23/ 2

EKONOMSKI VJESNIK / ECONVIEWS
VOL. 36 • NO. 2/2023 • PP. 221-426 • OSIJEK, DECEMBER 2023

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ECONVIEWS

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DOI: https://doi.org/10.51680/ev

UDK - 33 ISSN 0353 - 359X: CODEN EKVJEE e-ISSN 1847-2206

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English Language Editor
Ivanka Ferčec

Indexed in:
- Emerging Sources Citation Index, Web of Science, Clarivate Analytics, New York, USA
- CAB Abstract, Wallingford, United Kingdom
- Econlit, Pittsburg, USA
- EBSCOhost, Ipswich, USA
- ABI/INFORM, ProQuest, London, United Kingdom
- DOAJ - Directory of Open Access Journals, United Kingdom
- CEEOL - Central and Eastern European Online Library, Frankfurt am Main, Germany
- Index Copernicus, Warszawa, Poland
- Hrčak – Portal znanstvenih časopisa Republike Hrvatske (MZOS, Srce & HIDD)

Graphic Design
Grafika, Osijek

The publishing of Journal is supported by the Ministry of Science and Education of the Republic of Croatia

Published biannually

Address of the Editorial Board
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Ekonomski fakultet u Osijeku
Trg Ljudevita Gaja 7
31000 Osijek
Croatia

https://hrcak.srce.hr/ojs/index.php/ekonomski-vjesnik/
www.efos.unios.hr/ekonomski-vjesnik/en/

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JEL: C31, C33, E24, E27
Original scientific article
https://doi.org/10.51680/ev.36.2.1

Received: April 22, 2022
Revision received: March 7, 2023
Accepted for publishing: April 14, 2023

DO LABOUR MARKET INSTITUTIONS VARIABLES IMPACT UNEMPLOYMENT? EVIDENCE FROM THE CEE COUNTRIES

Abstract

Purpose: In this study, the aim is to determine whether labour market institutions (LMI) variables impacted the unemployment rate in the Central and Eastern Europe (CEE) countries between 2000 and 2017.

Methodology: Panel data methods that take cross-sectional dependence into account are used for the analysis.

Results: Empirical findings show that real minimum wages, tax wedge, and union density do not impact the unemployment rate in Poland, Latvia, and Estonia, while these variables impact the unemployment rate in Slovakia, the Czech Republic, Slovenia, and Hungary.

Conclusion: As a result of the research, it is concluded that the LMI variables do not have a substantial effect on the unemployment rate in Poland, Latvia, and Estonia. On the other hand, the LMI variables have a substantial impact on the unemployment rate in Slovakia, the Czech Republic, Slovenia, and Hungary. Therefore, it is understood that the LMI variables have an influence on the unemployment in only four out of seven CEE countries.

Keywords: Unemployment, labour market institutions variables, cross-sectional dependence, CEE countries

1. Introduction

Unemployment, defined as the partial or complete exclusion of the labour force from the production process, is a problem not only in developing but also in developed countries. Furthermore, unemployment is not only an economic but also a social problem. Therefore, determining the reasons for unemployment is important for national economy and social life. If unemployment increases, the output gap increases. For this reason, an increase in unemployment negatively affects the economy. On the other hand, if unemployment increases, social problems such as corruption, snatching, and bribery will increase as well. For these reasons, unemployment concerns both economy and sociology.

In this study, the determinants of unemployment in the CEE countries were analysed and the LMI variables were used for the analysis. Knowing whether the LMI variables affect unemployment helps policymakers to make better decisions in tackling unemployment. Therefore, the results of the study are important for policymakers in the decision-making process related to unemployment. This study aims to determine the factors that affect unemployment and find out whether unemployment originates from the LMI variables in the Central and Eastern Europe (CEE) countries between 2000 and 2017.

To analyse the factors which affect unemployment, the methods that do not take cross-sectional dependence into account (e.g., panel fixed effect, random effect, panel generalized least squares (GLS), panel ordinary least squares (OLS)) are used in the literature. Moreover, there are not many studies investigating the determinants of unemployment in the CEE countries. Studies in the literature generally research the determinants of unemployment in high-income Organisation for Economic Co-operation and Development (OECD) countries. This study fills this gap by examining the CEE countries. This study uses panel data methods that take into account the cross-sectional dependence problem. The assumption of cross-sectional independence can lack reliable results in the panel data analysis, and ignoring cross-sectional dependence can cause bias and inconsistency (Bai & Kao, 2006). Therefore, this study is expected to contribute to the literature in this respect.

The paper is organised as follows. After the introduction section, the unemployment model formed in this study covers the second section. Section 3 presents a literature review related to unemployment. Data and the econometric methods used in the paper are presented in Section 4. The estimation results are discussed in Section 5. Section 6 summarises the conclusion and policy recommendations.

2. Model

There are many studies in the literature that examine the causes of unemployment from a theoretical and empirical perspective. Considering the studies examining the issue theoretically, it is seen that the causes of unemployment differ in terms of economic schools.

There is no consensus between the Neoclassical and Keynesian views on the relationship between unemployment and wages. The neoclassical view states that there is a positive relationship between unemployment and wages. In other words, a decrease in wages causes an increase in the level of employment and, accordingly, a decrease in the unemployment rate. The Keynesian view criticises this point of view. According to the Keynesian view, a lower wage rate will lead to lower income for workers and correspondingly to lower demand for goods. Lower demand will reduce output, which will in turn reduce employment. Thus, the Keynesian view states that there is a negative relationship between wages and the unemployment rate (Apergis and Theodosiou, 2008). Neoclassical economists also emphasise that labour supply and labour demand are equal when money or real wages are not rigid. Workers will not work if they suffer a net loss of benefits due to giving up their leisure time (Spencer, 2006: 460-461). On the other hand, the Keynesian view emphasises that insufficient capital accumulation or high interest rates are the causes of high unemployment (Stockhammer and Klär, 2011: 438). Post-Keynesian economics is a movement connected to Keynesian economics that is rather sceptical about traditional microfoundations. Unemployment is seen as a result of demand gaps in the goods market, and wages are analysed as a source of demand and a cost factor (Stockhammer, 2011: 296).

Empirical studies examining the causes of unemployment focus on two issues. These are studies on the Keynesian view and LMI variables. While the debate on unemployment growth in the 1970s focused on shocks, the persistence of high unemployment for another twenty years caused the focus to shift from shocks to the labour market institutions (Blanchard and Wolfers, 2000: C12). According to the mainstream view[1], unemployment is determined by the labour market institutions (Stockhammer, 2011: 306). In this study, the CEE countries are analysed and as these countries are members of the EU, the monetary authority is responsible only for the money market in these countries. A government is also responsible for fiscal policy such as reducing unemployment. For these reasons, only the LMI variables were tested for determining the unemployment determinants. The tax wedge, union

1 See Table 1 for the mainstream view of unemployment determinants.

density, and real minimum wages were usually used as LMI determinants in the literature[2]. Therefore, the LMI variables were used for forming the model of unemployment in this study. The unemployment model used in this study is as follows:

$$UR_{it} = \alpha_0 + \alpha_1 TW_{it} + \alpha_2 UD_{it} + \alpha_3 RMW_{it} + \varepsilon_{it} \quad (1)$$

In equation (1), UR is the unemployment rate. TW, UD, and RMW represent the tax wedge, union density, and real minimum wages, respectively.

3. Literature review

The studies aiming to find out the determinants of unemployment that support the labour market institutions variables are as follows:

Boone and Ours (2004) analysed the effect of active labour market policies on the long-term unemployment rate in 20 OECD countries using panel fixed effect and panel random-effect methods. In this study, the employment rate, union density, unemployment benefit, and the tax rate are used as proxies of active labour market policies. As a result of the analysis, it is found out that active labour market policies are the most influential factor in reducing unemployment. Gianella et al. (2008) investigated the factors affecting unemployment in 23 OECD countries between 1976 and 2003 using the panel pooled regression method. Variables such as product market regulation, union density, the average unemployment benefit replacement rate, the tax wedge, the real interest rate, and the real minimum wage are used in the analysis. It is concluded that product market regulation, union density, and the unemployment benefit replacement rate impact the unemployment rate.

In the classification of the determinants of unemployment stated above, many of the studies focus on high-income OECD countries. In addition, mostly high-income OECD countries are preferred in the literature for the analysis of the determinants of unemployment. Therefore, many studies examine high-income OECD countries empirically to determine whether demand conditions or LMI variables are dominant in labour markets in these countries. These studies are summarised in Table 1.

Table 1 Literature review related to the determinants of unemployment

	Data and method	Dependent variable	Independent variables	Result
Blanchard & Wolfers (2000)	20 OECD countries (1960–1996). Panel data analysis with panel OLS	UR	UBR, BD, UD, COORD, TW, ALMP, MW, LTI, TFPS, TOTS, LDS	Labour market institutions have an important effect on unemployment. So, LMI variables are dominant.
Baker et al. (2002)	20 OECD countries (1960–1999). Panel data analysis with the fixed effect estimator.	UR	UBR, BD, UD, EPL	Labour market rigidities are largely responsible for high unemployment and labour market deregulation is therefore the best route to raising employment rates. Therefore, LMI variables are dominant determinants of unemployment.
Nickell et al. (2005)	20 OECD countries (1961–1995). Time series analysis with non-linear least squares.	UR	UBR, BD, UD, EPL, COORD, TW, LTI, TFPS, LDS, TOTS, money supply	Broad movements in unemployment across the OECD countries can be explained by shifts in labour market institutions. Therefore, LMI variables are dominant factors for unemployment.
Bertola et al. (2007)	20 OECD countries (1960–1996). Panel data analysis with the panel GLS estimator.	UR	UBR, BD, UD, EPL, COORD, ALMP, LTI, TFPS, LDS	Labour market institutions have an important effect on unemployment. Therefore, LMI variables are dominant factors for unemployment.

2 See Table 1 for LMI variables used in the literature.

	Data and method	Dependent variable	Independent variables	Result
Stockhammer & Klär (2011)	20 OECD countries (1983–2003; Panel data analysis with panel OLS and the panel fixed effect estimator.	UR	UBR, BD, UD, EPL, TW, COORD, CBC, PMR, TOTS, ACCU, TFPS, LTI, LDS	The estimation results show that capital accumulation and the real interest rate are found to have statistically significant effects on unemployment. Therefore, LMI variables are not dominant determinants of unemployment.
Avdagic & Salardi (2013)	EU and 32 OECD countries (1980–2009). Panel data analysis with the panel OLS estimator.	UR	UBR, EPL, TW, COORD, UD, TOTS, LTI, CBI	The authors find no systematic support for the conventional view that unemployment is a consequence of labour market institutions and insufficient demand. So, LMI variables are dominant.
Heimberger et al. (2017)	14 EU countries 1985-2012. ordinary least squares (OLS) with panel-corrected standard errors (PCSE)	UR	LMI, EPL, UD, TW, MW, ACCU	While LMI variables have no important effect on UR, insufficient demand has an important effect on unemployment. So, demand conditions are dominant for unemployment determinant.

Note: Illustration on the basis of Stockhammer & Klär (2011, p. 441), and Heimberger et al. (2017). ACCU: capital accumulation, ALMP: active labour market policy, BD: benefit duration, CBC: collective bargaining coverage, CBI: Central Bank Independence index, COORD: wage bargaining coordination, EPL: employment protection legislation, LMI: labour market institutions, LDS: labour demand shock, LTI: long-term real interest rate, MW: minimum wage, PMR: product market regulation, TFPS: deviation of total factor productivity from its trend, TOTS: terms of trade shock, TW: tax wedge, UD: union density, UBR: unemployment benefit replacement rate.

Source: Authors

Apart from the studies specified above, there are also several studies in the literature that analyse the determinants of unemployment in the CEE countries (Riboud et al., 2002; Nesporova, 2002; Fialova & Schneider, 2014; Vodopivec, 2015; Grossmann et al., 2019; Peric & Filipovic, 2021). Riboud et al. (2002) studied the labour market dynamics of six CEE countries (the Czech Republic, Hungary, Estonia, Poland, Slovakia, and Slovenia) compared to OECD countries in the years 1990-2000. In this paper, it is determined that employment protection legislation of the CEE countries is deficient and rigid when compared to OECD countries. It is also stated that the expenditure of the CEE countries on unemployment insurance and active labour policies is considerably lower than the average of OECD countries. Therefore, it is concluded that labour market regulations such as unemployment insurance and active labour policies do not significantly affect unemployment in the CEE countries contrary to OECD countries. Nesporova (2002) investigated the causes of poor employee performance and persistently high unemployment in the transition countries of CEE and Central Asia (CA) between 1990 and 2000. As a result of the research, it is defined that the unemployment rate increased in the CEE and CA countries in the long term. Moreover, it is stated that disadvantages such as low skills, higher age, immobility, health problems, or employer prejudice are essential to increase long-term unemployment in these countries. Fialova and Schneider (2014) estimated the effects of institutional barriers on the labour market flexibility in 25 Europeon Union (EU) countries between 1999 and 2004. Four models are used for determining the factors affecting the labour markets in the EU countries. The panel regression model is used for the estimation of these four models. The first model investigated the role of institutions in unemployment differentials among European countries. As a result of the analysis, only the tax wedge and labour market policies are statistically significant. Moreover, the coefficients of these variables are positive and negative, respectively. In the second model and the tax wedge and labour market policies, it is determined that a minimum wage has a significant positive effect on the unemployment rate. In the third and the fourth model, it is concluded that institutional factors proved to be more powerful. Besides, employment protection legislation, unemployment benefits, taxes on labour, and a minimum wage are all significant in both the third and the fourth

model. It is also stated that the effects of these variables are low in the CEE countries compared to EU countries. Vodopivec (2015) analysed whether the minimum wage had an effect on employment between 2005 and 2012 in Slovenia. The time series regression model is applied to estimate the relationship between the minimum wage and employment in this study. As a result of the analysis, it is found out that a minimum wage hike increased the probability of transition from employment to unemployment. Grossmann et al. (2019) examined the effects of minimum wage on employment of low-wage workers in the business sector in the Czech Republic in the period 2012-2017. As a result of the research, it is defined that increases in the national minimum wage in 2013, 2015, 2016, and 2017 did not have a significant negative effect on employment. On the other hand, it was determined that the minimum wage had a positive impact on salaries. Peric and Filipovic (2021) analysed the impact of foreign direct investments (FDI) on the labour force in transition economies through monitoring and quantification of selected labour force market indicators by applying linear mixed-effects models to 17 transition countries during the period 2000-2017. Empirical findings showed that FDI had a positive and significant impact on the employment rate, wages and salaries.

4. Data and methodology

The factors which affected unemployment between 2000 and 2017 in the CEE countries were analysed in this study. Poland, the Czech Republic, Slovakia, Slovenia, Hungary, Lithuania, Latvia, and Estonia are countries considered to be the CEE countries. In this context, it was investigated whether the LMI variables were the reason for unemployment. A tax wedge (TW), a real minimum wage (RMW), and union density (UD) were used as variables to determine the effects of LMI variables on the unemployment rate (UR). These data were obtained from the electronic database of the OECD and World Bank electronic database (WDI). The available annual data in the database were used in the study. RMW is logarithmic; TW, UD, and UR data were the original data. Panel data methods that take into account cross-sectional dependence and structural breaks were used for the analysis. The data used in the study are as follows:

Table 2 Data set

Variables	Data source	Data explanations
UR	OECD	UR is obtained as the percentage of unemployed workers in the total labour force.
TW	OECD	Tax wedge is calculated for a single person at 100% of average earnings and no child.
UD	OECD	Union density is defined as the ratio of union members divided by the total number of employees.
RMW	OECD	Real minimum wages as a constant price at 2016 USD PPPs.

Source: Authors' own organisation based on OECD data

4.1 Panel unit root test

Cross-sectional Augmented Dickey Fuller test (CADF) developed by Pesaran (2007) is applied in the case of cross-sectional dependence. The CADF test assumes that each section is affected separately by the time effect which creates panel data. In addition, this test takes spatial autocorrelation into account. The CADF test can be used when the time dimension is larger than the number of cross-sections in panel data. Moreover, based on the Monte Carlo evidence, Pesaran argues that the CADF is valid when N>T and T>N as well (Guloglu & Ivrendi, 2010).

A general model of the panel procedure with N cross-section units and T periods is as follows:

$$\Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \delta_i t + \sum_{j=1}^{\rho_j} \gamma_{i,j} \Delta y_{i,t-j} + u_{i,t} \qquad (2)$$
$$t = 1, 2, ..., T$$
$$i = 1, 1 ....., N$$

Pesaran assumes that the disturbance terms in equation (2) can be decomposed into their common and individual-specific (idiosyncratic) components as follows:

$$u_{i,t} = \varphi_t f_i + \varepsilon_{i,t} \qquad (3)$$

f_i indicates the unobserved common effect that is always assumed to be stationary, and ε_{it} shows individual-specific or idiosyncratic disturbances, which are *iid*. The cross-sectional dependence problem can occur for the unobserved common factor (f_t). Pesaran (2007) shows that the common factor can be approximated by the cross-sectional mean of y_{it} when the average value of φ_i is different from zero. Therefore, the CADF test procedure can reduce the estimating procedure of ordinary least squares (OLS) by the following equations:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{\rho i} \gamma_i \Delta y_{i,t-j} + \theta_i t + \delta_i \bar{y}_{i,t-1} + \sum_{j=0}^{\rho i} \mu_i \Delta \bar{y}_{t-1} + \varepsilon_{i,t}, \quad (4)$$

where and $\alpha_{i,0} = \alpha_i$, a constant, with $i = 1,.....,N$ individuals and $t = 1,.....,T$ time periods. $\bar{y}_{it}$ and t show the cross-sectional mean of y_{it} and t h e trend, respectively. An unobserved common effect in the model can be represented by y_{it}. Thus, cross-sectional dependence is taken into account by y_{it}. The CADF statistic tests the null hypothesis of non-stationarity $(\beta_1 = \beta_2 = \beta_3 = ...\beta_n = 0)$ against the alternative hypothesis of stationarity (at least one differs from 0).

The CADF test can be implemented for each panel unit. But it can be applied for all panels only with the cross-sectional augmented IPS (CIPS) test developed by Pesaran (2007). This test can analyse for all panels whose series is stationary under the null hypothesis, and use the Pesaran critical value. The CIPS test is a cross-sectionally augmented version of the IPS test (Akbas & Lebe, 2016).

4.2 Panel co-integration test

This test developed by Westerlund and Edgerton (2007) can be used in both cross-sectional dependence and cross-sectional independence. In this test, the bootstrap method based on the Lagrange multiplier (LM) is used (Akbas & Lebe, 2016). This test analyses co-integration under the null hypothesis and allows autocorrelation to differ from cross-section to cross-section (Westerlund & Edgerton, 2007).

