend tracking, idea development, personal education.
- **Specific applications:** Assistance in various stages of content creation, creating professional content for social media, email template creation, text adaptation, photo editing, long-form content writing, client industry research, AI tools in Photoshop, translation, and improving content quality with unique solutions. The tools mentioned include ChatGPT, AI features in Canva, Illustrator, Photoshop, Descript, Gemini, Monday, Content at Scale, Surfer SEO, Ideogram, Midjourney, Monica, CoPilot, CapCut, Claude, Jasper, SubMagic, Freepik AI Generator, Opus, and Leonardo AI.

Among the AI users, the largest group has been using these tools for 1-2 years (23.8%), only to be followed by those using it for 6 months to 1 year (20%), then those using it for less than 6 months (10%), and finally those using it for more than 2 years (3.8%).

The respondents who do not use AI for content creation (43.75%) provided various reasons for their choice, which can be categorized as follows:

- **Skepticism:** The belief that AI is not advanced enough to understand local consumer habits, satisfaction with their own creativity, belief in the importance of the human factor for video content creation, and a lack of trust.
- **Barriers:** Insufficient mastery of tools and processes, insufficient knowledge and experience, finding AI solutions generic and easily recognizable, and concerns about data security.
- **Exploration:** The ongoing evaluation of AI tools, considering future use, or concerns about alignment with the company's visual identity (which AI tools have not been developed for yet).

Table 2 The demographic characteristics of the sample

Category	Percentage (%)
Gender	
Female	77.5
Male	22.5
Education Level	
Undergraduate Academic Degree	50
Master's Academic Degree	40
Higher Education Diploma	6.3
High School Diploma	2.5
Doctoral Degree	1.35
Company Size	
51-250 employees	33.8
10-50 employees	26.3
More than 250 employees	18
Fewer than 10 employees	17.5
Company Longevity	
Over 10 years	62.5
1-5 years	20
6-10 years	13.8
Less than 1 year	3.8
Geographical Distribution	
Novi Sad	38.8
Belgrade	28.3
Čačak	7.5
Subotica	6.3
Indija, Kraljevo	3.8 (each)
Čenej, Zrenjanin	2.5 (each)
Gornji Milanovac, Rumenka, Veternik, Vrnjačka Banja, Area around Zrenjanin	1.3 (each)

Source: The author

Among the non-users, the largest group plan to adopt AI in the future without specifying a timeframe (20%), only to be followed by those with no plans to use it at all (13.8%), then come those planning its adoption within the next 6 months (8.8%), whereas the smallest group of the respondents intend to adopt it within the next year (1.3%).

After defining the elements of the decision-making problem, comparative calculations followed. First, all the criteria were compared in pairs relative to the main goal so as to determine their relative importance and contribution to the main goal. For each respondent, a pairwise comparison matrix was generated for the criteria at the second level of the analytical hierarchy, as well as the pairwise comparison matrices for the alternatives at the third level of the analytical hierarchy for each criterion individually. Tables 3 through 9 illustrate the pairwise comparison matrices constructed as part of the AHP methodology used in this research. The tables are derived from the responses provided by one participant as an illustrative example. Each table consists of the rows and columns representing the criteria or the alternatives being compared. The elements in the matrix quantify the relative importance or preference of one element over another, based on a scale typically ranging from 1 (equal importance) to 9 (extreme importance). The diagonal elements always equal 1, as each element is equally important when compared to itself. A value greater than 1 indicates that the row criterion/alternative is more important than the column criterion/alternative. A value less than 1 indicates that the row criterion/alternative is less important than the column criterion/alternative (Mimović *et al.*, 2018).