A general model of the panel data procedure is as follows:

$$y_{it} = \alpha_i + x'_{it}\beta_i + Z_{it} \quad (5)$$

$$Z_{it} = u_{it} + v_{it} \quad (6)$$

$$v_{it} = \sum_{j=1}^{t} \varphi_{ij} \quad (7)$$

After describing the model above, in the case of cross-sectional independence, a hypothesis test can be conducted using the LM test, as follows:

$$LM^{+}_{NT^2} = \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{\omega}_{it}^{-2} S_{it}, \quad (8)$$

where S_{it} is part of the Z_{it} process, which is a fully modified estimation of Z_{it}, and $\hat{\omega}^2_{it}$ is an estimation of long-term variance (u_{it}). The LM test can give biased results in the case of cross-sectional dependence. The asymptotic standard normal distribution of the LM test is also very sensitive to autocorrelation. To overcome this problem, bootstrap methodology can be preferred rather than an asymptotic standard normal distribution (Westerlund & Edgerton, 2007). Bootstrap methodology that follows an autoregressive process is given below:

$$\sum_{j=0}^{\infty} \gamma_{ij} w_{it-j} = e_{it} \quad (9)$$

The first step in bootstrap methodology is to estimate γ_{ij} in equation (9) using $\hat{w}_{it} = (\hat{z}_{it}, \Delta x'_{it})'$ rather than w_{it} and ρ_i. Then, the residual can be computed as follows:

$$\hat{e}_{it} = \sum_{j=0}^{\rho_i} \hat{\gamma}_{ij} \hat{w}_{it-j} \quad (10)$$

In the second step, e^*_t is obtained from the empirical distribution of the residuals $\hat{e}_i - \frac{1}{T}\sum_{j=1}^{T} \hat{e}_j$. Then, e^*_{it} and w^*_{it} are used rather than $\hat{w}_{it}$ and $\hat{e}_{it}$ in order to obtain e^*_t and w^*_{it}. In the final step, w^*_{it} is divided as $w^*_{it} = (z^*_{it}, \Delta x_{it}{}')'$, and the bootstrap samples x^*_{it} and y^*_{it} are generated using the following process:

$$y^*_{it} = \hat{\alpha}_i + x^{*\prime}_{it}\hat{\beta}_i + z^*_{it} \text{ with } x^*_{it} = \sum_{j=1}^{1} \Delta x^*_{ij} \quad (11)$$

4.3 Coefficient estimation

The augmented mean group (AMG) estimator developed by Eberhardt and Bond (2009) is used in this study to estimate the coefficients. The empirical model of the AMG estimator is as follows:

$$y_{i,t} = \beta_i' x_{it} + u_{it} \tag{12}$$

$$u_{it} = \alpha_i + \lambda_i' f_t + \varepsilon_{it} \tag{13}$$

$$x_{mit} = \pi_{mi} + \delta_{mi}' g_{mt} + \rho_{1mi} f_{1mt} + \ldots + \rho_{nmi} f_{nmt} + u_{mit}, \tag{14}$$

where $m = 1,\ldots,k$ and $f_{mt} \subset f_t$

$$f_t = \psi' f_{t-1} + \varepsilon_t \quad \text{and} \quad g_t = \kappa' g_{t-1} + \varepsilon_t. \tag{15}$$

In equation (12), x_{it} is a vector of observable covariates. In addition, a combination of group-specific fixed effects α_i and a set of common factors f_t with country-specific factor loadings λ_i is employed. In equation (13), an empirical representation of *k* observable regressors is added, which are modelled as linear functions of unobserved common factors f_t and g_t, with country-specific factor loadings, respectively (Eberhardt & Bond, 2009).

The AMG estimates can be derived as averages of the individual country estimates.

$$AMG - Stage(i)\Delta \ln\left[y_{i,t}\right] = \beta' \Delta X_{i,t} + \sum_{t=2}^{T} c_t \Delta D_t + e_{i,t} \tag{16}$$

$$\Rightarrow \hat{c}_t = \hat{\mu}_t^{\bullet}$$

$$AMG - Stage(ii) Ln[y_{i,t}] = \theta_i + \beta' X_{i,t} + c_i t + d_i \hat{\mu}_t^{\bullet} + \vartheta_{i,t} \tag{17}$$

The first stage defines a standard first difference OLS (FD-OLS) estimation of D_t year dummy coefficients of pooled regression. In this stage, the year dummy coefficients are collected, which are affected again as $\hat{\mu}_t^{\bullet}$. This variable is included in each of the *N* standard country regressions in the second stage. As a result, the AMG estimates can be derived as averages of the individual country estimates (Eberhardt & Bond, 2009).

The advantage of the common correlated effects (CCE) estimation procedure is that it can be computed by applying least squares auxiliary regressions, where the observed regressors are augmented by the cross-sectional averages of the dependent variable and the observed regressors are used as proxies for the unobserved factors.

$$Ln\left[y_{i,t}\right] = \alpha_i + \mu_i X_{i,t} + \gamma_1 \overline{\ln\left[y_{i,t}\right]} + \gamma_2 \bar{X}_t + \varepsilon_{i,t}$$
$$i = 1,\ldots N; \quad t = 1,\ldots T \tag{18}$$

In this equation, the coefficients γ_1 and γ_2 represent the elasticity estimates of $Ln\left[\inf_{i,t}\right]$. Accordingly, $Ln[\text{int}], Ln[exc]$ and $Ln[gdp]$ are contained in X. Finally, ε_{it} is the error term. In this test, the CCE estimator was used for heterogeneity and the CCE pooled estimator (CCEP) was used for homogeneity. Following this procedure, the individual coefficients μ_i in the panel framework were estimated and the CCE mean group (CCEMG) estimator, a simple average of the individual CCE estimators, was computed:

$$\hat{\mu}CCEMG = \sum_{i=1}^{N} CCE_i / N \quad \text{and}$$
$$SE_{(\hat{\mu}CCEMG)} = \frac{\left[\sum_{i=1}^{N} (\hat{\mu}CCE_i)\right]}{\sqrt{N}} \tag{19}$$

$\hat{\mu}CCEMG$ and $SE_{(\hat{\mu}CCEMG)}$ denote the estimated CCEMG coefficients and their standard deviations, respectively.

5. Empirical findings

The results of cross-sectional dependence and homogeneity tests are reported in Table A1 and Table A2 in the appendix section. CD tests analyse cross-sectional dependence. According to these results, the null hypothesis, which states that there is no cross-sectional dependence, is rejected for all variables and the model. As a result, there is cross-sectional dependence in the CEE countries for all variables and for the model. Delta-tilde and Delta-tilde-adj. tests analyse homogeneity. According to Table A2 in the appendix, the alternative hypothesis is accepted by rejecting the assumption of homogeneity under the null hypothesis. This result suggests that the CEE countries forming the panel have a heterogeneous structure. Based on these results, the panel data methods which take cross-sectional dependence and heterogeneity into account are used in this study.

After cross-sectional dependence and heterogeneity analysis, the stationarity of series can be tested. The results of unit root tests related to UR, RMW, TW and UD are shown in Table 3.

Table 3 CADF and CIPS test results (level)

	UR		RMW		TW		UD	
	CADF	p	CADF	p	CADF	p	CADF	p
Poland	-2.118	3	-0.542	2	0.002	5	-2.037	2
Czech R.	-1.649	4	-1.406	2	-2.255	2	-2.955	2
Slovakia	-2.481	4	-1.897	4	-0.956	2	0.003	5
Slovenia	2.187	4	-8.26***	2	-2.341	4	-2.633	3
Hungary	-1.111	2	-1.280	4	-1.838	2	0.001	5
Lithuania	-13.28***	4	-4.339**	2	-1.577	2	0.005	5
Latvia	-0.925	4	-4.088**	4	-2.800	2	-0.876	4
Estonia	-2.009	4	-2.386	3	-2.399	2	-3.388	2
CIPSstat	-2.1674		-2.2026		-1.771		-1.611	

Note: ** and * stand for significance at 5 and 10% levels, respectively. The lag lengths (p) are selected according to the Schwarz information criterion. The critical values for the CADF test were obtained from Pesaran (2007), Table I(b), Case II, and for the CIPS test they were obtained from Pesaran (2007), Table II(b), Case II.

Source: Authors' estimate

According to the CADF test results, the null hypothesis, which states that there is a unit root for UR, is rejected for Lithuania. However, the null hypothesis cannot be rejected for the other seven countries. Therefore, UR is stationary only in Lithuania, and it includes a unit root in the other seven countries.

The null hypothesis for RMW is rejected in Slovenia, Lithuania, and Latvia, but the null hypothesis is accepted for the other five countries. Finally, the null hypothesis for TW and UD is accepted in all eight countries. The CIPS test results revealing the panel statistics indicate that all of the variables include a unit root at the level values.

After the unit root test is conducted for the series' level values, it is necessary to determine whether the differences of the series are stationary. In this context, the unit root test results for the differences of the series are presented in Table 4.

Table 4 CADF and CIPS test results (first difference)

Country	DUR		DRMW		DTW		DUD	
	CADF	p	CADF	p	CADF	p	CADF	p
Poland	0.750	4	-1.22	4	-2.286	2	-3.246*	3
Czech R.	-1.640	2	-1.67	3	-4.693***	4	-164.15***	4
Slovakia	-1.742	3	-3.51**	2	-2.331	2	-0.907	4
Slovenia	-1.640	4	-10.0***	2	-3.643**	4	-3.700**	3
Hungary	-0.825	2	-3.58**	2	-1.303	2	-3.285*	4
Lithuania	-3.33*	4	-6.96***	2	-2.537	2	-3.726**	2
Latvia	-1.404	2	-6.41***	3	-2.145	2	73.796***	4
Estonia	-16.7***	4	-3.18*	3	-1.497	3	-3.17*	2
CIPS stat	-3.424***		-4.57***		-2.429**		-13.439***	

Note: ***, ** and * stand for significance at 1, 5 and 10% levels, respectively. The lag lengths (p) are selected according to the Schwarz information criterion. The critical values for the CADF test were obtained from Pesaran (2007), Table I(b), Case II, and for the CIPS test they were obtained from Pesaran (2007), Table II(b), Case II.

Source: Authors' estimate

According to the results of the CADF test conducted by taking the differences of the series, the null hypothesis stating that there is a unit root for UR is rejected in Lithuania and Estonia. Therefore, in these countries, UR becomes stationary when the first difference is taken. For RMW, the null hypothesis cannot be rejected in Poland and the Czech Republic, but it is accepted in the other six countries. For TW, the null hypothesis is rejected in the Czech Republic and Slovenia, but it is accepted in the other six countries. Finally, the null hypothesis for UD is accepted only in the Slovak Republic, but it is rejected in the other seven countries. According to the results of the CIPS test, which is a panel statistics test, the null hypothesis is rejected for all of the variables. Thus, UR, RMW, TW, and UD series become stationary when the first difference is taken. The order of stationarity of these seven series is I (1).

After testing the stationarity of the variables, the possible existence of a long-term relationship between the variables can be analysed. The results of the LM bootstrap test used for the analysis are presented in Table 5.

Table 5 LM bootstrap panel co-integration test results

LM statistic	Bootstrap p-value	Asymptotic p-value
24.756	0.510***	0.000

Note: The critical values for the LM bootstrap test were generated using Monte Carlo simulations with 10,000 replications.

Source: Authors' estimate

The results of the LM bootstrap test indicate that the null hypothesis that there is a co-integration between variables cannot be rejected for the bootstrap p-value, but it can be rejected for the asymptotic p-value. In our model, there is a cross-sectional dependence problem. For this reason, the results of the bootstrap method can be preferred as the bootstrap method takes the cross-sectional dependence problem into account.

The coefficients of the model belonging to UR can be estimated since the variables are co-integrated. The results of the model estimated through the AMG method are indicated in Table 6.

Table 6 Individual country results of the AMG estimator

	Variables		
Country	**RMW**	**TW**	**UD**
Poland	.1421994* (.08238352)	.0707062* (.0369532)	-0.412587 (.6637634)
Czech R.	.1266412*** (.0290259)	-.0236348 (.0335549)	0.204727*** (.03055459)
Slovakia	.2432448 (0.178945)	.0551804*** (.0154503)	0.2893117*** (.08242612)
Slovenia	.4956995 (.6319086)	.0712546 (.1020312)	-0.374658*** (.0671670)
Hungary	-.2577504 (1.120519)	-.076201 (.0524627)	-0.4307802*** (0.156838)
Lithuania	.2207476* (1.202098)	-.3216475 (.3617093)	0.0782712 (.1421008)
Latvia	.1518983*** (.0318119)	.1013649*** (.0373707)	0.7434261 (.4904936)
Estonia	-.4030775 (.339582)	-.0654304* (.0393022)	0.0865874 (.1349688)

Note: Figures in parentheses are Newey–West standard errors. ***, ** and * stand for significance at 1, 5 and 10% levels, respectively.

Source: Authors' estimate

The results of the AMG estimator show that UD is not significant for Poland. Therefore, this variable is not effective in determining UR. RMW and TW are statistically significant and positive. The coefficients of these variables are 0.1421 and 0.07070, respectively. Therefore, an increase in RMW and TW is expected to increase UR.

TW is not significant for the Czech Republic. Therefore, TW is not expected to affect UR. RMW and UD are statistically significant and positive. The coefficients of these variables are 0.1266 and 0.2047, respectively. According to these results, if RMW and UD increase, UR increases as well.

TW and UD are statistically significant and positive for Slovakia. The coefficients of these two variables are 0.0551804 and 0.289311, respectively. RMW is not significant. Therefore, this variable does not affect the unemployment rate. In Slovenia, UD is statistically significant and negative. The coefficient of this variable is -0.374. But, RMW and TW are not significant. Therefore, these two variables do not have any effect on UR. For Hungary, UD is statistically significant and negative; if UD increases, UR decreases. The other two variables are insignificant for Hungary, so these two variables do not affect UR.

In Lithuania, only RMW affects UR. The coefficients of other variables are not significant. Finally, in Estonia, TW is statistically significant and negative. UR is inversely related to TW; if TW increases, UR decreases. The other two variables are statistically insignificant. Therefore, RMW and UD do not affect UR in Estonia.

These results indicate that the labour market regulations are not strongly affected by UR in Poland, Latvia, and Estonia. However, in the Czech Republic, Slovenia, Slovakia, and Hungary, the LMI variables are highly effective. Consequently, it can be said that the LMI variables are dominant in the labour market in the Czech Republic, Slovenia, Slovakia, and Hungary.

In order to check the robustness of estimation results of the AMG estimator, the CCE estimator was applied. The results of the CCE estimator are summarised in Table 7.

Table 7 Individual country results of the CCE estimator

Country	Variables		
	RMW	TW	UD
Poland	.1421994* (.08238352)	.0707062* (.0369532)	-0.412587 (.6637634)
Czech R.	.1266412*** (.0290259)	-.0236348 (.0335549)	0.204727*** (.03055459)
Slovakia	.2432448 (0.178945)	.0551804*** (.0154503)	0.2893117*** (.08242612)
Slovenia	.4956995 (.6319086)	.0712546 (.1020312)	-0.374658*** (.0671670)
Hungary	-.2577504 (1.120519)	-.076201 (.0524627)	-0.4307802*** (0.156838)
Lithuania	.2207476* (1.202098)	-.3216475 (.3617093)	0.0782712 (.1421008)
Latvia	.1518983*** (.0318119)	.1013649*** (.0373707)	0.7434261 (.4904936)
Estonia	-.4030775 (.339582)	-.0654304* (.0393022)	0.0865874 (.1349688)

Note: Figures in parentheses are Newey–West standard errors. ***, ** and * stand for significance at 1, 5 and 10% levels, respectively.

Source: Authors' estimate

The results of the CCE estimator confirm the results of the AMG estimator. Accordingly, UR is not strongly affected by the LMI variables in Poland, Latvia, and Estonia. However, in the Czech Republic, Slovenia, Slovakia, and Hungary, the LMI variables are highly effective. Consequently, it can be

said that the LMI variables are dominant factors for unemployment in the labour market in the Czech Republic, Slovenia, Slovakia, and Hungary.

The fact that the LMI variables impact unemployment in the Czech Republic, Slovenia, Slovakia, and Hungary indicates that unemployment can be affected by adjusting the labour market. Labour market regulations fall within the jurisdiction of the government responsible for fiscal policy. This result shows that the governments of these four countries can have an impact on unemployment with their policy implementations. Accordingly, governments in the Czech Republic, Slovenia, Slovakia, and Hungary can affect unemployment by interfering with the tax burden, minimum wages, and union activities. On the other hand, the fact that labour market regulations are not very effective in relation to unemployment in Poland, Latvia, and Estonia shows that policymakers in these three countries cannot affect unemployment through fiscal policy practices alone. Therefore, policymakers in Poland, Latvia, and Estonia may need to benefit from not only fiscal policy but also other economic policies such as a monetary policy to reduce unemployment.

6. Concluding remarks

This study analyses whether the labour market institutions (LMI) variables affected UR in the CEE countries between 2000 and 2017. In addition, it is examined whether the LMI variables impact unemployment in these countries. Panel data methods that take cross-sectional dependence into account are used for the analysis. The findings of the study suggest that RMW, TW, and UD do not have any substantial impact on UR in Poland, Latvia, and Estonia. Thus, the LMI variables do not affect unemployment in Poland, Latvia, and Estonia. On the other hand, the results show that RMW, TW, and UD have a great impact on UR in Slovakia, Slovakia, the Czech Republic, Slovenia, and Hungary. This result indicates that the LMI variables have a great impact on UR. Therefore, the LMI variables are dominant factors for unemployment in Slovakia, the Czech Republic, Slovenia, and Hungary. These results differ from Riboud et al. (2001) and Grossmann et al. (2019). In addition to these results, in this study, only the LMI variables were used as control variables while investigating the causes of unemployment in the CEE countries. Unemployment can be affected by many social and economic factors. Therefore, while investigating the causes of unemployment, future studies may include in the model social factors or monetary factors such as the interest rate and money supply. In this way, the expansion of the model may allow for a more detailed examination of unemployment.

The effect of the LMI variables on unemployment indicates that some policies may have an effect on the labour market. For example, the fact that unemployment in Slovakia, the Czech Republic, Slovenia, and Hungary is affected by real minimum wages, the tax wedge, and union density shows that only fiscal policy implementations impact unemployment. While there is an intervention in the money market with monetary policy, issues such as employment and growth are targeted with fiscal policy. The CEE countries are EU member states. Central banks in the EU aim for price stability as the ultimate goal. Governments are interested in issues such as employment and growth. Therefore, fiscal policy is crucial to combat unemployment in the CEE countries. Therefore, the governments of Slovakia, the Czech Republic, Slovenia, and Hungary have great responsibility to reduce their unemployment rates. In this respect, institutional arrangements should be made with employers to minimise the cost of workers. While these regulations are implemented, it is important to avoid any pressure on the public sector and the rights of employees should be protected at the same time. Institutional arrangements made for wages, taxes and social security contributions should also be adjusted for unionisation. Therefore, unionisation activities should be arranged to contribute to employment growth, not to put pressure on the public sector, and to adopt an economic system dominated by the private sector rather than an economic structure under the supervision of the state. Furthermore, unions should be organised in a way that supports the efficient functioning of the private sector and aims to increase the level of productivity.

Moreover, the fact that the LMI variables are dominant factors determining unemployment indicates that the LMI variables impact a decrease in UR. Thus, policymakers can take precautions to make the labour market more flexible in Slovakia, the Czech Republic, Slovenia, and Hungary. In addition, doing business in a country should be facilitated to increase employment. Business life and the process of starting up a company should be facilitated to overcome this problem. Furthermore, transaction costs and bureaucratic procedures related to the investments can be reduced.

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Appendix

Table A1 Test results of cross-sectional dependence for variables

Variables	CDLM2		CDLM		Bias-adjusted CD test	
	Statistics	p-value	Statistics	p-value	Statistics	p-value
UR	2.896	0.002	-2.559	0.005	2.321	0.003
TW	3.514	0.000	-1.623	0.052	2.994	0.001
UD	3.254	0.000	-2.747	0.003	9.836	0.000
RMW	2.013	0.022	-1.860	0.031	7.271	0.000

Source: Authors' estimate

Table A2 Test results of cross-sectional dependence and homogeneity for the model

Test	Statistics	p-value
CDLM2	13.058	0.000
CDLM	3.527	0.000
Bias-adjusted CD test	4.021	0.000
Delta-tilde	2.202	0.014
Delta-tilde-adj.	2.817	0.002

Source: Authors' estimate

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JEL: C23, F51, H56, O13, Q34, Q43
Original scientific article
https://doi.org/10.51680/ev.36.2.2

Received: July 05, 2022
Revision received: August 17, 2023
Accepted for publishing: August 25, 2023

THE RELATIONSHIP BETWEEN ENERGY SECURITY AND MILITARY EXPENDITURES: A BOOTSTRAP PANEL GRANGER CAUSALITY ANALYSIS FOR ENERGY EXPORTER COUNTRIES

Abstract

Purpose: The aim of this study is to analyze the causality relationship between military expenditures and energy security risk levels. In this context, the main purpose of the study is to investigate whether military expenditures have a role in ensuring energy security and to perform a pioneering study examining the relationship between energy security and military expenditures. In addition, the variables of economic growth and energy export revenues are also included in empirical analysis.

Methodology: The Kónya (2006) bootstrap panel Granger causality approach is used in empirical analysis. The analysis covers 16 major energy exporter countries and the years 1990 and 2018.

Results: It was found that there is one-directional causality from military expenditures to energy security risk levels for three countries, and from energy security risk levels to military expenditures for two countries. On the other hand, it was determined that there is one-directional causality from energy security risk levels to economic growth for four countries, from economic growth to energy security risk levels for two countries, from energy security risk level to energy export revenues for four countries, and from energy export revenues to energy security risk levels for one country. Moreover, it was determined that there is bidirectional causality between energy security risk levels and economic growth for four countries, and between energy security risk levels and energy export revenues for two countries.

Conclusion: The results obtained in this study demonstrate that the causality relationship between energy security and other variables (military expenditures, GDP, and energy export income) cannot be generalized across countries. However, it may be argued that energy security is an important policy tool that has important economic consequences for energy-exporting countries through its effects on different variables.

Keywords: Energy security, military expenditures, economic growth, energy export revenues, bootstrap panel Granger causality

1. Introduction

According to SIPRI (2021), global military expenditures are approximately $1.8 trillion[1] as of 2018. The majority of the global military expenditures have been carried out by the USA with approximately 682.5 billion dollars. The share of the USA in total military expenditure alone is 37.7%, and it is followed by China with 14% and Saudi Arabia with 4.01%. The total share of the top 10 countries in global military expenditures is 76%. Globally, military expenditures increased by approximately 1.94 times compared to 1990. In this period, the military expenditures of the USA increased approximately two times, whereas the military expenditures of China increased approximately 25 times. Accordingly, there is a globally unbalanced distribution of military expenditures.

It is quite remarkable that China's share in global military expenditures was approximately 1% in 1990, while it increased to 14% in 2018. A huge increase in military expenditures in parallel with China's enormous economic growth can be argued as proof that economic growth in China has increased military expenditures. Threats from other global powers that are dissatisfied with China becoming a global power (in a sense, an increase in enemies due to global competition) may have triggered military expenditures by increasing national security risks for China. As a third option, China's desire to have access to global resources as it needs more resources for sustained economic growth as well as to expand to influence the world as a global power in the military sense may have prompted military expenditures. Accordingly, it can be suggested that all these options are partially valid for China.

The main reason for military expenditures is to secure the fundamental rights and freedoms of citizens living within the borders of the country, especially security of life and property. At the same time, as in the case of China, there are many different reasons why countries increase their military expenditures. In this regard, the reasons for increasing military expenditures are e.g. population growth, expanding borders, the possibility of allocating a larger budget to military expenditures thanks to economic growth, increased security risks to natural resources in natural resource-rich countries, increasing global and regional security risks, global power competition, and providing access to global resources to ensure the continuity of economic growth. On the other hand, military expenditures may affect economic growth in two ways. Firstly, in a broadly Keynesian framework, it may stimulate the growth process through increased use of capital stock. In this way, employment, profits, and investment may be stimulated. Secondly, military expenditures may harm economic growth by crowding out investment as well as civilian budget expenditures including health and infrastructure expenditures (Topcu & Aras, 2015, p. 233)

Revenues from energy exports have a large share in the economies of energy exporter countries. In this respect, when analyzing Table 1 for the 16 major energy exporter countries, it is shown that the share of energy export revenues in GDP is above 10% in 10 of these countries. In addition, the panel average is 11.4%. Taking into account the share of export revenues from energy exports in total exports, it is shown that the share of energy exports in total exports is over 10% in all countries - in fact, this rate is over 80% in some countries. Moreover, the panel average is 37.46%. In these countries, it can be expected that fluctuations in energy revenues affect many economic variables, especially export revenues and GDP. Therefore, if diversity of export products cannot be achieved in these countries, it is necessary to ensure the continuity of revenues from energy exports.

At this point, the issue of energy security gains importance. According to the International Energy Agency (IEA) (2020), energy security is "the uninterrupted availability of energy sources at an affordable price". However, energy security is expressed with the 4As of energy security, i.e., availability, affordability, accessibility, and acceptability (Kartal, 2022b, pp. 224-225). In this direction, the IEA definition of energy security can be expanded as "the uninterrupted availability of energy sources that are acceptable with their environmental effects at an affordable price". Here, the most important element of energy security for energy exporter countries is the security of energy resources and export routes. Moreover, having rich energy resources is a source of global power, and on the other hand, it is also a source of conflict in international competition. For this reason, it may be argued that it is necessary to increase military expenditures both to ensure energy security and to deter countries that have ambitions in relation to their resources.

1 For 2020, this figure is approximately 2 trillion dollars.

In addition, it can be expected that an increase in energy export revenues maybe allows more resources to be allocated to military expenditures by increasing the state budget revenue. Moreover, given that military expenditures can also provide safer opportunities for energy export (i.e., increase the level of energy security), it can also be argued that increased military expenditures may contribute to export revenues and thus to the economic growth process. In this direction, this study focuses on the causality relationship among military expenditures and economic growth, energy export revenues, and energy security risk level for 16 important energy exporter countries.

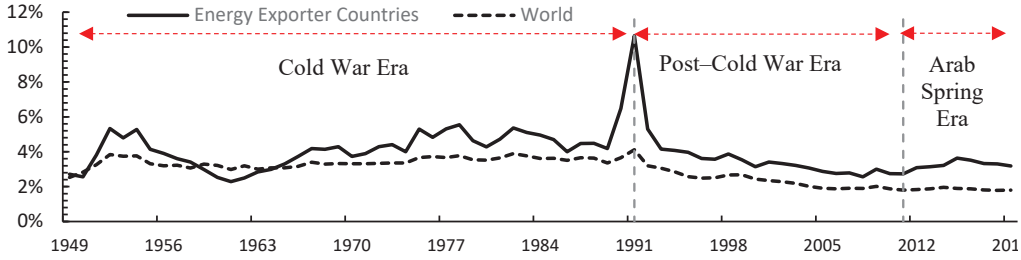
Table 1 Share of energy exports in GDP and total exports in energy exporter countries

C.N	Country	Energy Exports (%GDP)				Energy Exports (%Exports)			
		1990	Rank	2018	Rank	1990	Rank	2018	Rank
1	Algeria	16.84	6	23.11	4	71.83	6	89.60	2
2	Australia	2.40	14	4.07	15	15.88	14	18.65	13
3	Bahrain	72.29	1	18.39	5	62.56	7	23.11	11
4	Canada	2.14	15	5.81	13	8.49	15	18.11	14
5	Colombia	4.19	13	7.26	12	22.22	12	45.69	8
6	Ecuador	9.71	12	8.19	11	42.65	9	36.22	10
7	Indonesia	10.59	10	4.03	16	38.78	10	19.22	12
8	Iran	11.71	9	14.62	9	88.19	3	43.99	9
9	Kuwait	42.72	3	46.49	1	95.07	1	81.97	4
10	Malaysia	12.26	8	10.74	10	16.46	13	15.66	15
11	Nigeria	15.96	7	14.79	8	76.10	4	95.41	1
12	Norway	10.05	11	17.61	6	25.49	11	45.80	7
13	Oman	43.28	2	36.30	2	91.63	2	62.52	6
14	Paraguay	0.01	16	5.22	14	0.03	16	14.54	16
15	S. Arabia	29.11	4	29.44	3	72.17	5	73.54	5
16	Venezuela	20.19	5	17.34	7	52.89	8	86.79	3
	Panel Average	**8.67**	**-**	**11.41**	**-**	**32.59**	**-**	**37.46**	**-**

Source: World Bank (2021); UN (2021a); Trademap (2021); Enerdata (2021)

The change in the share of military expenditures in GDP over time in the 16 major energy exporter countries and worldwide is shown in Figure 1. Accordingly, it is clearly seen that the share of military expenditures in GDP in energy-exporting countries is generally above the world average, except for a few years. This situation suggests that the need for military expenditures is relatively higher in energy exporter countries.

Figure 1 Share of military expenditures in GDP



Note: While calculating the averages, the countries with data for the relevant period were considered.
Source: SIPRI (2021)

Some statistical data regarding the energy exporter countries included in this study are given in Table 2. According to the information obtained from the table, it can be seen that, compared to 1990, military expenditures increased in all countries except for Iran, Kuwait, and Venezuela. It can be seen that military expenditures in these countries increased approximately 12.6 times in Ecuador, 11.4 times

in Colombia, and 10.6 times in Algeria. Moreover, while the total military expenditures of energy exporter countries increased approximately 2.7 times, total global military expenditures increased 1.9 times in this period.

Table 2 Military expenditures in energy-exporting countries

C.N	Country	Military Expenditure			Military		Military		Energy Security Risk Levels		
		1990	2018	Change*	1990	2018	1990	2018	1990	2018	%Change
1	Algeria	904	9,584	10.6	1.46	5.46	8.65	23.65	891.03	1,251.19	40.42
2	Australia	6,704	26,840	4.0	2.16	1.87	89.71	46.03	716.70	805.29	12.36
3	Bahrain	239	1,528	6.4	5.66	4.06	7.83	22.06	1,527.68	1,342.78	-12.10
4	Canada	11,415	22,729	2.0	1.92	1.32	89.94	22.80	754.16	801.96	6.34
5	Colombia	890	10,135	11.4	1.86	3.04	44.38	41.84	768.59	677.66	-11.83
6	Ecuador	202	2,549	12.6	1.33	2.37	13.65	28.95	887.63	1,042.01	17.39
7	Indonesia	1,614	7,557	4.7	1.52	0.73	14.36	17.99	897.04	931.91	3.89
8	Iran	16,474	11,231	-0.3	13.20	2.47	112.71	16.92	959.68	1,370.70	42.83
9	Kuwait	8,962	7,296	-0.2	48.63	5.19	113.82	11.16	1,108.99	1,645.39	48.37
10	Malaysia	1,125	3,470	3.1	2.56	0.97	20.84	9.01	1,006.85	1,272.24	26.36
11	Nigeria	277	2,043	7.4	0.51	0.51	3.21	3.48	818.46	837.07	2.27
12	Norway	3,395	7,067	2.1	2.83	1.63	28.21	9.25	746.17	869.35	16.51
13	Oman	1,448	7,565	5.2	12.39	9.48	28.63	26.12	908.14	1,730.74	90.58
14	Paraguay	112	387	3.4	1.93	0.96	13,560	18.33	1,007.66	1,094.04	8.57
15	S. Arabia	16,355	74,400	4.5	13.90	9.46	47.77	32.13	1,213.73	1,517.71	25.04
16	Venezuela	738	473	-0.4	1.52	0.25	7.52	1.44	937.51	649.97	-30.67
Panel		**72,845**	**196,871**	**2.7**	**4.32**	**2.55**	**49.21**	**22.29**	**946.88**	**1,115.00**	**17.76**
World		**930,659**	**1,809,337**	**1.9**	**3.66**	**1.79**	**-**	**-**	**1,048.66**	**1,192.84**	**13.75**

Note: * The relevant value demonstrates how many times it increased in 2018 compared to 1990.
Source: SIPRI (2021); World Bank (2021); UN (2021a); Trademap (2021); Enerdata (2021); Global Energy Institute (2020)

According to remarkable results obtained from Table 2, the share of military expenditures in GDP decreased in other countries except for Algeria, Colombia, Ecuador, and Nigeria. Likewise, the share of military expenditures in energy export revenues decreased in other countries, excluding Algeria, Bahrain, Ecuador, and Nigeria. While military expenditures increase in almost all countries, a decrease in the share of military expenditures in GDP can be attributed to high economic growth rates in countries relative to military expenditures in this process. This situation is in line with the global trend, which has fallen from 3.66% to 1.79%. Similarly, in 2018, military expenditures in China increased 25 times compared to 1990, while the share of military expenditures in GDP decreased from 2.5% to 1.9%. Considering the example of China, it may be argued that the main reason for a decrease in the share of military expenditures in GDP in energy exporter countries is also high growth in these countries. When the period between 1990 and 2018 is compared in terms of energy security risk levels, it can be seen that energy security risk level has increased in other countries except for Venezuela, Colombia, and Bahrain.

The next section of this study gives a literature review of the subject. Section 3 introduces empirical methodology used in the study. Finally, the results obtained by empirical analysis are reported in the last section.

2. Literature review

There are many studies examining the effect of economic growth on military expenditures using different methods and data from different countries and periods. One of the studies examining this relationship is Benoit's study (1978), which spanned the period from 1955 to 1965 and analyzed 44 less developed countries. The study discovered a strong positive correlation between high defensive loads and rapid economic growth rates in these nations. Chowdhury (1991) investigated a diversified period for each country and found evidence of a causality relationship between defense expenditures and economic growth in 15 developing countries. Moreover, the study identified causality from economic growth to defense expenditures in 7 developing countries and a bidirectional relationship in 3 developing countries. Dritsakis (2004) examined the period from 1960 to 2001 and concluded that there is no cointegrated relationship between defense expenditures and economic growth. However, the Granger causality results highlighted a one-

way causality link from economic growth to defense expenditures for both Greece and Türkiye.

Karagianni and Pempetzoglu (2009) focused on Türkiye in the period from 1949 to 2004. The study demonstrated the presence of causality between military expenditures and economic development. Furthermore, it identified both linear and non-linear causal relationships in the context of Türkiye. Hirnissa et al. (2009) conducted a comprehensive study spanning the years 1965 to 2006 across several Southeast Asian nations. For Indonesia, Thailand, and Singapore, the study revealed a long-term relationship between military spending and economic growth. The results were mixed for other nations in the ASEAN-5 group: Singapore exhibited bi-directional causality, Indonesia and Thailand displayed one-way causality from military spending to economic growth, while no significant relationship was observed for Malaysia and the Philippines. Topcu and Aras (2015) examined the period from 1973 to 2010 and explored the interactions between defense expenditures and economic growth in the context of European Union (EU) member states. Their findings reveal a significant long-term relationship within 10 out of 16 EU member states. Notably, Belgium, Italy, Spain, and the UK displayed a bidirectional relationship between defense expenditures and economic growth. Conversely, France, Germany, the Netherlands, and Sweden exhibited one-directional causality from defense expenditures to economic growth. Similarly, Austria, Bulgaria, Hungary, Ireland, Poland, Portugal, Denmark, and Greece displayed one-directional causality from economic growth to defense expenditures. Khalid and Razaq (2015) explored a reverse direction relationship between military spending and economic growth within the United States during the period from 1970 to 2011. The results of their study underscore a reverse direction relationship between military spending and economic growth for the USA. Malizard (2016) focused on the years 1960 to 2011 and found that public expenditures have detrimental effects on economic growth. In contrast, military expenditures were observed to be less harmful compared to non-military civilian expenditures within the European Union (EU15) economies. Augier et al. (2017) evaluated models with the Feder-Ram model and the augmented Solow model to understand economic growth in China. Their findings suggest that the Feder-Ram model poorly explained economic growth in China, while the augmented Solow model demonstrated that a 1% increase in defense expenditures increases economic growth by about 0.15% to 0.19%. Hatemi-J et al. (2018) explored the hypotheses centered around military spending and economic growth. They confirmed the hypothesis linking military spending to economic growth in China and Japan. Moreover, they validated the growth-based hypothesis in several countries, including France, Russia, Saudi Arabia, and the US. The authors revealed that robust economic growth does not inherently lead to automatic growth in military spending, except in the case of Saudi Arabia. Additionally, they postulated that heightened perceptions of threats in these countries correlate with increased defense spending. Bellos (2019) conducted an examination covering the years from 1985 to 2018, focusing on the association between variables in a sample of 31 transition economies. The study unveiled diverse patterns of association, with certain samples indicating positive relationships, while others displayed negative associations. Importantly, the direction of causality is from military expenditure towards growth and development-related variables in the vast majority of the cases.

Chun (2010) conducted a study spanning the period from 1997 to 2007, focusing on five oil-rich countries. The study uncovers an inelastic correlation between oil revenues and defense expenditures in these nations. Notably, during periods characterized by substantial declines in oil revenues, governments displayed a propensity to either augment their defense expenditures or, at the very least, mitigate a decrease in defense spending at a slower pace compared to a decline in oil revenues. Likewise, at a time of high oil revenues, defense expenditures often witnessed a more pronounced increase compared to an upsurge in oil sales. The author posits that in both scenarios, governments seemed to safeguard defense expenditures in the face of adverse economic circumstances. Farzanegan (2011) explored the years 1959 to 2007 and focused on Iran's reactions to shocks in oil revenues or oil prices. The study found that while Iran's military and security spending exhibited noteworthy responses to these shocks, its social spending components displayed relatively muted reactions. Perlo-Freeman (2012) analyzed the period from 1975 to 2008, focusing specifically on Algerian military spending. The study unearthed a statistically significant and positive effect of oil income on Algerian military expenditures, underscoring the influence of oil revenues on defense spending. Cotet and Tsui (2013) undertook a comprehensive examination spanning the period from 1930 to 2003, but focusing especially on the period from 1988 to 2003. The study elucidated a meaningful positive correlation between oil assets and the defense burden in non-democratic countries. This connection sheds light on the role

of oil assets in shaping defense expenditure patterns within such political contexts. Ali and Abdellatif (2015) conducted an investigation spanning from 1987 to 2012, focusing on the Middle East and North Africa (MENA) countries. The study reveals that certain natural resources, notably oil and forest resources, have led to the escalation of military expenditures in these regions. Additionally, the study found that the rent received from coal and natural gas exerts a negative influence on military expenditures, while the rent derived from minerals has no discernible impact on military spending. These findings were established while accounting for variables such as GDP growth and per capita income. Al-Mawali (2015) explored the years 1987 to 2012, particularly concentrating on the Gulf Cooperation Council (GCC) countries. The study suggests that military spending is predominantly driven by the rent obtained from oil rather than gas and minerals. Furthermore, the study concludes that the Gulf Wars (I and II) and the Arab Spring events do not hold statistical significance in explaining the variance in GCC's military expenditures. Khan and Haque (2019) undertook a comprehensive analysis from 1986 to 2016, encompassing the Middle East region. The study uncovers a significant adverse correlation between military expenditures and both exports and oil rents. This correlation persists across the analysis of countries with higher average oil exports than the Middle East norm. Moreover, the study reveals that the military burden exerts a negative influence on economic growth throughout the entire model specification. Notably, the authors observe that a decrease in military spending over time indicates adverse causality between development and conflict. Erdoğan et al. (2020) conducted a study with varying periods across different countries. Their research established a connection between variables encompassing entire countries. Furthermore, the study found that volatility in oil prices positively impacts military spending in six Gulf Cooperation Council (GCC) countries, with the exception of Bahrain. Bakirtas (2020) focused on the years 1980 to 2016, particularly concentrating on seven countries within the Organization of the Petroleum Exporting Countries (OPEC). The study discerns causality in several directions: from crude oil exports and crude oil prices to military spending, from crude oil exports and military spending to crude oil prices, and from spending and crude oil prices to crude oil exports. These intricate relationships highlight the influence of oil markets on military expenditures. Dizaji and Farzanegan (2021) analyzed the period from 1960 to 2017, with a specific focus on Iran. The study demonstrates that an increase in the density of sanctions against Iran is associated with a considerable decrease in military expenditures, both in the short term and in the long term. Notably, multilateral sanctions exhibit a particularly pronounced impact, leading to a decline of approximately 77% in Iran's military expenditures in the long term.

Accordingly, when the literature examining the effect of economic growth on military expenditures is generally evaluated, it is seen that there is no certain consensus in the literature. In this direction, there are different results in different countries and time periods. However, the dominant view is that there is a positive relationship between economic growth and military expenditures. Likewise, there is no consensus on the impact of energy export revenues and resource wealth on military spending. Again, the dominant view here is that there is a positive relationship between energy export revenues on military expenditures.