Table 3 presents the pairwise comparison matrix for all the criteria relevant for the evaluation of the effectiveness of humans, artificial intelligence, and their combination in content creation for digital marketing. The criteria include creativity, speed, costs, content quality, adaptability, and conversion. The matrix allows for the analysis of the interrelationships between these factors. Creativity is considered significantly more important than speed and costs, with the scores of 9 (creativity vs. speed) and 8 (creativity vs. costs), respectively, which implies that creativity is perceived as nine times more crucial than speed, and eight times more important than costs in achieving marketing success. Conversely, speed and costs are rated 1/9 and 1/8 relative to creativity, reflecting their lower perceived importance. Content quality is highly valued, with a score of 7 (content quality vs. speed) and 7 (content quality vs. costs). These values indicate that content quality is seen as seven times more significant than both speed and costs. Adaptability has a moderate importance level, being rated as 1/5 (adaptability vs. creativity) and 1/5 (adaptability vs. content quality), which is indicative of the fact that, while adaptability is less critical than creativity or content quality, it still remains more impactful than speed (5 (adaptability vs. speed)) and costs (3 (adaptability vs. costs)). While not the top priority, conversion holds significant weight when compared to speed (3 (conversion vs. speed)) and costs (7 (conversion vs. costs)), which suggests that, although conversion is not as critical as creativity or content quality, it is still a vital metric in evaluating campaign success.

Table 3 The example of the pairwise comparison matrix for the criteria

Criteria	Creativity	Speed	Costs	Content Quality	Adaptability	Conversion
Creativity	1	9	8	2	5	2
Speed	1/9	1	1	1/7	1/5	1/3
Costs	1/8	1	1	1/7	1/3	1/7
Content Quality	1/2	7	7	1	5	4
Adaptability	1/5	5	3	1/5	1	1
Conversion	1/2	3	7	1/4	1	1

Source: The author

Tables 4 through 9 provide a detailed analysis of the pairwise comparisons between different alternatives (humans, AI, and their combination) within each criterion. These matrices show how humans, AI, and their combination are compared within each criterion, based on the respondents' subjective assessments.

Table 4 (Creativity) demonstrates the comparative effectiveness of humans, Artificial Intelligence, and their combination in delivering creativity in digital marketing strategies. Humans are perceived to be significantly more effective than AI in terms of creativity, with the relative effectiveness score of 4 (humans vs. AI), which indicates that humans are considered four times more creative than AI. Conversely, AI has a reciprocal score of 1/4 relative to humans, highlighting its lower perceived creative ability compared to humans. Humans are also deemed equally effective as the combination of humans and AI, as evidenced by a score of 4 (humans vs. combination), which suggests that the collaborative approach does not surpass the inherent creative strengths of humans alone. The combination of humans and AI are twice as effective than AI alone (combination vs. AI), with the reciprocal value of 1/2 showing AI's reduced creative capacity relative to the

combination. These results emphasize the fact that, while AI can contribute to creativity, it still remains subordinate to human capabilities in this area. Even when humans and AI are combined, their creative output does not exceed that of humans working independently. Therefore, human involvement is indispensable for achieving high levels of creativity, a key factor in successful digital marketing campaigns.

Table 5 (Speed) shows that AI is faster than humans in content creation. While the combination of humans and AI is less efficient than AI alone, it is faster than humans alone. These findings suggest that AI excels in speed, but the combination of human expertise and AI balances quality and speed.

Table 6 (Costs) shows that AI is more cost-effective than humans. The combination of humans and AI is more cost-effective than humans alone, but AI remains the most cost-efficient. These results suggest that AI offers the greatest cost savings in content creation

Table 7 (Content Quality) shows that humans are more effective than AI in producing high-quality content, and the combination of humans and AI

Table 4 The example of the pairwise comparison matrix for the *creativity* criterion

CREATIVITY	Humans	Artificial Intelli-gence	Combination of Humans and Artificial Intelligence
Humans	1	4	4
Artificial Intelligence	1/4	1	1/2
Combination of Humans and Artificial Intelligence	1/4	2	1

Source: The author

Table 5 The example of the pairwise comparison matrix for the *speed* criterion

SPEED	Humans	Artificial Intelli-gence	Combination of Humans and Artificial Intelligence
Humans	1	1/6	1/6
Artificial Intelligence	6	1	2
Combination of Humans and Artificial Intelligence	6	1/2	1

Source: The author

outperforms AI alone. However, human involvement is still essential for maintaining content quality.

Table 8 (Adaptability) shows that humans are more adaptable than AI, with the combination of humans and AI outperforming AI alone. However, human involvement is key for flexibility in content creation.

Table 9 (Conversion) shows that humans are more effective than AI in achieving conversions. The combination of humans and AI is more effective than AI alone, suggesting that human involvement is critical for optimizing conversions.