On the other hand, there are few studies that analyze the effects of energy security on economic growth. In a series of research endeavors, various scholars have examined the intricate relationship between energy security and economic growth across different periods and regions. Kartal (2018) and Kartal and Öztürk (2020) investigated the interplay between these variables within the time frame spanning the period from 1996 to 2014 for 15 Middle Eastern countries. Their study revealed a notable long-term connection between energy security risk levels and economic growth. Specifically, they found that an escalation in energy security risk levels exerted a negative influence on long-term economic growth. However, the cross-sectional dependence was not considered in the study. Additionally, their analysis presented evidence supporting a bidirectional causal relationship between energy security and economic growth. Kartal (2022d) conducted an analysis of the intricate relationship between energy security, economic growth, and exports within the context of 16 Middle Eastern countries. The study covered the period from 1980 to 2016, and special attention was paid to addressing cross-sectional dependence. The findings of this study unveiled a noteworthy pattern: a 1% escalation in energy security risk level corresponded to an approximate 0.66% reduction in economic growth. Furthermore, it is detected that a bidirectional causality relationship existed between energy security, economic growth, and exports. Stavytskyy et al. (2018) con-

tributed to this discourse by examining 29 European countries in the period from 1997 to 2016. Through their research, they discerned a positive correlation between an increase in gross domestic product (GDP) and the new Energy Security Index (NSI). Conversely, their findings indicated a negative correlation between GDP and the Consumer Price Index (CPI). Fang et al. (2018) took a distinctive approach by proposing five distinct dimensions to characterize energy security: availability, accessibility, affordability, acceptability, and developability. They employed these dimensions to establish China's Sustainable Energy Security (CSES) evaluation index model. This study, conducted between 2005 and 2015, offered insights into China's energy security dynamics and revealed changing trends within the proposed model. Their results spotlighted the pivotal importance of availability and developability within China's energy security index system. The authors identified a downward trajectory for availability and an inverted U-shaped trend for developability, with the nadir in 2011. Notably, the years 2008 to 2012 were identified as a period of risk for China's sustainable energy security. Le and Nguyen (2019) extended the analysis to a global scale, encompassing 74 countries from 2002 to 2013. They demonstrated a positive relationship between energy security and economic growth for both the entire sample and sub-samples. Their findings also indicated that energy insecurity, quantified by energy density and carbon density, had a negative impact on economic growth. The authors underscored the interconnectedness of economic development, energy security, and climate change mitigation at a global level, advocating for comprehensive policies to address these interlinked challenges. Shifting focus to the Turkic world countries including Türkiye, Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan, Kartal (2022a) evaluated the relationship between energy security and economic growth from 1992 to 2016. Employing the panel Durbin-Hausman cointegration test, the study established a significant long-term association between the variables. Notably, a 1% increase in energy security risk level within the Turkic world countries was found to correspond to a reduction of approximately 0.95% in economic growth. In further investigations, Kartal (2022b) utilized asymmetric causality analysis for the period from 1980 to 2018. The findings indicated unidirectional causality, where an increase in energy security risk level led to negative shocks in GDP. Expanding on this topic, Kartal (2022c) employed the NARDL and ARDL methods to probe the asymmetric effects of energy security on Turkish economic growth during the same period. The study identified an asymmetrical relationship between energy security and economic growth in Türkiye. The results showcased that a 1% escalation in energy security risk level correlated with an approximate 0.60% reduction in economic growth, whereas a 1% decrease in energy security risk level corresponded roughly with a 1.72% upswing in economic growth. Lastly, Kartal (2022e) examined a broad range of 74 countries, revealing varying causality relationships between energy security risk level and GDP. While unidirectional causality from energy security risk level to GDP was established for 14 countries and from GDP to energy security risk level for 20 countries, a bidirectional causal association emerged for 22 countries. Notably, 18 countries exhibited no discernible causality between energy security risk level and GDP.

These cumulative research endeavors shed light on the intricate interdependencies between energy security and economic growth across diverse temporal and geographical contexts. Despite that, according to the literature review conducted in this study, although there are many studies examining the effect of economic growth and energy exports on military expenditures and between energy security and economic growth, empirical studies examining the relationship between energy security and military expenditures cannot be determined. In this context, this paper investigating the causality relationship between economic growth, energy export revenues, and military expenditures, as well as the causality relationship between energy security and military expenditures, was designed to fill this important gap in the literature.

3. Data and methodology

This study aims to examine the causality relationship between military expenditures and economic growth, energy export revenues, and energy security risk level for 16 major energy exporter countries between 1990 and 2018 by using Kónya's (2006) bootstrap panel causality approach.[2] The variables included in the empirical analysis and the sources the variables were obtained from are given in Table 3.the variables were obtained from are given in Table 3.

2 Econometric analysis was carried out by using Gauss21 econometrics package program and Nazlıoğlu's (2021) Gauss library.

Table 3 Definitions and data sources

Data	Definitions	Main source	Additional source(s)
me	Military expenditure (current USD)	SIPRI (2021)	World Bank (2021); Global Firepower (2021)
enx	Energy export revenues (current USD) (HS Code: 27)	UN (2021a)	Trademap (2021); Enerdata (2021)
gdp	Gross domestic product	World Bank (2021)	IMF (International Monetary Fund (IMF), 2021); UN (2021b); UN (2021c)
es	Energy security risk index	Global Energy Institute (2020)	

Note: Missing data in the "main source" were supplemented with the help of "additional sources".

Source: Author

The biggest advantage of Kónya's (2006) bootstrap panel causality, which is based on the seemingly unrelated regression (SUR) method and assumed country-specific heterogeneity, does not require any pre-testing such as unit roots and cointegration and takes into account cross-sectional dependence. Kónya's (2006) bootstrap panel causality, which was generated to analyze the causality relationship between military expenditures and economic growth, energy export revenues and energy security risk level in this study, is based on the following systems of equations:

$$\begin{aligned} me_{1,t} &= \alpha_{1,1} + \sum_{i=1}^{kme} \beta_{1,1,i} me_{1,t-i} + \sum_{i=1}^{kenx} \delta_{1,1,i} ex_{1,t-i} + \varepsilon_{1,1,t} \\ me_{2,t} &= \alpha_{1,2} + \sum_{i=1}^{kme} \beta_{1,2,i} me_{2,t-i} + \sum_{i=1}^{kenx} \delta_{1,2,i} ex_{2,t-i} + \varepsilon_{1,2,t} \\ &\vdots \\ me_{N,t} &= \alpha_{1,N} + \sum_{i=1}^{kme} \beta_{1,N,i} me_{N,t-i} + \sum_{i=1}^{kenx} \delta_{1,N,i} ex_{N,t-i} + \varepsilon_{1,N,t} \end{aligned} \quad (1)$$

and

$$\begin{aligned} enx_{1,t} &= \alpha_{2,1} + \sum_{i=1}^{kme} \beta_{2,1,i} me_{1,t-i} + \sum_{i=1}^{kenx} \delta_{2,1,i} ex_{1,t-i} + \varepsilon_{2,1,t} \\ enx_{2,t} &= \alpha_{2,2} + \sum_{i=1}^{kme} \beta_{2,2,i} me_{2,t-i} + \sum_{i=1}^{kenx} \delta_{2,2,i} ex_{2,t-i} + \varepsilon_{2,2,t} \\ &\vdots \\ enx_{N,t} &= \alpha_{2,N} + \sum_{i=1}^{kme} \beta_{2,N,i} me_{N,t-i} + \sum_{i=1}^{kenx} \delta_{2,N,i} ex_{N,t-i} + \varepsilon_{2,N,t} \end{aligned} \quad (2)$$

and

$$\begin{aligned} me_{1,t} &= \alpha_{1,1} + \sum_{i=1}^{kme} \beta_{1,1,i} me_{1,t-i} + \sum_{i=1}^{kgdp} \delta_{1,1,i} gdp_{1,t-i} + \varepsilon_{1,1,t} \\ me_{2,t} &= \alpha_{1,2} + \sum_{i=1}^{kme} \beta_{1,2,i} me_{2,t-i} + \sum_{i=1}^{kgdp} \delta_{1,2,i} gdp_{2,t-i} + \varepsilon_{1,2,t} \\ &\vdots \\ me_{N,t} &= \alpha_{1,N} + \sum_{i=1}^{kme} \beta_{1,N,i} me_{N,t-i} + \sum_{i=1}^{kgdp} \delta_{1,N,i} gdp_{N,t-i} + \varepsilon_{1,N,t} \end{aligned} \quad (3)$$

and

$$\begin{aligned} \mathrm{gdp}_{1,t} &= \alpha_{2,1} + \sum_{i=1}^{kme} \beta_{2,1,i} \mathrm{me}_{1,t-i} + \sum_{i=1}^{kgdp} \delta_{2,1,i} \mathrm{gdp}_{1,t-i} + \varepsilon_{2,1,t} \\ \mathrm{gdp}_{2,t} &= \alpha_{2,2} + \sum_{i=1}^{kme} \beta_{2,2,i} \mathrm{me}_{2,t-i} + \sum_{i=1}^{kgdp} \delta_{2,2,i} \mathrm{gdp}_{2,t-i} + \varepsilon_{2,2,t} \\ &\vdots \\ \mathrm{gdp}_{N,t} &= \alpha_{2,N} + \sum_{i=1}^{kme} \beta_{2,N,i} \mathrm{me}_{N,t-i} + \sum_{i=1}^{kgdp} \delta_{2,N,i} \mathrm{gdp}_{N,t-i} + \varepsilon_{2,N,t} \end{aligned} \quad (4)$$

and

$$\begin{aligned} me_{1,t} &= \alpha_{1,1} + \sum_{i=1}^{kme} \beta_{1,1,i} me_{1,t-i} + \sum_{i=1}^{kes} \delta_{1,1,i} es_{1,t-i} + \varepsilon_{1,1,t} \\ me_{2,t} &= \alpha_{1,2} + \sum_{i=1}^{kme} \beta_{1,2,i} me_{2,t-i} + \sum_{i=1}^{kes} \delta_{1,2,i} es_{2,t-i} + \varepsilon_{1,2,t} \\ &\vdots \\ me_{N,t} &= \alpha_{1,N} + \sum_{i=1}^{kme} \beta_{1,N,i} me_{N,t-i} + \sum_{i=1}^{kes} \delta_{1,N,i} es_{N,t-i} + \varepsilon_{1,N,t} \end{aligned} \quad (5)$$

and

$$\begin{aligned} es_{1,t} &= \alpha_{2,1} + \sum_{i=1}^{kme} \beta_{2,1,i} me_{1,t-i} + \sum_{i=1}^{kes} \delta_{2,1,i} es_{1,t-i} + \varepsilon_{2,1,t} \\ es_{2,t} &= \alpha_{2,2} + \sum_{i=1}^{kme} \beta_{2,2,i} me_{2,t-i} + \sum_{i=1}^{kes} \delta_{2,2,i} es_{2,t-i} + \varepsilon_{2,2,t} \\ &\vdots \\ es_{N,t} &= \alpha_{2,N} + \sum_{i=1}^{kme} \beta_{2,N,i} me_{N,t-i} + \sum_{i=1}^{kes} \delta_{2,N,i} es_{N,t-i} + \varepsilon_{2,N,t} \end{aligned} \quad (6)$$

The following notations are used in the systems of equations given above: "me"- military expenditure, "enx" - energy export revenues, "gdp" - gross domestic product, "es" - energy security risk level, "N" - number of countries, "T" - time period, and "k" - lag length. Accordingly, there is causality from export revenues to military expenditure in Eq. (1), from military expenditure to energy export revenues in Eq. (2), from gross domestic product to military expenditure in Eq. (3), from military

expenditure to gross domestic product in Eq. (4), from energy security to military expenditure in Eq. (5), and from military expenditure to energy security in Eq. (6).

In this study, the slope homogeneity test, which is one of the two pre-testings required for Kónya's (2006) bootstrap panel causality approach, was carried out with the delta tests proposed by Pesaran and Yamagata (2008), which derived from the $\hat{S}$ test of Swamy (1970). While the null hypothesis of these tests is that parameters are homogeneous, an alternative hypothesis is that parameters are heterogeneous.

Whether the data sets used in this study contain cross-sectional dependence was investigated using by the LM_{BP} test (Breusch & Pagan, 1980), the CD_{LM} test (Pesaran, 2004), the CD test (Pesaran, 2004), and the LM_{adj} test (Pesaran et al., 2008). The null hypothesis of these tests is that there is no cross-sectional dependence, while an alternative hypothesis is that there is cross-sectional dependence.

4. Empirical results

Cross-sectional dependence tests and slope heterogeneity tests need to be implemented before analyzing the Kónya (2006) bootstrap panel granger causality. Accordingly, test results, which include delta tests for slope heterogeneity detection and the LM_{BP} (Breusch & Pagan, 1980), the CD_{LM} (Pesaran, 2004), the CD (Pesaran, 2004), and the LMadj (Pesaran et al., 2008) for cross-sectional dependence detection, are given in Table 4. When the results obtained from the cross-sectional dependence tests were examined, the null hypothesis stating that there is no cross-sectional dependence was rejected at a 1% significance level, and the alternative hypothesis stating that there is cross-sectional dependence was accepted, except for the result obtained from the CD_{LM} (2004) test for the lnme variable. Considering the results obtained from the CD (Pesaran, 2004) test for the lnme variable, the null hypothesis was rejected at a 10% significance level. Likewise, when the results obtained from delta tests for slope heterogeneity were examined, the null hypothesis indicating that parameters are homogeneous was rejected at a 1% significance level, and the alternative hypothesis indicating that the parameters are heterogeneous was accepted.

Table 4 Cross-sectional dependence and slope heterogeneity tests

Tests	lnme		lnenx		lngdp		lnes	
	Stat.	p-val.	Stat.	p-val.	Stat.	p-val.	Stat.	p-val.
LM_{BP}	228.609	0.000	344.247	0.000	231.427	0.000	190.185	0.000
CD_{LM}	7.011	0.000	14.475	0.000	7.193	0.000	4.530	0.000
CD	-1.442	0.075	7.618	0.000	-2.294	0.011	-2.914	0.002
LM_{adj}	20.638	0.000	0.914	0.180	6.285	0.000	3.809	0.000
Delta	3.014	0.001	2.026	0.021	4.280	0.000	2.555	0.005
$Delta_{adj}$	3.183	0.001	2.140	0.016	4.520	0.000	2.698	0.003

Source: Author

Causality analysis is performed after providing the necessary pre-conditions for the Kónya (2006) bootstrap panel granger causality test. The results obtained from Eq. (1) expressing causality from energy export revenues to military expenditure, and Eq. (2) expressing causality from military expenditure to energy export revenues are shown in Table 5. According to the results obtained, it was determined that there is causality from export revenues to military expenditure for Canada, Iran, Norway, Oman, and Saudi Arabia, and that there is causality from military expenditure to energy export revenues for Algeria, Colombia, and Nigeria.

Table 5 Panel causality test results (energy export revenues vs. military expenditure)

CN	Countries	H_0: ENX does not cause ME				H_0: ME does not cause ENX			
		Statistic	Critical values			Statistic	Critical values		
			1%	5%	10%		1%	5%	10%
1	Algeria	12.602	75.131	53.835	46.037	6.118**	9.001	5.831	4.461
2	Australia	6.968	70.554	40.710	32.267	3.506	55.525	41.031	34.573
3	Bahrain	15.855	50.933	34.308	25.656	0.768	19.777	15.695	13.440
4	Canada	12.109***	11.914	8.006	6.256	0.033	65.061	45.267	37.512
5	Colombia	0.407	13.289	7.944	5.731	30.145**	50.085	29.363	22.478
6	Ecuador	26.828	53.599	39.993	35.180	10.162	31.597	23.982	21.102
7	Indonesia	3.341	21.583	14.202	11.149	0.225	41.433	26.218	21.495
8	Iran	9.127*	17.338	9.628	6.698	0.939	39.524	21.572	12.833
9	Kuwait	13.893	129.040	95.448	78.077	2.111	76.210	60.235	49.500
10	Malaysia	27.629	68.072	44.162	33.714	12.212	67.855	41.625	32.588
11	Nigeria	6.970	45.390	30.557	24.199	3.392**	5.531	3.350	2.343
12	Norway	11.497**	11.795	6.719	4.960	0.710	18.054	12.131	9.946
13	Oman	11.485**	19.786	11.466	8.786	0.960	22.752	13.881	10.272
14	Paraguay	0.895	86.091	58.017	48.484	0.352	16.345	10.246	7.638
15	S. Arabia	36.951***	18.741	14.053	10.824	2.117	52.752	34.835	28.454
16	Venezuela	2.931	22.004	10.015	7.271	1.846	31.160	16.035	10.381

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

The results obtained from Eq. (3) expressing causality from GDP to military expenditure and Eq. (4) expressing causality from military expenditure to GDP are shown in Table 6. According to the results obtained, it was determined that there is one-directional causality from GDP to military expenditure for Bahrain, Canada, Colombia, Norway, Oman, and Saudi Arabia, there is one-directional causality from military expenditure to GDP for Australia, Indonesia, Nigeria, Paraguay, and Venezuela, and there is bidirectional causality between military expenditure and GDP for Iran.

Table 6 Panel causality test results (GDP vs. military expenditure)

CN	Countries	H_0: GDP does not cause ME				H_0: ME does not cause GDP			
		Statistic	Critical values			Statistic	Critical values		
			1%	5%	10%		1%	5%	10%
1	Algeria	6.282	20.411	15.699	12.904	3.608	9.621	7.042	5.735
2	Australia	0.042	58.531	39.808	32.305	133.259***	73.650	56.619	48.992
3	Bahrain	27.828**	43.512	23.811	16.799	0.000	23.333	18.173	16.475
4	Canada	17.528**	18.087	10.553	7.372	9.180	61.755	41.868	35.266
5	Colombia	9.301***	6.917	4.341	3.076	0.376	47.738	29.472	23.031
6	Ecuador	6.369	52.323	31.520	25.964	0.059	30.977	23.607	20.475
7	Indonesia	12.091	23.775	15.772	12.140	37.052***	32.597	21.421	17.285
8	Iran	12.519**	21.539	10.736	7.207	19.608**	29.188	13.008	8.395
9	Kuwait	9.062	27.653	20.221	17.800	0.051	71.469	58.058	50.503
10	Malaysia	9.846	61.688	37.345	31.593	0.045	70.079	49.558	41.317
11	Nigeria	4.383	45.214	25.417	17.072	4.647**	4.712	2.367	1.624
12	Norway	7.702*	18.172	10.616	7.282	3.118	17.462	11.195	9.042
13	Oman	17.898***	8.239	4.704	3.370	2.296	23.392	13.345	10.129
14	Paraguay	3.980	59.624	34.634	28.936	6.069*	12.227	7.071	5.558
15	S. Arabia	83.095***	22.897	14.870	11.689	0.837	40.067	30.361	25.972
16	Venezuela	2.576	16.924	9.334	7.009	15.889**	24.047	13.656	9.981

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

The results from the Kónya (2006) bootstrap panel causality test obtained from Eq. (5) expressing causality from energy security to military expenditure and Eq. (6) expressing causality from military expenditure to energy security are shown in Table 7. According to the results obtained, it was determined that there is one-directional causality from energy security to military expenditure for Iran and Oman, and there is one-directional causality from military expenditure to energy security for Algeria, Nigeria, and Saudi Arabia.

Table 7 Panel causality test results (energy security vs. military expenditure)

CN	Countries	H_0: ES does not cause ME				H_0: ME does not cause ES			
		Statistic	Critical values			Statistic	Critical values		
			1%	5%	10%		1%	5%	10%
1	Algeria	1.705	55.079	40.639	34.719	13.262***	8.519	6.204	4.988
2	Australia	18.645	54.073	34.835	28.076	1.580	45.913	36.515	31.770
3	Bahrain	0.283	84.773	55.053	44.336	2.000	23.198	16.134	13.828
4	Canada	3.006	10.478	6.973	5.785	6.680	70.674	48.674	42.057
5	Colombia	0.053	9.537	6.021	4.178	0.100	22.377	15.674	11.539
6	Ecuador	5.893	47.543	28.787	22.130	9.516	39.794	25.944	22.540
7	Indonesia	1.204	6.888	4.362	3.066	1.870	34.916	25.379	19.844
8	Iran	15.383*	30.255	16.693	11.189	0.946	27.789	12.188	8.123
9	Kuwait	7.827	23.524	17.524	14.542	0.644	74.674	51.662	43.511
10	Malaysia	16.629	56.873	37.676	31.601	7.786	43.234	32.436	26.934
11	Nigeria	0.051	13.371	8.497	5.835	10.183***	4.945	2.689	1.908
12	Norway	0.195	36.988	25.529	20.393	0.907	22.388	16.373	14.022
13	Oman	23.164***	19.421	11.958	9.335	0.506	16.497	9.887	7.060
14	Paraguay	0.005	4.690	2.692	1.854	0.059	11.445	6.261	4.544
15	S. Arabia	0.129	15.047	8.294	5.422	40.516**	45.411	32.448	27.010
16	Venezuela	5.455	23.233	12.746	8.932	0.717	28.468	15.744	10.397

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

Moreover, all results are summarized in Table 8 and Table 9, including causality from GDP to energy export revenues, from energy export revenues to GDP, from energy security to GDP, and from GDP to energy security (for results, see Appendix 1, Appendix 2, and Appendix 3).

Table 8 Summary of the direction of causality

Causality	dza	aus	bhr	can	col	ecu	idn	irn	kwt	mys	nga	nor	omn	pry	sau	ven
enx → me				***				*				**	**		***	
gdp → me			**	**	***			**				*	***		***	
es → me								*					***			
me →enx	**				**						**					
gdp → enx					***								***			*
es → enx				*	**					*			**	***		
me → gdp		***					***	**			**			*		**
enx → gdp					***	**	***	***		*			*		***	***
es → gdp																
me → es	***										***				**	
enx → es				**				**					**			
gdp → es				***				***	**				***		**	*

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively. "→" represents the direction of causality.
Source: Author

When the results obtained for the countries are examined, there are one-directional causality relationships from military expenditures to energy export revenues and energy security in Algeria. There is one-directional causality from military expenditures to GDP in Australia. There is one-directional causality from GDP to military expenditures in Bahrain. There are one-directional causality relationships from energy export revenues and GDP to military expenditures, from GDP to energy security, and there is bidirectional causality between energy security and energy export revenues in Canada. There is one-directional causality from military expenditures to energy export revenues, from GDP to military expenditures and energy export revenues, and from energy security to GDP energy export revenues in Colombia. There is one-directional causality from energy security to GDP in Ecuador. There is one-directional causality from military expenditures and energy security to GDP in Indonesia. For Iran, there is one-directional causality from energy export revenues to military expenditures, GDP, and energy security, and from energy security to military expenditures. There is bidirectional causality between military expenditures and GDP, and energy security and GDP. There is one-directional causality from GDP to energy security in Kuwait. There is one-directional causality from energy security to GDP and energy export revenues in Malaysia. There is one-directional causality from military expenditures to energy export revenues, and GDP and energy security in Nigeria. There is one-directional causality from energy export revenues and GDP to military expenditures in Norway. There is one-directional causality from energy export revenues, GDP, and energy security to military expenditures, and from GDP to energy export revenues, and there is bidirectional causality between GDP and energy security, and energy export revenues and energy security in Oman. There is one-directional causality from military expenditures to GDP, and from energy security to energy export revenues in Paraguay. There is one-directional causality from energy export revenues and GDP to military expenditures, from military expenditures to energy security, and from energy security to energy export revenues. There is bidirectional causality between GDP and energy security in Saudi Arabia. And finally, there is one-directional causality from military expenditures to GDP, and bidirectional causality between GDP and energy export revenues, and GDP and energy security in Venezuela.

Table 9 Summary of the direction of causality by country

CN	Countries	ENX vs ME	GDP vs ME	ES vs ME	GDP vs ENX	GDP vs ES	ES vs ENX
1	Algeria	←	-	←	-	-	-
2	Australia	-	←	-	-	-	-
3	Bahrain	-	→	-	-	-	-
4	Canada	→	→	-	-	→	⇄
5	Colombia	←	→	-	→	←	→
6	Ecuador	-	-	-	-	←	-
7	Indonesia	-	←	-	-	←	-
8	Iran	→	⇄	→	←	⇄	←
9	Kuwait	-	-	-	-	→	-
10	Malaysia	-	-	-	-	←	→
11	Nigeria	←	←	←	-	-	-
12	Norway	→	→	-	-	-	-
13	Oman	→	→	→	→	⇄	⇄
14	Paraguay	-	←	-	-	-	→
15	Saudi Arabia	→	→	←	-	⇄	→
16	Venezuela	-	←	-	⇄	⇄	-

Note: "→, ← and ⇄" represent the direction of causality.

Source: Author

5. Conclusion

This study aims to examine the causality relationship between military expenditures and economic growth, energy export revenues, and energy security risk level for 16 major energy exporter countries between 1990 and 2018 using the Kónya bootstrap panel causality approach. According to the results obtained, it was found that there is at least one causality relationship between military expenditures, energy export revenues, GDP, and energy security for all countries. Moreover, it was determined that there is at least one causal relationship between military expenditures and other variables, includ-

ing energy export revenues, GDP, and energy security in all countries except Ecuador, Kuwait, and Malaysia.

When the results obtained are evaluated, the fact that there is causality determined from energy export revenues to military expenditures in Canada, Iran, Norway, Oman, and Saudi Arabia, demonstrates that military expenditures are affected by energy export revenues in these countries. Therefore, it may be argued that energy stimulation of export revenues in these countries may also stimulate military expenditures. On the other hand, the fact that there is causality determined from military expenditures to energy export revenues in Algeria, Colombia, and Nigeria, demonstrates that energy export revenues are affected by military expenditures in these countries.

Moreover, the fact that there is causality determined from GDP to military expenditures in Bahrain, Canada, Colombia, Iran, Norway, Oman, and Saudi Arabia, demonstrates that military expenditures are affected by GDP in these countries. Therefore, it may be argued that stimulation of economic growth in these countries may also stimulate military expenditures. On the other hand, the fact that there is causality determined from military expenditures to GDP in Australia, Indonesia, Iran, Nigeria, Paraguay, and Venezuela, demonstrates that GDP is affected by military expenditures in these countries. Therefore, it may be argued that military expenditures stimulate economic growth in these countries.

When the results obtained for the causal relationship between military expenditures, economic growth, and energy export revenues are evaluated in general, they demonstrate that they cannot be generalized across countries. However, it may be argued that the direction of causality between military expenditures and energy export revenues is predominantly from energy export revenues to military expenditures, while causality between economic growth and military expenditures is predominantly from economic growth to military expenditures.

The most important factor that distinguishes this study from other studies on the subject is also the inclusion of the energy security variable in the analysis. Quite remarkable results have been obtained in this direction. Firstly, the fact that there is causality determined from military expenditures to energy security risk level in Algeria, Nigeria, and Saudi Arabia, demonstrates that energy security risk level is affected by military expenditures in these countries. On the other hand, the fact that there is causality determined from energy security risk level to military expenditures in Iran and Oman, demonstrates that military expenditures are affected by energy security risk level in these countries. Therefore, it may be argued that military expenditures are an important policy tool for ensuring energy security in these countries.

Secondly, the fact that there is causality determined from energy security risk level to economic growth in Colombia, Ecuador, Indonesia, Iran, Kuwait, Oman, and Saudi Arabia, demonstrates that economic growth is affected by energy security risk level in these countries. Therefore, it may be argued that energy security promotes economic growth in these countries, and energy security is an important policy tool for ensuring economic growth. On the other hand, the fact that there is causality determined from economic growth to energy security risk level in Canada, Iran, Kuwait, Oman, Saudi Arabia, and Venezuela, demonstrates that energy security risk level is affected by economic growth in these countries. This result demonstrates that economic growth is an important factor in ensuring energy security in these countries. It is also quite remarkable that there is a bidirectional causality relationship between energy security and GDP in Iran, Saudi Arabia, and Venezuela, which are among the world's most important energy exporters.

Thirdly, the fact that there is causality determined from energy security risk level to energy export revenues in Canada, Colombia, Malaysia, Oman, Paraguay, and Saudi Arabia, demonstrates that energy export revenues are affected by energy security risk level in these countries. Therefore, it may be argued that among the policies to be implemented to increase energy export revenues, policies for energy security should also be included in these countries. On the other hand, the fact that there is causality determined from energy export revenues to energy security risk level in Canada, Iran, and Oman, demonstrates that energy security risk level is affected by energy export revenues in these countries. Since fluctuations and potential risks in energy exports in these countries may also affect the energy security risk level, policy practices that will eliminate the risks in energy exports may also positively affect the energy security risk level.

When the results obtained from the causality relationship between energy security and other variables (military expenditures, GDP, and energy export income) are evaluated in general, they demonstrate that they cannot be generalized across countries. However, it may be argued that energy security is an important policy tool that has important economic consequences for energy-exporting countries through its effects on different variables. In this direction, although various policy proposals can be made between countries, both indirect and direct effects should be considered. For example, energy security will be stimulated by stimulation of military expenditures in Saudi Arabia, and energy export revenues will also be stimulated through causality from energy security to export revenues. In addition to these two links, thanks to the bidirectional link between economic growth and energy security risk level, stimulation of energy security will stimulate economic growth. Therefore, it may be mentioned that there is an indirect effect of military expenditures on economic growth. In this way, policymakers may be providing different policy recommendations that may influence energy export revenues, economic growth, energy security, and military expenditures by making more connections between variables for energy-exporting countries.

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Appendix

Appendix 1 Panel causality test results (GDP vs. Energy export revenues)

CN	Countries	Ho: GDP does not cause ENX				Ho: ENX does not cause GDP			
		Statistic	Critical values			Statistic	Critical values		
			1%	5%	10%		1%	5%	10%
1	Algeria	4.146	25.757	18.489	15.157	19.544	52.390	41.325	34.336
2	Australia	4.024	50.836	28.911	23.609	9.234	84.853	53.111	43.563
3	Bahrain	3.183	92.962	63.554	52.917	0.161	54.654	36.619	28.550
4	Canada	2.478	29.715	17.164	13.352	3.445	38.835	26.931	21.153
5	Colombia	43.073***	12.911	7.081	5.165	1.480	35.413	24.079	18.966
6	Ecuador	11.518	39.907	24.089	17.521	36.130	55.409	43.042	36.366
7	Indonesia	5.708	59.172	42.519	35.641	1.015	57.304	38.879	31.838
8	Iran	3.855	23.793	13.405	8.805	8.429*	16.001	8.803	6.166
9	Kuwait	14.865	43.917	28.262	22.539	19.745	118.675	83.256	72.167
10	Malaysia	8.305	58.028	33.508	25.663	1.700	97.582	62.164	49.446
11	Nigeria	5.349	95.611	65.414	53.189	17.660	55.273	37.970	31.043
12	Norway	0.079	29.280	16.559	12.815	10.627	29.000	20.622	15.005
13	Oman	11.505***	10.755	7.068	4.980	0.008	65.206	40.304	32.996
14	Paraguay	0.626	43.881	27.553	20.198	2.721	64.651	46.769	38.673
15	S. Arabia	7.061	50.533	35.795	29.023	2.625	50.765	34.564	27.673
16	Venezuela	8.100*	17.523	10.066	6.665	9.703**	15.527	8.014	5.749

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

Appendix 2 Panel causality test results (GDP vs. Energy security)

CN	Countries	H_0: GDP does not cause ES				H_0: ES does not cause GDP			
		Statistic	Critical Values			Statistic	Critical Values		
			1%	5%	10%		1%	5%	10%
1	Algeria	8.187	20.655	14.152	10.924	3.360	57.123	40.728	34.091
2	Australia	0.405	61.483	41.742	33.460	19.443	49.851	32.686	26.905
3	Bahrain	0.772	79.633	54.634	44.991	1.185	64.187	50.210	40.847
4	Canada	21.652***	19.482	13.167	9.843	0.022	11.605	7.851	6.122
5	Colombia	0.000	6.995	4.068	3.024	38.780***	7.641	4.649	3.379
6	Ecuador	7.830	43.286	23.605	18.635	37.410**	43.485	29.475	24.950
7	Indonesia	0.660	68.950	45.708	34.279	30.155***	9.413	6.642	5.040
8	Iran	20.210***	16.968	9.780	6.718	191.734***	33.126	15.383	10.355
9	Kuwait	18.571**	27.629	18.338	15.051	5.835	26.121	17.959	14.849
10	Malaysia	18.904	59.414	42.138	34.113	34.278*	57.081	38.378	31.582
11	Nigeria	2.410	81.912	54.437	44.590	0.551	11.465	7.296	5.578
12	Norway	1.024	21.860	13.036	9.429	0.106	67.564	38.777	30.288
13	Oman	28.444***	7.608	4.611	3.328	16.885*	26.358	18.433	15.480
14	Paraguay	0.000	47.876	27.008	21.273	1.705	4.460	3.153	2.561
15	S. Arabia	47.123**	54.880	38.955	30.782	64.184***	22.884	14.420	10.877
16	Venezuela	9.784*	17.884	10.510	7.002	37.693***	24.833	14.544	9.730

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

Appendix 3 Panel causality test results (Energy security vs. Energy export revenues)

CN	Countries	H_0: ES does not cause ENX				H_0: ENX does not cause ES			
		Statistic	Critical values			Statistic	Critical values		
			1%	5%	10%		1%	5%	10%
1	Algeria	1.608	55.294	40.516	34.085	1.785	63.047	43.557	37.420
2	Australia	11.899	45.168	30.379	23.932	0.000	80.675	46.004	36.068
3	Bahrain	0.928	74.738	53.798	44.457	0.813	52.156	31.666	25.094
4	Canada	6.535*	9.857	6.893	5.902	11.899**	15.741	8.536	6.203
5	Colombia	10.300**	18.307	9.130	6.246	0.285	10.508	6.868	5.346
6	Ecuador	0.454	48.784	30.499	23.741	2.982	57.404	43.809	36.369
7	Indonesia	4.598	16.261	9.935	7.639	0.472	64.508	43.976	34.045
8	Iran	0.058	50.209	22.552	15.392	15.368**	15.562	9.114	6.433
9	Kuwait	2.952	27.836	17.869	15.247	17.463	122.876	77.316	65.960
10	Malaysia	29.246*	49.675	31.466	25.125	5.972	82.185	50.852	40.986
11	Nigeria	5.036	12.279	7.199	5.782	13.823	46.121	32.434	24.425
12	Norway	7.486	65.512	40.879	30.402	0.107	13.937	7.422	5.487
13	Oman	17.393**	27.433	17.029	13.508	16.553**	18.442	10.867	8.166
14	Paraguay	4.144***	4.142	2.842	2.227	0.075	82.243	57.361	48.602
15	S. Arabia	9.341*	18.977	11.009	8.214	21.016	54.203	38.211	35.380
16	Venezuela	0.752	21.367	12.504	9.473	4.308	21.321	10.380	6.564

Note: *, **, *** indicate significance at the 0.01, 0.05, and 0.1 levels, respectively.

Source: Author

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JEL: C23, E52, E58
Original scientific article
https://doi.org/10.51680/ev.36.2.3

Received: July 5, 2022
Revision received: April 24, 2023
Accepted for publishing: May 14, 2023

THE IMPACT OF FINANCIAL FACTORS ON MONETARY POLICY RESPONSES IN EMERGING MARKET ECONOMIES

Abstract

Purpose: This study investigates the monetary policy responses of emerging market inflation targeters to financial factors both before and after the 2008 global financial crisis (GFC).

Methodology: Taylor rules, augmented with the nominal exchange rate, the exchange market pressure index, and the U.S. federal funds effective rate, are analyzed by using the augmented mean group (AMG) panel estimator for 12 emerging market economies (EMEs) that adopted an inflation targeting regime. The sample is divided into two periods around the GFC: 2002Q1-2007Q4 and 2010Q1-2019Q4.

Results: Inflation significantly and positively impacted interest rate settings during both periods. The panel AMG results indicate that the EMEs' responses to financial variables only had a significant effect during the post-crisis period, while the federal funds effective rate had the most impact among the financial variables. The country-specific results indicate that some central banks also reacted to financial variables before the GFC.

Conclusion: Inflation played an important role in policy rate decisions for both periods despite the slightly decreasing weight in interest rate settings after the GFC due to the increasing influence of financial variables. Although financial variables were important in setting interest rates during both periods, the EMEs' post-GFC monetary policies focused more on financial stability. Furthermore, their monetary policies became more compatible with external financial conditions after the GFC.

Keywords: Emerging market economies, financial stability, monetary policy, panel AMG, Taylor rule

1. Introduction

The 2008 global financial crisis (GFC) showed that price stability is not sufficient to ensure financial stability. This has brought into question the "benign neglect" view, which suggests a reactive monetary policy strategy for financial instabilities and which represented the consensus before the GFC (Bernanke & Gertler, 2001; Greenspan, 2002). Research on the financial cycle and the risk-taking channel of monetary policy has triggered debates on whether monetary policy should focus on financial stability. First, it has been realized that financial cycles differ from traditional business cycles (Borio, 2014). Specifically, Claessens et al. (2012) and Drehman et al. (2012) reported that financial cycles last longer and

have a greater amplitude than business cycles. Second, the risk-taking channel showed that monetary authorities that ignore financial stability handle trade-offs regarding output and inflation variability quite optimistically (King, 2012). Many studies have demonstrated that a low-interest-rate environment increases risk-taking behaviors (Adrian & Shin, 2008; De Nicolò et al., 2010; Ongena & Peydro, 2011; Borio & Zhu, 2012; Dell'Ariccia et al., 2013; Bruno & Shin, 2015). Therefore, financial stability has been considered a secondary goal of monetary policy regarding financial cycles and the risk-taking channel of monetary policy, while the policy horizon has lengthened (Smets, 2014). This view of a proactive monetary policy response to financial imbalances is called "leaning against the wind" (Borio & Lowe, 2002; White, 2006).

While the lean against the wind approach has gained considerable ground since the GFC, debates on the ability of monetary policy have focused on imbalances in advanced economies (AEs). However, emerging market economies (EMEs) face different financial risks than AEs. Unlike AEs, which do not depend on capital flows and foreign credit (Menna & Tobal, 2018; Tobal & Menna, 2020), exchange rate stability is more important for EMEs because they have liability dollarization and high exchange rate pass-through. Consequently, the implications of domestic currency depreciation for EME balance sheets and upward inflation pressures force EMEs to consider risks originating from capital flows, even if they are inflation targeters (Mishkin, 2008).

In AEs, monetary policy mainly focuses on the domestic business cycle. In contrast, global financial conditions can prevent EMEs from achieving domestic goals through monetary policy. The necessity to manage both external dominance due to the global financial cycle and the domestic business cycle can weaken monetary policy independence in these economies (Sheel, 2014). Indeed, Rey (2013) argues that the global financial cycle has transformed the "trilemma"[1] into a "dilemma". In a financially integrated world, flexible exchange rates are no longer sufficient for an independent monetary policy. In addition, EMEs cannot protect themselves against external financial shocks, even if they implement a flexible exchange rate regime (Siklos, 2018).

1 Mundell-Fleming's "trilemma" (also known as the "impossible trinity") refers to a country that can simultaneously achieve only two of three policy goals, namely financial integration, monetary independence, and exchange rate stability (Aizenman, 2019).

Various policy options are available to manage the implications of the global financial cycle. The best option is to manage the capital account with a separate tool, such as a macroprudential instrument (Rey, 2013). However, considering the deterrent effects of controls on capital inflows in the long run, this option may be unattractive to EMEs that have to maintain a current account balance (Sheel, 2014). Therefore, monetary policy may react to external financial conditions in these countries.

Motivated by the potential of the GFC to influence monetary policies, this study explores the monetary policy responses of emerging market inflation targeters to financial variables both before and after the GFC. It analyzes Taylor rules augmented with the nominal exchange rate, the exchange market pressure index (EMPI), and the U.S. federal funds effective rate using the augmented mean group (AMG) panel estimator for 12 EMEs in the pre- and the post-GFC. By doing so, it provides new empirical evidence of changing EMEs' monetary policy responses with the GFC.