Table 6 The example of the pairwise comparison matrix for the *costs* criterion

COSTS	Humans	Artificial Intelligence	Combination of Humans and Artificial Intelligence
Humans	1	1/5	1/7
Artificial Intelligence	5	1	1/3
Combination of Humans and Artificial Intelligence	7	3	1

Source: The author

Table 7 The example of the pairwise comparison matrix for the *content quality* criterion

CONTENT QUALITY	Humans	Artificial Intelligence	Combination of Humans and Artificial Intelligence
Humans	1	5	8
Artificial Intelligence	1/5	1	4
Combination of Humans and Artificial Intelligence	1/8	1/4	1

Source: The author

Table 8 The example of the pairwise comparison matrix for the *adaptability* criterion

ADAPTABILITY	Humans	Artificial Intelligence	Combination of Humans and Artificial Intelligence
Humans	1	8	4
Artificial Intelligence	1/8	1	1/3
Combination of Humans and Artificial Intelligence	1/4	3	1

Source: The author

Table 9 The example of the pairwise comparison matrix for the *conversion* criterion

CONVERSION	Humans	Artificial Intelligence	Combination of Humans and Artificial Intelligence
Humans	1	6	3
Artificial Intelligence	1/6	1	1/4
Combination of Humans and Artificial Intelligence	1/3	4	1

Source: The author

The previous procedure was conducted on a sample of 80 respondents. In the end, the calculations were completed for 65 respondents, while the others were excluded due to inconsistencies in their answers and the insufficient understanding of the AHP methodology. When multiple decision-makers are involved, the final weights of the criteria and the ranking of the alternatives are determined using the following formula to calculate the geometric mean

$$w_i = \sqrt[k]{\prod_{k=1}^k w_{ik}} \quad \forall i \tag{1}$$

where w_i represents the final weight of the i^{th} criterion, and w_{ik} denotes the relative weight of the i^{th} element calculated using the k^{th} evaluator.

Accordingly, the geometric mean of all 65 evaluations of the criteria obtained from all the respondents is as follows:

$$w_i = \sqrt[65]{\prod_{k=1}^{65} w_{ik}} \quad \forall i \tag{2}$$

For the criterion K1, the final weight of the evaluations obtained from all 65 respondents is calculated as follows:

$$w_{K_1} = \sqrt[65]{w_{K_1,1} \times w_{K_1,2} \times \dots \times w_{K_1,65}} = 0,40787 \tag{3}$$

Using the same method, the priorities of the criteria were calculated by applying the geometric mean of the weighted coefficients obtained from all the individual AHP evaluations within the model (Table 10). Analyzing the obtained criteria weights, it is evident that creativity (0.408) is the most important factor in content creation for marketing employees, followed by content quality (0.284), conversion (0.134), and adaptability (0.087). The least prioritized factors are speed (0.042) and costs (0.032), which indicates that employees rated speed and costs as the least important when choosing content creation alternatives, while creativity was rated as the most crucial.

The advantage of the AHP method is its ability to measure the model's consistency index (CI). In the following table, the consistency indicator is approximately 0.085, which is within the acceptable

limits as it is below 0.10 (10%). If CI exceeds 10%, the reasons for inconsistency should be identified and pairwise comparisons should be repeated. If repeating the process does not result in an acceptable limit of 0.10, all the results should be discarded, and the entire process should be restarted.

In this model, the evaluations were repeated whenever inconsistency exceeded 0.10 in order to ensure acceptable consistency levels. The number of the iterations varied; some respondents provided consistent judgments immediately, while others needed multiple attempts to refine their pairwise comparisons. This iterative process aligns with the AHP methodology, which emphasizes consistency and reliability. Allowing the respondents to adjust their evaluations follows the AHP best practices as CI values below 0.10 are considered acceptable. These repetitions improved both the validity of the individual responses and the overall credibility of the study itself.

Calculated as the geometric mean of all individual consistency indices, the overall consistency index concluded at approximately 0.085, which falls well within the acceptable threshold. By addressing the inconsistencies through the repeated evaluations, the study maintained methodological rigor and ensured that the final results reflected a high level of reliability.