The rest of the paper proceeds as follows. The following section reviews the literature. The third section explains the methodology. The fourth section describes models and data. The fifth section reports the findings. The sixth section ends the paper.

2. Literature review

This review focuses on studies dealing with country groups, although there are many country-specific studies exploring the impact of financial factors on monetary policy. The exchange rate is one of the primary variables used to examine the effect of financial stability on monetary policy in EMEs. Analyzing 13 EMEs, Mohanty and Klau (2004) showed that interest rate responses to the exchange rate are significant in most countries. Aizenman et al. (2011) investigated the role of the real exchange rate in inflation targeting in 16 EMEs, including inflation targeters and non-inflation targeters, from 1989Q1 to 2006Q4. They found that emerging market central banks that adopt inflation targeting reacted to inflation and real exchange rates. Feldkircher et al. (2016) examined central banks' reaction functions in four European inflation targeters from July 2004 to May 2015, and found that some countries tended to adjust interest rates to exchange rate movements. Fouejieu (2017) found that inflation targeting EMEs responded to exchange rate mis-

alignments between 2000Q1 and 2010Q4. Caporale et al. (2018) explored the interest rate settings in five EMEs for low- and high-inflation regimes and reported that central banks reacted to inflation, output, and real exchange rate movements. Fabris and Lazić (2022) analyzed the role of the exchange rate in the interest rate settings for 37 advanced countries and EMEs from 1995Q1 to 2018Q3. They reported that monetary policy response to the exchange rate is statistically significant in EMEs but insignificant in developed countries. Elsayed et al. (2023) investigated the relationship between financial stability and monetary policy for the four Gulf Cooperation Council countries between 2006Q4 and 2020Q2. They found that the real exchange rate is considered in the interest rate setting in Bahrain and Saudi Arabia. Furthermore, countries respond to financial stability with different reactions in the short or long term.

There is a growing body of evidence that external financial conditions impact interest rate settings in EMEs. Caputo and Herrera (2017) found that, along with inflation and the output gap, the Fed funds rate determined the policy rate in both EMEs and AEs that adopted inflation targeting. Turkay (2017) investigated the reaction functions of 15 inflation targeting EMEs by augmenting the Taylor rule with financial variables between January 2006 and October 2016. He found that EMEs responded to 10-year U.S. government bond yields, inflation, output, and the real exchange rate. Gülşen and Özmen (2020) analyzed the impact of global financial conditions and the Fed rate on monetary policy in 22 AEs and 38 EMEs between January 1990 and February 2016. The effect of the Fed rates on policy rates increased after the GFC in EMEs, although not as much as in AEs. Poirson et al. (2020) investigated the monetary policy responses of 66 non-reserving economies to global financial conditions from 1996Q1 to 2015Q4. Non-reserving economies increased their policy rates whenever the Federal fund rate increased. Similarly, Arimurti and Morley (2020) reported that inflation targeters raised their policy rates in line with increases in the Fed fund rate. Analyzing four EMEs between January 2002 and December 2019, Yildirim (2022) showed that EMEs' monetary policy responses to global financial risk shocks are procyclical.

Other studies have shown that inflation plays a greater role than financial factors in determining policy rates. For example, Cabral et al. (2020) analyzed the exchange rate effect on the reaction function in 24 EME central banks, including inflation targeters and non-targeters, from 2000Q1 to 2015Q2. They found that inflation targeters responded only to inflation. Similarly, Paranavithana et al. (2020), who augmented the Taylor rule with exchange rates, concluded that inflation carried more weight for inflation-targeting EMEs.

There are studies on country groups that examine the monetary policy responses to financial variables by considering the GFC as a turning point. However, some focus only on the exchange rate, while others concentrate on external factors. This study addresses both domestic and external financial variables for EMEs adopting inflation targeting. The research hypothesis to be tested is that monetary policy responses to financial factors have been changed after the GFC in emerging market inflation targeters.

3. Methodology

This paper employs the panel AMG estimator developed by Eberhardt and Bond (2009) and Eberhardt and Teal (2010) to estimate augmented Taylor rules. External financial conditions do not affect countries equally due to their idiosyncratic characteristics. Furthermore, spillovers may occur between countries from their monetary and fiscal policies. The AMG, which considers country-specific heterogeneity and cross-sectional dependence (CD) across countries, is an appropriate panel estimation framework for examining interest rate settings (Lanzafame, 2016, pp. 486-490).

Since the method allows for the investigation of the parameters of nonstationary variables, there is no pre-requisite test, such as unit root or cointegration (Danish et al., 2019; Destek & Sarkodie, 2019). Therefore, the only necessary preliminary tests are for CD and slope homogeneity. Pesaran et al.'s (2008) bias-adjusted Lagrange multiplier (LM_{adj}) test, which eliminates the drawbacks of previous tests, is used to evaluate cross-sectional dependency across countries, while delta tilde ($\tilde{\Delta}$) and adjusted delta tilde ($\tilde{\Delta}_{adj}$) tests of Pesaran and Yamagata (2008) are used to investigate the homogeneity of the slope coefficients.

The AMG is a two-stage estimator (Eberhardt & Bond, 2009, p. 3; Eberhardt & Teal, 2010, p. 7; Eberhardt, 2012, p. 64):

First stage: $\Delta y_{i,t} = b'\Delta X_{i,t} + \sum_{t=2}^{T} c_t \Delta D_t + e_{i,t} \quad \Rightarrow \hat{c}_t = \hat{u}_t^*$ (1)

Second stage: $y_{i,t} = a_i + b_i' X_{i,t} + c_i t + d_i \hat{u}_t^* + e_{i,t} \qquad \hat{b}_{AMG} = N^{-1} \sum_i \hat{b}_i$ (2)

In Eq. 1, y_{it} and X_{it} stand for the dependent and independent variables, respectively. ΔD_t shows the first-difference $T-1$ time dummies, while c_t is the parameter for the time dummies. The first-difference ordinary least squares regression augmented with $T-1$ time dummies in the first differences is estimated, and $\hat{\mu}_t^*$ replaces the estimated c_t. This indicates a common dynamic process. In the second stage, the obtained $\hat{\mu}_t^*$ is included in each N standard group-specific regression to obtain the omitted idiosyncratic processes. Alternatively, a common process is imposed on each group member with a unit coefficient by subtracting $\hat{\mu}_t^*$ from y_{it}. In either case, following the MG method (Pesaran & Smith, 1995), the AMG estimates are the mean values of the group-specific parameters.

4. Models and data

To examine the effects of the GFC on the EMEs' interest rate setting, this study analyzes augmented Taylor rules for two periods, i.e., 2002Q1-2007Q4 and 2010Q4-2019Q4. The two samples exclude the GFC period itself, while the post-crisis sample ends in 2019Q4 to exclude the effects of the COVID-19 pandemic on monetary policy behavior. The sample consists of 12 EMEs[2] (Brazil, Chile, Colombia, the Czech Republic, Hungary, Korea, Mexico, Philippines, Poland, South Africa, Thailand, and Turkey) that adopted the inflation targeting regime in 2002 or before.[3]

Analyzing the Fed's monetary policy, Taylor (1993) proposed a short-term interest rate rule known as the Taylor rule. According to this rule, the short-term interest rate is mainly determined by inflation and output—the interest rate increases when inflation deviates positively from its target and output reaches above its potential (Hutchison et al., 2010). Many researchers enhance this baseline rule with several financial variables, especially for EMEs, which are more sensitive to financial shocks (Käfer, 2014).

Consistent with the literature, this study augments the Taylor rule with financial variables. The exchange rate is one financial variable used in the analysis. Furthermore, the Taylor rule is extended with the EMPI because there may be appreciation or depreciation pressures in the foreign exchange market, although the actual exchange rate is at the target (Klaassen & Mavromatis, 2016). Finally, the federal funds effective rate is used to explore the effect of external financial conditions on domestic monetary policy. Model 1 shows the standard Taylor rule, while models 2, 3, and 4 represent Taylor rules augmented with the nominal exchange rate, the EMPI, and the U.S. federal funds effective rate, respectively.

Model 1: $\text{int}_{i,t} = \alpha_i + \beta \,\text{int}_{i,t-1} + \delta(\pi_{i,t} - \pi_{i,t}^*) + \theta(y_{i,t} - y_{i,t}^*) + \varepsilon_{i,t}$, (3)

Model 2: $\text{int}_{i,t} = \alpha_i + \beta \,\text{int}_{i,t-1} + \delta(\pi_{i,t} - \pi_{i,t}^*) + \theta(y_{i,t} - y_{i,t}^*) + \omega \Delta ner_{i,t} + \varepsilon_{i,t}$, (4)

Model 3: $\text{int}_{i,t} = \alpha_i + \beta \,\text{int}_{i,t-1} + \delta(\pi_{i,t} - \pi_{i,t}^*) + \theta(y_{i,t} - y_{i,t}^*) + \varphi empi_{i,t} + \varepsilon_{i,t}$, (5)

Model 4: $\text{int}_{i,t} = \alpha_i + \beta \,\text{int}_{i,t-1} + \delta(\pi_{i,t} - \pi_{i,t}^*) + \theta(y_{i,t} - y_{i,t}^*) + \vartheta ffer_{i,t} + \varepsilon_{i,t}$, (6)

where i is the cross-section dimension and t is the time dimension; α_i and ε_{it} are the constant term and the error term, respectively; int_{it} denotes the policy interest rate; and π_{it} and π_{it}^* stand for the actual and target inflation, respectively. The annual percentage changes in the consumer price indices (2010=100) are used for inflation. The inflation gap $(\pi_{it} - \pi_{it}^*)$ is calculated by subtracting the inflation target from actual inflation. y_{it} shows the annual growth rate of real gross domestic product

2 The EMEs are identified from the Morgan Stanley Capital International (MSCI) market classification (MSCI, 2021).

3 Although Turkey switched to full-fledged inflation targeting in 2006, it is included in the analysis since it adopted implicit inflation targeting in 2002.

(GDP) in domestic currency, which is a proxy for output. The output gap $(y_{it} - y_{it}^*)$ is calculated as the difference between the output from its trend obtained using the Hodrick-Prescott filter[4]. The series containing seasonality are adjusted.

Δner_{it} in Model 2 is the annual percentage change in the nominal exchange rate and it represents the domestic currency per U.S. dollar (period average). $empi_{it}$ in Model 3 is the EMPI, while $ffer_{it}$ in Model 4 is the Fed funds effective rate. Although there are different and sophisticated versions of the EMPI in the literature, a standard version of the EMPI is preferred in the study (Aizenman & Binici, 2016, p. 72). Instead of quarterly percentage changes of variables, annual percentage changes are used. The EMPI is as below:

$$empi_{i,t} = \Delta ner_{i,t} - \Delta ir_{i,t} \quad (7)$$

Δir_{it} is the annual percentage change in foreign exchange reserves excluding gold in the U.S. dollar. $empi_{it}$ is calculated as the difference between the foreign exchange reserves and the nominal exchange rate in their annual percentage change. An increase in $empi_{it}$ indicates depreciation pressure in the foreign exchange market, whereas a decrease indicates appreciation pressures.

The series employed in the study are retrieved from various databases. The monetary policy-related interest rates, consumer price indices, nominal exchange rates, and total foreign exchange reserves are imported from IMF International Financial Statistics. Constant GDP is obtained from the WB Global Economic Monitor, while the Fed funds effective rate is taken from the FRED database. Inflation targets are retrieved from the central banks' monetary policy-related reports. Table 1 shows the descriptive statistics of the variables.

Table 1 Descriptive statistics

2002Q1-2007Q4				
Variables	**Mean**	**Max.**	**Min.**	**Std. Dev.**
int_{it}	8.350	54.730	1.250	7.255
int_{it-1}	8.557	59.000	1.250	8.127
$\pi_{it} - \pi_{it}^*$	0.591	37.124	-6.266	3.481
$y_{it} - y_{it}^*$	5.613	4.905	-7.743	1.347
Δner_{it}	-2.890	65.654	-30.974	11.698
$empi_{it}$	-20.113	55.223	-150.772	25.038
$ffer_{it}$	2.954	5.340	0.940	1.620
2010Q1-2019Q4				
Variables	**Mean**	**Max.**	**Min.**	**Std. Dev.**
int_{it}	4.260	22.500	0.050	3.344
int_{it-1}	4.266	22.500	0.050	3.337
$\pi_{it} - \pi_{it}^*$	0.387	17.430	-3.662	2.325
$y_{it} - y_{it}^*$	1.041	11.617	-8.407	1.596
Δner_{it}	4.161	60.398	-25.863	11.667
$empi_{it}$	-1.935	87.205	-90.097	21.177
$ffer_{it}$	0.604	2.430	0.040	0.798

Source: Author's estimations

4 The smoothing parameter (λ) is set to 1600.

The mean and standard deviation values help compare the pre-and post-crisis periods. In particular, the striking decrease in the mean interest rate after the GFC reflects the abundance of global liquidity. Following the crisis, the mean and standard deviation of the inflation gap declined. On the other hand, the increasing standard deviation shows that output stability slightly decreased. The EMPI means indicate that the appreciation pressures in the foreign exchange markets also decreased considerably in the post-crisis period. Furthermore, the mean nominal exchange rate suggests that appreciation pressure on domestic currencies before the GFC was replaced by depreciation pressure after it. This is not surprising for EMEs exposed to the taper tantrum, which led to capital outflows after May 2013.

5. Empirical results and discussion

Before proceeding with the AMG estimation, the CD and slope homogeneity among the series were examined. Table 2 presents the results of the CD and slope homogeneity tests.

Table 2 Cross-sectional dependence and slope homogeneity test results

2002Q1-2007Q4			
	LM_{adj}	$\tilde{\Delta}$	$\tilde{\Delta}_{adj}$
Model 1	87.688***	1.801**	2.013**
Model 2	17.389***	2.719***	3.119***
Model 3	14.835***	2.384***	2.734***
Model 4	74.381***	4.141***	4.750***
2010Q1-2019Q4			
	LM_{adj}	$\tilde{\Delta}$	$\tilde{\Delta}_{adj}$
Model 1	29.850***	8.667***	9.249***
Model 2	10.735***	7.520***	8.139***
Model 3	15.766***	8.315***	8.999***
Model 4	38.660***	8.927***	9.662***

Note: *, **, and *** show significance at 10%, 5%, and 1%, respectively.

Source: Author's estimations.

The LM_{adj} test statistics for the pre-crisis period show that the probability values of all models are less than 1%. Therefore, the null hypothesis of no cross-sectional dependence between the countries is strongly rejected. Similarly, the LM_{adj} test statistics for the post-crisis period strongly indicate cross-section dependence between the countries for all models. Thus, in both periods, a shock in one country impacted other countries. Moreover, the $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ test results reject the null hypothesis that the slope coefficients are homogenous for both periods and all models. That is, there is country-specific heterogeneity across countries in both periods.

The AMG estimator uses the Wald χ^2 test statistic as a post-estimation test for investigating the validity of the augmented Taylor rule models (Tachie et al., 2020). The Wald χ^2 test statistics with probability values in Table 3 indicate that all models are statistically significant.

Table 3 Panel AMG test results

2002Q1-2007Q4				
	Model 1	**Model 2**	**Model 3**	**Model 4**
int_{it-1}	0.653 (0.000)	0.707 (0.000)	0.649 (0.000)	0.409 (0.000)
$\pi_{it} - \pi_{it}^{*}$	0.220 (0.016)	0.224 (0.024)	0.205 (0.009)	0.366 (0.000)
$y_{it} - y_{it}^{*}$	0.156 (0.057)	0.122 (0.080)	0.153 (0.020)	0.183 (0.117)
Δner_{it}		-0.001(0.937)		
$empi_{it}$			0.001 (0.876)	
$ffer_{it}$				-0.180 (0.110)
α_i	3.474 (0.000)	2.420 (0.000)	3.335 (0.000)	4.561 (0.000)
Wald χ^2	56.27 (0.000)	86.78 (0.000)	138.33 (0.000)	114.16 (0.000)
2010Q1-2019Q4				
	Model 1	**Model 2**	**Model 3**	**Model 4**
int_{it-1}	0.821 (0.000)	0.857 (0.000)	0.851 (0.000)	0.747 (0.000)
$\pi_{it} - \pi_{it}^{*}$	0.206 (0.005)	0.159 (0.012)	0.155 (0.016)	0.211 (0.000)
$y_{it} - y_{it}^{*}$	0.070 (0.032)	0.044 (0.157)	0.054 (0.070)	0.053 (0.160)
Δner_{it}		0.014 (0.015)		
$empi_{it}$			0.008 (0.013)	
$ffer_{it}$				0.333 (0.076)
α_i	0.290 (0.060)	0.597 (0.000)	0.681 (0.000)	0.634 (0.002)
Wald χ^2	886.35 (0.000)	984.97 (0.000)	1406.93(0.000)	573.25 (0.000)

Note: Probability values are given in parentheses. The common dynamic process imposed with the unit coefficient in the AMG estimation.

Source: Author's estimations

The coefficients indicate that the EMEs' policy responses largely followed the standard Taylor rule for both periods. Inflation and the output gap had a positive impact on the policy rate, although the latter was insignificant for some models. The positive coefficients show that central banks increase policy rates when inflation and/or the output rise above the target and potential, respectively. On the other hand, responses to financial variables differed across the two periods as EMEs only reacted to financial variables after the GFC. More specifically, the exchange rate, the EMPI, and the Fed funds effective rate all significantly determined the policy rate after the GFC. The AMG estimator also provides country-specific estimation results. Tables 4 and 5 present the country-specific findings for each period.

Table 4 Country-specific AMG test results: 2002Q1-2007Q4

	int_{it-1}	$\pi_{it} - \pi_{it}^{*}$	$y_{it} - y_{it}^{*}$	Δner_{it}	$empi_{it}$	$ffer_{it}$
Brazil	0.939***	0.004	0.628**			
	1.004***	-0.154	0.426	0.045*		
	0.658**	0.124	0.368		0.018*	
	0.941***	0.122	0.770***			-0.107
Chile	0.758***	0.442**	0.289			
	1.096***	0.340***	0.309***	-0.084***		
	0.988***	0.390***	0.255*		-0.068***	
	0.095***	0.253***	-0.148			0.329***
Colombia	1.079***	0.122	-0.000			
	0.533*	0.571*	-0.017	-0.046*		
	0.648**	0.329	-0.000		-0.020	
	0.865***	0.480	0.101			0.035
Czech Rep.	-0.115	0.416***	-0.508			
	0.296***	0.279***	-0.022	0.026**		
	0.358***	0.193***	-0.059		0.014***	
	-0.734	0.372***	-0.066			-0.410***
Hungary	0.576***	0.370**	0.633**			
	0.603***	0.290*	0.613	-0.007		
	0.636***	0.322*	0.665*		-0.003	
	0.088	0.727***	1.127***			-1.102***
Korea	0.567	-0.629**	-0.121			
	0.571	-0.609***	-0.079	0.016		
	0.324	-0.449*	-0.100		0.020	
	0.370	0.406	-0.046			0.040
Mexico	0.601***	0.119	0.158			
	0.416**	0.605	0.260	-0.122**		
	0.624***	-0.082	0.229		0.013	
	0.463**	0.560	0.106			-0.054
Philippines	0.959***	0.393***	0.217			
	1.209***	0.296***	0.106	0.001		
	1.107***	0.347***	0.184		0.001	
	0.267	0.261***	0.283**			-0.155
Poland	0.535***	0.387***	0.027			
	0.605***	0.404***	-0.055	0.059***		
	0.516***	0.404***	0.045		0.031***	
	0.539***	0.387***	0.302			-0.472***
South Africa	0.240***	0.257***	-0.327**			
	0.500***	0.161***	-0.222	0.021***		
	0.391***	0.151***	-0.044		0.008**	
	0.181	0.281***	-0.362			-0.529***
Thailand	0.902***	0.613***	0.117			
	0.862***	0.512***	-0.027	-0.024		
	0.726***	0.598***	-0.030		-0.019	
	0.304	0.465***	0.143			0.106
Turkey	0.801***	0.151**	0.301*			
	0.786***	-0.007	0.171	0.098***		
	0.809***	0.131*	0.332*		0.018	
	0.872***	0.073	0.265*			0.152

Note: *, **, and *** show significance at 10%, 5%, and 1%, respectively. The common dynamic process imposed with the unit coefficient in the AMG estimation.

Source: Author's estimations

The standard Taylor rule estimations for the pre-crisis period show that the impact of the inflation gap was significant and positive in 8 out of 12 EMEs, whereas the output gap significantly affected the policy rate in only a few countries. The augmented Taylor rules indicate that five countries responded significantly and positively to the nominal exchange rate, as did four countries to the EMPI. The Fed funds effective rate was a significant factor for 5 out of 12 EMEs, while it had a negative impact on policy rates in 4 out of these 5 countries.

Table 5 Country-specific AMG test results: 2010Q1-2019Q4

	int_{it-1}	$\pi_{it} - \pi_{it}^{*}$	$y_{it} - y_{it}^{*}$	Δner_{it}	$empi_{it}$	$ffer_{it}$
Brazil	0.827***	0.593***	0.392***			
	0.807***	0.636***	0.345***	0.002		
	0.797***	0.637***	0.337***		0.000	
	0.810***	0.535***	0.348***			0.160
Chile	0.910***	-0.088	0.083*			
	0.909***	0.074	0.085**	-0.008		
	0.900***	0.026	0.089**		-0.001	
	0.817***	-0.121***	0.129***			-0.055
Colombia	0.686***	0.257***	0.014			
	0.662***	0.300***	0.020	0.006		
	0.678***	0.290***	0.022		0.004	
	0.729***	0.235***	0.035			0.171***
Czech Rep.	0.824***	0.127**	0.041			
	0.828***	0.053	0.036	0.005		
	0.837***	0.045	0.025		-0.000	
	0.754***	0.112**	0.035			0.429***
Hungary	0.959***	0.086**	0.090*			
	0.953***	0.030	0.057	0.017***		
	0.936***	0.078*	0.116**		0.009***	
	0.741***	0.289***	0.137***			-0.201
Korea	1.082***	0.091**	0.159***			
	1.079***	-0.014	0.131**	0.014*		
	1.031***	-0.037	0.120*		0.006	
	1.041***	0.097**	0.144**			0.287***
Mexico	0.932***	0.211***	0.040			
	0.938***	0.261***	-0.058	0.033***		
	0.913***	0.232***	0.007		0.017***	
	0.963***	0.205***	0.045			0.267
Philippines	0.624***	0.079**	0.012			
	0.754***	-0.003	-0.12	0.008		
	0.751***	0.007	-0.019		0.006**	
	0.639***	0.119***	0.027			0.228***
Poland	0.921***	0.105***	0.011			
	0.933***	0.026	0.014	0.005		
	0.906***	0.034	-0.005		0.003	
	0.522***	0.321***	-0.064**			-0.172**

	int_{it-1}	$\pi_{it} - \pi_{it}^{*}$	$y_{it} - y_{it}^{*}$	Δner_{it}	$empi_{it}$	$ffer_{it}$
South Africa	0.920***	0.086*	-0.003			
	0.976***	0.041	-0.025	0.015***		
	1.008***	0.038	-0.012		0.012***	
	0.923***	0.085*	-0.002			0.329***
Thailand	0.795***	0.102***	0.007			
	0.970***	-0.003	-0.001	0.004		
	0.985***	-0.022	0.005		-0.000	
	0.767***	0.094***	0.006			0.258***
Turkey	0.374***	0.821***	-0.010			
	0.469***	0.511***	-0.057	0.074***		
	0.468***	0.539***	-0.037		0.038***	
	0.259**	0.561***	-0.199			2.303**

Note: *, **, and *** show significance at 10%, 5%, and 1%, respectively. The common dynamic process imposed with the unit coefficient in the AMG estimation.

Source: Author's estimations

There is no dramatic change in the standard Taylor rule estimations for the post-crisis period. The output gap was an insignificant variable in most countries, as before the GFC, whereas the inflation gap had a significant and positive impact in all countries except Chile. The nominal exchange rate and the EMPI had significant positive effects in 5 out of 12 EMEs. Contrary to the pre-crisis period, the Fed funds effective rate had a significant positive impact in 7 out of 12 EMEs.

Taking the panel and country-specific findings together provides some important insights. The positive impact of inflation in both periods is largely confirmed by Aizenman et al. (2011), Paranavithana et al. (2020), and Cabral et al. (2020). However, the weight of inflation in policy rate decisions slightly decreased compared to the pre-crisis period. The positive coefficients of the nominal exchange rate and the EMPI indicate that EME central banks tried to reduce depreciation pressures on their domestic currency by increasing the policy rate. Furthermore, a statistically significant contribution of the exchange rate is confirmed by Mohanty and Klau (2004), Aizenman et al. (2011), Feldkircher et al. (2016), Fouejieu (2017), Turkay (2017), Caporale et al. (2018), Fabris and Lazić (2022), and Elsayed et al. (2023). Consistent with the findings of Turkay (2017), Gülşen and Özmen (2020), Poirson et al. (2020), Arimurti and Morley (2020), and Yildirim (2022), EMEs' policy rate setting was affected by external financial conditions. The coefficient of the Fed funds effective rate had the greatest impact among the financial variables and was significant for many countries in the post-crisis period.

The country-specific results show considerable heterogeneity across the EMEs. Each country responded to different financial variables, while some central banks did not react to financial variables during specific periods. Furthermore, some EMEs were already considered financial variables in their interest rate settings before the GFC. These heterogeneous results reflect each country's unique characteristics. Many factors affect policy rate decisions, including trade and capital openness, financial development and integration, the degree of liability dollarization, and exchange rate pass-through. For instance, where exchange rate pass-through is high, EMEs may focus more on exchange rate stability, whereas financially more integrated countries may produce a greater response to global financial conditions (Turkay et al., 2017; Arregui et al., 2018).

6. Conclusion

This paper analyzed the monetary policy responses of emerging market inflation targeters to the nominal exchange rate, the EMPI, and the U.S. federal funds effective rate for two periods around the GFC: 2002Q1-2007Q4 and 2010Q1-2019Q4. The findings indicate that inflation has been important for monetary policy in emerging market inflation targeters for both periods. However, the weight of

inflation in policy rate decisions slightly decreased after the crisis due to the increasing influence of financial variables.

The panel AMG results show that EMEs only reacted to financial variables after the GFC, although the country-specific results indicate that not all EMEs aligned with the benign neglect view before the GFC. There is also considerable heterogeneity across countries depending on their idiosyncratic characteristics. However, the evidence is clear that EMEs have focused more on financial stability in their interest rate settings since the crisis.

The Fed funds effective rate had the greatest positive impact among financial variables and was significant for many countries in the post-crisis period. The effect of external financial conditions on policy rate settings confirms the dilemma (Rey, 2013) and reflects that EMEs have tried to follow a more accommodative monetary policies.

These findings should be interpreted cautiously. Considering the country-specific results for the pre-crisis period, EMEs increased the weighting of financial stability in their post-GFC monetary policies rather than switching sharply from a reactive to a proactive stance. Moreover, there are some limitations to the study. The variables considered in the analysis represent financial stability to some extent. Since the employing method is linear, the sample was divided into two periods to analyze the impact of the GFC. Therefore, future studies that examine the effects of different financial variables on monetary policy responses with nonlinear methods are needed.

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JEL: L26, A20, J13
Original scientific article
https://doi.org/10.51680/ev.36.2.4

Received: November 7, 2022
Revision received: February 11, 2023
Accepted for publishing: April 14, 2023

PERCEIVED OBSTACLES TO THE EARLY-STAGE ENTREPRENEURIAL ACTIVITY OF YOUTH

Abstract

Purpose: The fundamental driving force of entrepreneurship is the individual with their ambitions and entrepreneurial spirit, but also with their obstacles that prevent them from following an entrepreneurial path. These obstacles can be of a personal nature, but also factors of the immediate living environment, the prevailing cultural values, the general attitude of society towards entrepreneurship, etc. The purpose of this paper is to discuss the known barriers to early-stage youth entrepreneurship compared to the total population based on the Global Entrepreneurship Monitor (GEM) data for the 34 countries studied.

Methodology: The methodology includes frequency distribution, descriptive statistics and linear regression analysis. Data from GEM 2016-2020 on early-stage entrepreneurial activity, perceived skills, and fear of failure were used.

Results: We showed that there are differences in perceived entrepreneurial skills between youth and the total population, namely that youth perceive lower levels of entrepreneurial knowledge, experience, and skills. We confirmed that perceived entrepreneurial skills have a positive, statistically significant impact on total early-stage entrepreneurial activity, which is true for both the total population and youth. The test of the influence of fear of failure on total early-stage entrepreneurial activity for a sample of the total population and youth indicates a negative influence, but it is not statistically significant.

Conclusion: From the study, recommendations emerge for policymakers regarding entrepreneurship education as a key intervention to help youth acquire and develop relevant entrepreneurial skills that are thus beneficial for the youth to better overcome obstacles in the business environment as well as in various life situations.

Keywords: Early-stage entrepreneurial activity, self-employment, youth, perceived entrepreneurial knowledge, fear of failure

1. Introduction

Entrepreneurship is the most powerful driver of economic growth and development that has a very large impact on overall social development. It is a complex system of interdependence of economic, social and cultural connections (Spigel, 2017). It is neither nationally self-sufficient nor limited to individual states. Therefore, it should also be researched and recognized as such, and those factors that could hinder or encourage it should be extracted. Since entrepreneurship is international and globally interdependent, it is important to research and learn about it in cooperation and comparison with other countries (Rebernik et al., 2021, p. 15). In general, youth remained one of the most vulnerable groups on the labor market (Kluve, 2014) since this age group is largely subjected to precarious forms of employment, such as employment in the form of reduced working hours, part-time and student employment, employment through self-employment contracts, etc., as noted in the *Resolution on the National Youth Program 2013–2022* (Lavrič & Deželan, 2021). This issue led us to investigate the entrepreneurial activities of youth. It is important to note that, according to Eurostat, youth is defined as individuals between the ages of 15 and 24. Other sources define youth differently, such as the Global Entrepreneurship Monitor, which conducts surveys of those 18-64 years old and consequently defines youth differently. The Global Entrepreneurship Monitor defines youth as the age group from 18 to 30 years old (OECD & European Union, 2017). Since the data used in the research were from the GEM database, the age group from 18 to 30 years old was considered youth.

The world depends on youth is a statement we are very fond of using. At the same time, we are perhaps too little aware that without a suitable environment, youth will also be unable to develop their diverse potential and meet the challenges of the future. Youth can significantly influence the development of economies through their own participation. The education system as well as cultural and social norms contribute to the development of an entrepreneurial mindset (Hopp & Ute, 2012). This can easily lead to entrepreneurial engagement, which we examine in our study.

In the paper, we discuss and present the basic starting points of youth entrepreneurial activity. Since entrepreneurship is one of the possible exits from the labor market, we present the levels of self-employment and early-stage entrepreneurial activities of youth according to Eurostat data and the Global Entrepreneurship Monitor (GEM) survey. The fact is that traditional jobs are becoming increasingly rare, so it is necessary to understand youth entrepreneurship (including self-employment) as an additional way to boost employment and create new jobs. Many studies (Kim et al., 2020; Tubadji et al., 2021) emphasize the positive effects of promoting youth entrepreneurship. They point out that youth are particularly responsive to new economic opportunities and trends. There are many challenges that youth face when they decide to pursue an entrepreneurial career. Research on entrepreneurship also shows that youth around the world cite lack of appropriate skills as the most common barrier to entrepreneurship, i.e., lack of entrepreneurial education through formal and informal education systems (Schøtt et al., 2015; Green, 2013). They also point to the lack of mentoring, business culture, and appropriate support structures, as well as difficult access to financial resources. In general, lack of entrepreneurial knowledge is one of the most frequently cited barriers to successful entrepreneurial participation, and this barrier is even more intensely expressed among youth, as they have less experience in the labor market than older people.

The next inhibiting factor to entrepreneurial participation that youth frequently mention is the fear of failure. The latter is largely related to the risk they take in becoming self-employed compared to a perceived safer work environment or employment in an established firm. In this paper, we therefore examine the relationship between early-stage entrepreneurial activity among youth and two fundamental barriers to entrepreneurial engagement, namely perceived entrepreneurial knowledge, experience, and skills, and fear of failure.

In what follows, we first present the theoretical starting points for the variables under consideration, and based on previous research, we propose research hypotheses, which we test in the third section using selected statistical methods, and present the conclusions of our findings. We conclude the paper with a description of government policies aimed at promoting youth entrepreneurship and point out the main assumptions and limitations referring to the topic under study.

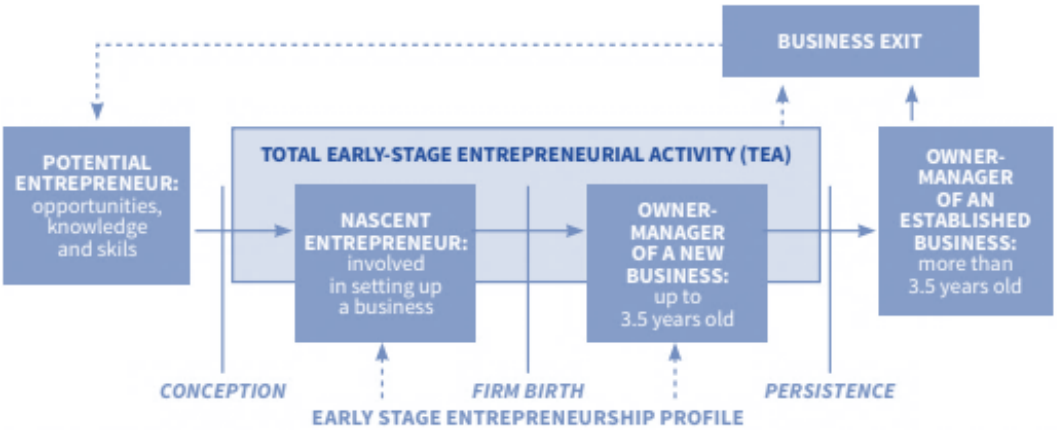
2. Theoretical starting points and research hypotheses

2.1 Youth self-employment and their early-stage entrepreneurial activity

Young people's entrepreneurial activity is expressed in their entrepreneurial participation and interest in self-employment. Although youth interest in self-employment has increased in the EU over the past decade, the share of self-employed youth remains relatively low. In 2020, there were about 2 million self-employed youth (20-29 years old) in the EU. This represented 7% of working youth (ages 20-29), half of the total share of working people (ages 15-64) who were self-employed (14%) (OECD & European Commission, 2021, p. 130). The highest rate of self-employed youth was found in Greece (12.8%), followed by Italy (12.1%), and the lowest rate was recorded in Germany (2.7%). At the same time, it should be noted that there are significant differences in the motivation of young entrepreneurs who decide to follow an independent entrepreneurial path. High youth unemployment leads to entrepreneurial engagement motivated by the need or desire to survive. Those who choose a self-employment path and were not previously unemployed are mostly motivated by a desire for greater independence, but also by the opportunity to become their own boss (OECD & European Union, 2019).

In what follows, early entrepreneurial activity among youth is presented using data from the Global Entrepreneurship Monitor (GEM), the world's largest longitudinal study of entrepreneurship. Starting from the perception of an entrepreneurial opportunity, the entrepreneurial process goes through several successive stages initiated by potential entrepreneurs, then by nascent entrepreneurs, and finally by new entrepreneurs. Nascent and new entrepreneurs together constitute total early-stage entrepreneurial activity (Bosma et al., 2020; Rebernik et al., 2021), one of the fundamental measures of GEM research that will be analyzed in our paper. To understand the entrepreneurial process, we present it in Figure 1.

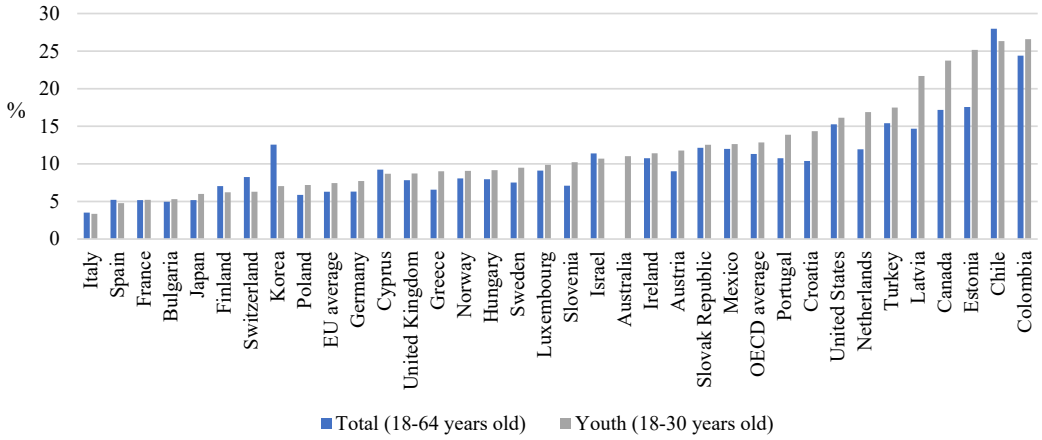
Figure 1 Entrepreneurial process



Source: Rebernik et al., 2021, p. 20

In what follows, we will look at the comparison between European countries and OECD countries. In 2016-2020, the level of early-stage entrepreneurial activity among youth differed eightfold between EU and OECD countries (Figure 2). The percentage of youth involved in starting a business varied from about 3.3% in Italy to 26.6% in Colombia. These differences can be explained by many factors, including societal attitudes toward entrepreneurship and risk, the power of enterprise policy, market dynamics, the relative size of the public sector, an economic structure, and others (OECD & European Commission, 2021, p. 140). A comparison of the share of early-stage entrepreneurial activity among youth compared to the total population also shows significant differences across countries. In Slovenia, youth were, on average, more entrepreneurially active (10.2%) than the adult population (7.1%), while in Korea their share lagged far behind the adult population average (7% vs. 12.6%).

Figure 2 Early-stage entrepreneurial activity of the total population and youth

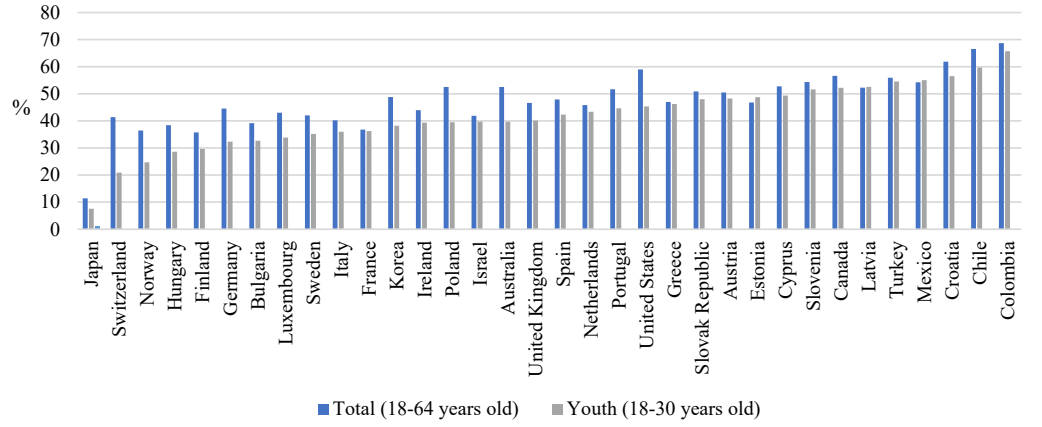


Source: Adapted from GEM (2021), Special Tables for OECD Adult Surveys Global Entrepreneurship Monitor (GEM) for the years 2016 to 2020

2.2 Perceived knowledge, experience and skills for entrepreneurship

According to the data from the *Mladina 2020* survey, youth in Slovenia report that they have the knowledge to start and run their own business based on their previous education. As many as 31.0% of youth fully agree with this statement. In 2010, the figure was still at 27.0%. The data on self-perception of their ability to identify business opportunities also show that youth are equipped with knowledge and skills necessary for entrepreneurial activity. No less than 50.9% of youth agree with the statement that they have enough knowledge to identify a good business opportunity (Lavrič & Deželan, 2021). Figure 3 also shows that youth in Slovenia are certain about their own entrepreneurial knowledge and skills, as Slovenia ranks third among the European countries studied.