Table 10 The obtained criteria weights in the AHP method

Criteria	Priority
Creativity	0.40787
Speed	0.04201
Costs	0.03251
Content Quality	0.28396
Adaptability	0.08674
Conversion	0.13374
Consistency Index	0.08468 (8.5%)

Source: The author

After comparing the criteria, the next step was to conduct the pairwise comparisons of all the alternatives for each criterion so as to calculate their local priorities and the final rankings by finding the geometric mean of all the respondent ratings. When comparing two alternatives against a specific criterion, the general preference for the alternative is calculated as the weighted sum of the criterion weights and the alternative's scores for that criterion. First, pairs of alternatives are compared with respect to each criterion in order to obtain their local priorities, while their global priorities are obtained by simultaneously synthesizing the results with respect to all the criteria (Mimović *et al*, 2018). The final results show the ranking of the alternatives for each criterion, as is presented in Table 11.

Based on the data given in Table 11, the most recommended option for content creation in digital marketing is human engagement, which is logical given the fact that AI is still a developing technology. Humans rank highest, with the preference score of 0.55778, excelling in the key criteria such as creativity (0.67010), content quality (0.54641), adaptability (0.56494), and conversion (0.54191). These results confirm that human-driven content creation is the most effective when high-quality and adaptable content are prioritized. The combination of humans and AI ranks second, with the preference score of 0.21172, showing the strengths in cost efficiency

(0.59305) and moderate advantages in speed (0.29194) and adaptability (0.29372). The combination offers benefits by leveraging AI to accelerate content creation and reduce costs, still relying on human creativity and adaptability. Artificial intelligence alone ranks lowest, with the preference score of 0.18239, excelling in speed (0.58052) and cost savings (0.25478), but performing poorly in creativity (0.09323), content quality (0.29888), adaptability (0.09697), and conversion (0.13770). These findings highlight the current limitations of AI tools, including a lack of trust and poor performance in the areas that require nuanced human judgment.

Hypothesis 1: "Creativity and content quality are the most critical factors for marketing professionals when selecting a content creation method in digital marketing." is confirmed. The results show that creativity (0.67010 for humans) is the most influential criterion. However, adaptability (0.56494 for humans) ranks slightly higher than content quality (0.54641 for humans). While creativity and content quality are important, adaptability also plays a crucial role in decision-making.

Hypothesis 2: "Combining humans and artificial intelligence in content creation for digital marketing yields superior business outcomes, balancing creativity, speed, content quality, adaptability, conversion, and cost efficiency, thereby outperforming the use of only human resources or AI tools alone."

Table 11 The alternative preferences

Alternative	Criterion Weight						Degree of Preference	Preference Rank
	Creativity	Speed	Costs	Content Quality	Adaptability	Conversion		
	0.40787	0.04201	0.03251	0.28396	0.08674	0.13374		
Humans	0.67010	0.09755	0.11472	0.54641	0.56494	0.54191	0.55778	1
Artificial Intelligence	0.09323	0.58052	0.25478	0.29888	0.09697	0.13770	0.18239	3
Combination of Humans and Artificial Intelligence	0.21596	0.29194	0.59305	0.11058	0.29372	0.26332	0.21172	2

Source: The author

is partially confirmed. The combination of humans and AI performs strongly in cost efficiency (0.59305) and moderately in speed (0.29194) and adaptability (0.29372). However, humans alone dominate in the key criteria, including creativity (0.67010), content quality (0.54641), adaptability (0.56494), and conversion (0.54191), making them the most effective choice. AI alone excels in speed (0.58052) and moderately in cost efficiency (0.25478) but has limitations in creativity, content quality, adaptability, and conversion. While the combination of humans and AI shows the potential for balancing multiple criteria, it still does not outperform human-driven content creation. Further optimization, especially in creativity, adaptability, and conversion, is needed to achieve superior results across all the aspects.

CONCLUSION

For an accurate assessment of digital marketing success, it is crucial to consider the criteria that directly impact marketing campaign performance. Criteria such as creativity, speed, costs, content quality, conversion, and adaptability are essential when choosing between humans, artificial intelligence, or a combination of humans and artificial intelligence in the content creation process. Each of these factors plays a key role in optimizing strategies for maximum impact in the digital environment, allowing for informed decisions about the best content creation alternatives in digital marketing.

The research has demonstrated significant theoretical and practical contributions, providing valuable guidelines for resource selection in digital content creation. The results have revealed that the AHP method for multicriteria analysis enables a comprehensive comparison and evaluation of humans, artificial intelligence, and their combination, aimed at enhancing the content creation process in digital marketing.

A detailed analysis must consider all the relevant criteria in digital marketing that impact content creation. The AHP method helped identify and

assess the key criteria for evaluating content success. The research results have indicated that marketing employees view creativity, content quality, and conversion as the most important criteria, whereas adaptability, speed and costs rate as less significant. Regarding the ranking of the alternatives, humans emerged as the most desirable option based on the selected criteria, whereas the combination of humans and artificial intelligence was the second-best choice, and artificial intelligence alone ranked the least desirable option. These findings confirm Hypothesis 1, which posits that creativity and content quality are critical factors for marketing professionals. While creativity was the highest-ranked criterion, adaptability also played a significant role in decision-making. The results also partially confirm Hypothesis 2, which suggests that combining humans and artificial intelligence would yield superior business outcomes. While the combination of humans and AI demonstrated strengths in cost efficiency and speed, it did not outperform human-driven content creation in the most critical areas, such as creativity and content quality, which indicates that, while the integration of AI holds a potential, further optimization is necessary to enhance its effectiveness in content creation.

Despite these contributions, it is important to acknowledge the limitations of this research study. The limitations include the data collection methods, the sample structure, and the number of the criteria analyzed. The sample size may not fully represent a broader population of marketing professionals, and the limited number of the criteria could restrict the comprehensiveness of the findings. Additionally, the study primarily focused on short-term outcomes, which may not capture the long-term effects of integrating AI in content creation. However, based on the available data, only the relative relationship between the observed variables can be concluded. Further research is needed to more precisely examine the effects of using AI and its combination with the human factor under specific conditions. Future research should aim to broaden the empirical scope by including a larger sample size and a more diverse set of criteria over an extended period, which on its

part would provide more comprehensive insights and guidelines for future researchers. To date, no study has utilized the AHP method for comparative analysis and evaluation of humans, artificial intelligence, and their combination with the aim of improving the content creation process in digital marketing.

To enhance their strategies, marketing professionals should focus on creativity, content quality, and conversion when making decisions on content creation. Additionally, they should consider how to effectively integrate artificial intelligence tools to complement human creativity, particularly in areas where speed and adaptability are crucial. As AI technology continues to evolve, its role in content creation is likely to expand, and marketing teams should remain open to exploring these innovations, simultaneously prioritizing the quality and creativity provided by the human input.

In conclusion, not only does this study enrich the existing literature by clearly defining the studied factors, but it also equips marketing professionals with actionable insights for decision-making in the content creation process. The confirmation of Hypothesis 1 and the partial confirmation of Hypothesis 2 provide a solid foundation for future research and practical applications in the evolving landscape of digital marketing. The innovative aspect of this research lies in its integration of AI tools with human creativity, addressing a timely and relevant topic in digital marketing. By bridging the gap between technology and marketing strategies, this study offers new insights and methodologies that can significantly impact both the academic literature and practical applications.

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Received on 10th September 2024,
after revision,
accepted for publication on 10th July 2025.
Published online on 8th August 2025.

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ACKNOWLEDGEMENT TO THE REVIEWERS

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The Editorial Board of the *Economic Horizons* scientific journal thanks the reviewers for their critical, objective and argued valuation of the manuscripts submitted to the Editorial Board in 2024.

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EKONOMSKI horizonti / glavni i odgovorni urednik
Milena Jakšić. - God. 1, br. 1/2 (1999)- . - Kragujevac:
Ekonomski fakultet Univerziteta u Kragujevcu, 1999 -
(Kragujevac: InterPrint). - 26 cm

Tri puta godišnje. - Tekst na srp. i engl. jeziku. - Drugo
izdanje na drugom medijumu : Ekonomski horizonti
(Online) = ISSN 2217-9232
ISSN 1450-863X = Ekonomski horizonti (Štampano izd.)
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