Figure 3 Perceived entrepreneurial knowledge, experience and skills of the total population and youth



Source: Adapted from GEM (2021), Special Tables for OECD Adult Surveys Global Entrepreneurship Monitor (GEM) for the years 2016 to 2020

According to the GEM survey data, a comparison of perceived entrepreneurial knowledge, experience and skills shows that there are significant differences between countries. For example, in some countries, youth are significantly more confident about their entrepreneurial skills; on the other hand, the comparison shows that youth are less likely than adults to report entrepreneurial skills. Differences in perceptions of one's knowledge and skills can be explained by societal attitudes toward entrepreneurship and work, as well as by the value that national policies place on entrepreneurship education and the degree to which entrepreneurship education is integrated into the formal education system (Rebernik et al., 2020). An important trend in intergroup research explains the generation theory. The generation theory (Mannheim, 1969) refers to historical changes in generations of young people and how today's youth differ from those who grew up in earlier times. Considering this, the older generation grew up when experience, especially experience of working in a business, was seen as the way to acquire entrepreneurial skills. In contrast, today's younger generation tends to grow up seeing training and education as ways to develop entrepreneurial skills. Education and training are seen as a pathway to entrepreneurship. As a result, today's budding entrepreneurs are often younger than previous generations (Schøtt et al., 2015). Entrepreneurship, however, shows a long-term positive relationship with age, but there is also a point at which the relationship inverts into an inverted U-curve (Blanchflower, 2004; Caliendo et al., 2014; Tubadji et al., 2021).

There are many studies that confirm that students who participate in entrepreneurial training/education have higher levels of entrepreneurial capacity and motivation to start a business than untrained individuals (Rasheed & Rasheed, 2003). Entrepreneurial training and entrepreneurial behaviours can have a significant impact on entrepreneurial traits and engagement in entrepreneurship, implying that policy makers should allocate more resources in the field of entrepreneurial education (Rudawska & Kowalik, 2019, Campo et al., 2021; Olugbola, 2017).

In what follows, we analyzed the relationships between early-stage entrepreneurial activity and perceived entrepreneurial skills at the global level. In doing so, we are interested in the differences between the studied groups of the total population and youth. Consistent with the above, we test the following two hypotheses:

H1: Perceived entrepreneurial skills have a positive, statistically significant impact on total early-stage entrepreneurial activity.

H2: Perceived entrepreneurial skills of youth have a positive, statistically significant impact on early-stage entrepreneurial activity of youth.

2.3 Fear of failure

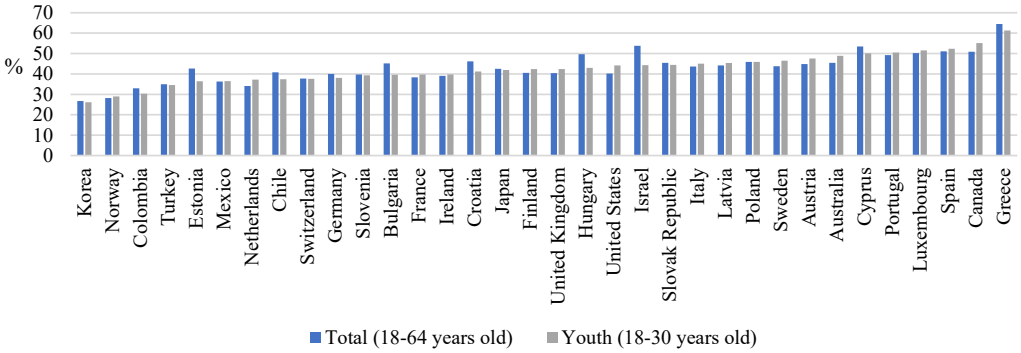
Research shows that intention to engage in entrepreneurship is strongly negatively related to perceived fear of failure (Vodă et al., 2020), and results also show that fear of failure is, on average, lower in environments and cultures with a family tradition of entrepreneurship and with a developed business network. In the environments where the fear of failure is strong, the perception and exploitation of business opportunities can be easily affected.

Using GEM data, Wennberg et al. (2013) found that the negative effect of fear of failure on entrepreneurial entry is moderated by the cultural practices of institutional collectivism and uncertainty avoidance. Tubadji et al. (2021) also found that country-specific differences in perceptions have the greatest impact on entrepreneurial propensity. They examined the sensitivity of young people's fear of failure to local culture in Germany and Greece and found that young people aged 15-24 years are less entrepreneurial in both Greece and Germany. According to Cacciotti et al. (2014), fear of failure not only represents an experience resulting from environmental influences, but also defines fear of failure as risk aversion considered as a personal trait (Hessels et al., 2011; Arenius & Minniti, 2005; Nefzi, 2018). Using a sample of students, Nefzi (2018) confirmed that trait fear is significantly related to a higher entrepreneurial risk perception and that this relationship is mediated by cognitive appraisal dimensions, particularly the theme of certainty. We acknowledge that fear of failure is an integral part of the entrepreneurial experience (Cacciotti et al., 2020), but its influence in the early stages of entrepreneurial activity may be more important than when it exists as an integral part of entrepreneurial practice.

Approximately four in ten youth (18-30 years old) in the EU in 2016-2020 reported that fear of failure was a barrier to starting a business. In general, fear of failure is the most frequently cited barrier to successful business creation, but in the EU, young peo-

ple were slightly less likely than the general average to report this barrier (39% vs. 44%). Interestingly, Slovenia had the lowest percentage of youth citing this obstacle among EU countries (39.3%), as shown in Figure 4.

Figure 4 Fear of failure in the total population and among youth



Source: Adapted from GEM (2021), Special Tables for OECD Adult Surveys Global Entrepreneurship Monitor (GEM) for the years 2016 to 2020

In addition, we analyze the relationships between early-stage entrepreneurial activity and the fear of failure at the global level. We are interested in the difference between the studied groups of the total population and youth. Consistent with the above, we test the following two hypotheses:

H3: Fear of failure has a statistically significant negative impact on total early-stage entrepreneurial activity.

H4: Fear of failure among youth has a statistically significant negative impact on the early-stage entrepreneurial activity of youth.

3. Methodology and data

This study is based on secondary data analysis, meaning that we based our findings on data analyses that are publicly available and collected by credible research institutions. We extracted data on youth self-employment from EUROSTAT databases. The central theme - early-stage entrepreneurial activity among youth - is based on data from the GEM survey.

We conducted a macroeconomic analysis of self-employment and entrepreneurial activity among youth and the total population. Research in this area is dynamic, as we study youth entrepreneurship over time, or how it changes over time. We used frequencies and descriptive methods where we described theories and concepts, as well as compilations where we summarized the viewpoints of other authors and combined their findings into a whole. Based on this whole picture, we formed our own positions. We also applied the comparative method of work, in which we compared the phenomena under study (self-employment, entrepreneurial activity, etc.). This was followed by an analysis and synthesis of the relationships between the theoretical starting points of the phenomena and the empirical results.

To test the hypotheses, we used the following variables:

Dependent variables:

- *TEA index* - indicates the number of persons per 100 adult inhabitants, aged 18 to 64, who are personally involved in the creation of new ventures, but are employed as owners/managers of new enterprises, which are not older than 42 months.
- *TEA index of youth* - indicates the number of persons per 100 adult inhabitants, aged 18 to 30, who are personally involved in the creation of new ventures, but are employed as owners/managers of new enterprises, which are not older than 42 months.

Independent variables:

- *Perceived entrepreneurial skills* - refers to the share of the adult population ages 18-64 who believe that they have knowledge, experience and skills for entrepreneurship.
- *Perceived entrepreneurial skills of youth* - refers to the share of youth ages 18-30 who think they have knowledge, experience and abilities for entrepreneurship.
- *Fear of failure* - refers to the share of the adult population ages 18-64 who believe that fear of failure would deter them from entrepreneurship.
- *Fear of failure in youth* - refers to the share of youth ages 18-30 who say that fear of failure would deter them from entrepreneurship.

Hypotheses H1, H2, H3, and H4 were tested using regression analysis to estimate the relationship between the dependent variable and the independent variable (Janssens et al., 2008), that is, the extent to which the independent variables can explain or predict the dependent variable and the contribution of the independent variables to explaining variations in the dependent variable. IBM SPSS Statistics 28.0 software was used for the analysis. The regression model in stochastic form used to test the hypotheses is as follows:

$$y = \beta_0 + \beta_n x_n + e ,$$

where: y – dependent variable; β_0, β_n – value of regression coefficients; n=1, 2, 3; x_n – independent variable; n=1, 2, 3; e – residual.

For data processing, we also used the software tool Excel, which enabled us to prepare clear visual representations of some key findings.

4. Analysis results

Table 1 shows the descriptive statistics of the variables studied. The results show that, on average, youth has higher levels of entrepreneurial activity than the total population, perceived fear of failure is almost the same, while perceived entrepreneurial skills are significantly lower.

Table 1 Descriptive statistics

Statistics	TEA index	TEA index of youth	Fear of failure	Fear of failure in youth	Perceived entrepreneurial skills	Perceived entrepreneurial skills of youth
N	34	34	34	34	34	34
Mean	10.2	11.9	43.0	42.5	47.6	41.7
Standard error	0.9	1.1	1.3	1.3	1.8	2.0
Standard deviation	5.6	6.4	7.5	7.4	10.4	11.8
Kurtosis	2.5	0.3	1.2	0.6	3.5	1.0
Skewness	1.3	1.1	0.3	0.1	-0.9	-0.6
Minimum	0.0	3.3	26.7	26.2	11.4	7.6
Maximum	28.0	26.6	64.5	61.3	68.7	65.7

Source: Authors

According to Table 1, interestingly, the average TEA index of youth is higher than the average TEA index, while the average perceived entrepreneurial skills of youth are lower compared to average perceived entrepreneurial skills. This relationship may be due to the enthusiasm of youth, and willingness or desire to start a business or take on entrepreneurial opportunities. The rapid pace of technological change has also created new entrepreneurial opportunities that are particularly attractive to young people, who are often more technically savvy than older generations. This may also reflect the growing global entrepreneurial culture, where entrepreneurship is increasingly seen as a positive, viable and achievable career choice (Schøtt et al., 2015; OECD & European Union, 2020). Despite this higher level of early-stage entrepreneurial activity, perceived entrepreneurial skills of youth are lower

compared to the average perceived entrepreneurial skills of the population. The difference in perceived entrepreneurial skills between youth and the total population may be due to different perspectives and life experiences, with older individuals having more experience and knowledge of the realities of entrepreneurship. Young entrepreneurs often mention lack of experience, education or training in entrepreneurial skills as barriers to a successful entrepreneurial mindset (OECD & European Union, 2020). They typically have less work experience than their older counterparts, which may lead to a lower perception of skills, or they may perceive themselves as less mature and less capable than older entrepreneurs. In addition, young entrepreneurs often have fewer resources, such as funding, support and a small professional network, which can limit their ability to demonstrate their capabilities.

We tested *hypothesis H1* with model I. The results of the regression model related to *the influence of perceived skills on the index TEA* show a positive and statistically significant influence, which we assumed in hypothesis H1. The regression coefficient (β_1 = 0.336) of the perceived skill variable is positive and statistically significant (p = 0.000; p < 0.05). The correlation coefficient between the dependent variable (TEA index) and the independent variable (perceived skills) is 0.613, indicating a medium-strong correlation. Moreover, the coefficient of determination (R^2 = 0.376) states that 37.6% of the variance of the TEA index is explained by the perceived skills variable, included in this model. Moreover, the F-statistic of the model (F = 20.446; p = 0.000; p < 0.05) states that the model is valid. We can easily *accept* hypothesis H1. The results of the test are also shown graphically in Figure 5.

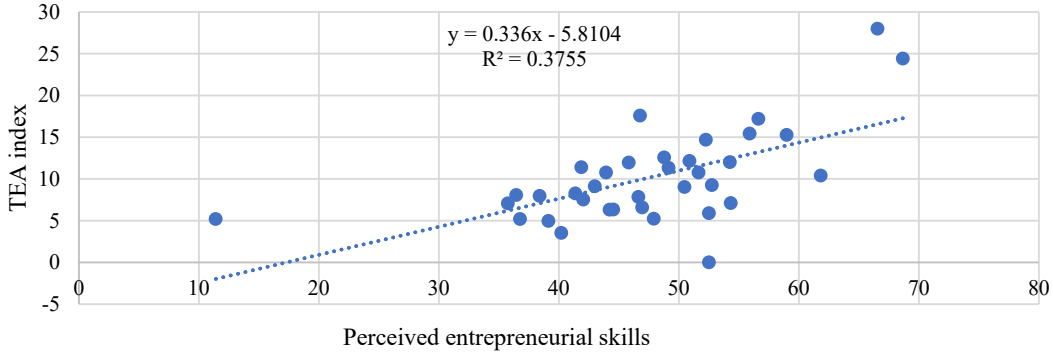
Table 2 Regression model I - impact of perceived skills on the TEA index

Model I	B	Std. error	Beta	t	Sig.
(Constant)	-5.810	3.609		-1.610	0.117
Perceived skills	0.336	0.074	0.613	4.522	0.000
R	0.613				
R square	0.376				
Std. error of the estimate	4.445				
F-test (Sig.)	20.446*				

Dependent variable: TEA index
*Note: statistically significant at p = 0.000

Source: Authors

Figure 5 Impact of perceived skills on the TEA index



Source: Authors

We tested *hypothesis H2* with model II. The presented results of the regression model related to the *influence of perceived skills of youth on the TEA index of youth* are positive and statistically significant (Figure 6). In particular, the regression coefficient (β_1 = 0.384) of the perceived skills of youth variable is positive and statistically significant (p = 0.000; p < 0.05). The correlation coefficient between the dependent variable (*TEA index of youth*) and the independent variable (*perceived skills of youth*) is 0.703, indicating a medium-strong correlation. The coefficient of determination (R^2 = 0.494) states that 49.4% of the variance of the TEA index of youth is explained by the perceived skills of youth variable included in this model. As for the F-statistic of the model, the value of the F-test is high (F = 33.217), which also means that most of the variance of the dependent variable is explained by the regression equation, and the significance of the F-factor is 0, which means that the model is valid as a whole. We can easily *confirm* hypothesis H2, which assumes that perceived entrepreneurial skills of youth have a positive, statistically significant impact on youth early-stage entrepreneurial activity.

Table 3 Regression model II - influence of perceived skills of youth on the TEA index of youth

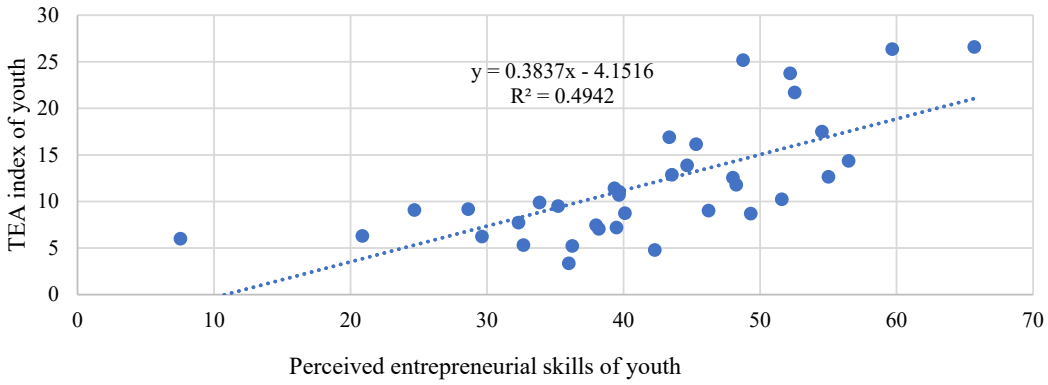
Model II	B	Std. error	Beta	t	Sig.
(Constant)	-4.152	2.878		-1.444	0.158
Perceived skills of youth	0.384	0.067	0.703	5.763	0.000
R	0.703				
R square	0.494				
Std. error of the estimate	4.522				
F-test (Sig.)	33.217*				

Dependent variable: TEA index

*Note: statistically significant at p = 0.000

Source: Authors

Figure 6 Influence of perceived skills of youth on the TEA index of youth



Source: Authors

We tested *hypothesis H3* using regression model III, in which we tested the *influence of perceived fear of failure on the index TEA*. The results show that *perceived fear of failure has a negative influence on the TEA index*. The regression coefficient (β_1 = -0.179) is negative and too small to be statistically significant (p = 0.163; p > 0.05). The correlation coefficient between the dependent variable (*TEA index*) and

the independent variable *(fear of failure)* is 0.238, indicating a weak correlation. The coefficient of determination (R^2 = 0.056) states that only 5.6% of the variance of the TEA index (dependent variable) is explained by the fear of failure variable included in the model. Furthermore, the F-statistic of the model (F = 2.034; p = 0.163) states that the model as a whole is neither statistically significant nor valid. So we *reject* hypothesis H3. The direction of influence is as hypothesized, but it is not statistically significant. The results of the test are also shown graphically in Figure 7.

Table 4 Regression model III - influence of perceived fear of failure on the TEA index

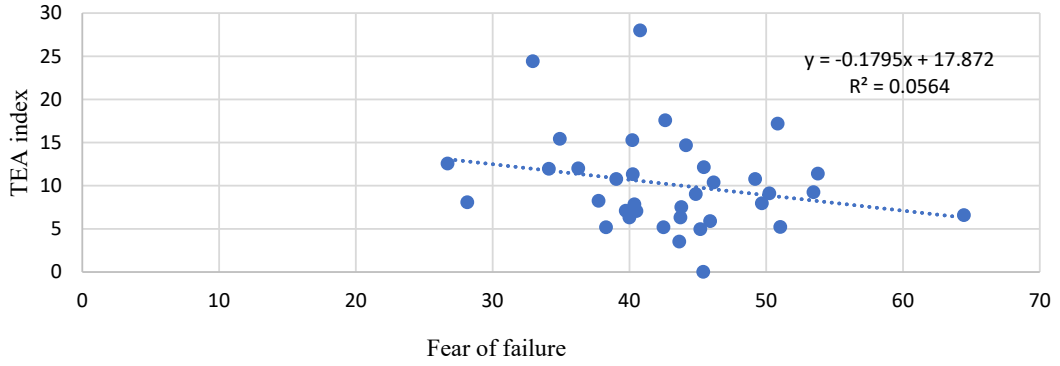
Model III	B	Std. error	Beta	t	Sig.
(Constant)	17.872	5.485		3.260	0.003
Perceived fear of failure	-0.179	0.126	-0.230	-1.426	0.163
R	0.238				
R square	0.056				
Std. error of the estimate	5.464				
F-test (Sig.)	2.034*				

Dependent variable: TEA index

*Note: statistically not significant at p = 0.163

Source: Authors

Figure 7 Influence of perceived fear of failure on the TEA index



Source: Authors

We tested *hypothesis H4* with regression model IV. The results show that the regression coefficient for the fear of failure in youth variable (β_1 = -0.116) is negative and not statistically significant (p = 0.440; p > 0.05). The correlation coefficient (R) between the dependent variable (TEA index of youth) and the independent variable (fear of failure in youth) is 0.133, indicating a weak correlation between the observed variables. The coefficient of determination (R^2 = 0.018) states that only 1.8% of the variance of the TEA index of youth is explained by the independent variable (fear of failure in youth) included in the observed model. In addition, the F-statistic for the regression model is 0.612, which also indicates that only a small portion of the variance of the dependent variable is explained by the regression equation. The F-statistic of the model also states that the proposed model is not valid, so we *reject* hypothesis H4. The direction of influence is as hypothesized, but it is not statistically significant. The results are also illustrated graphically in Figure 8.

Table 5 Regression model IV - influence of perceived fear of failure in youth on the TEA index of youth

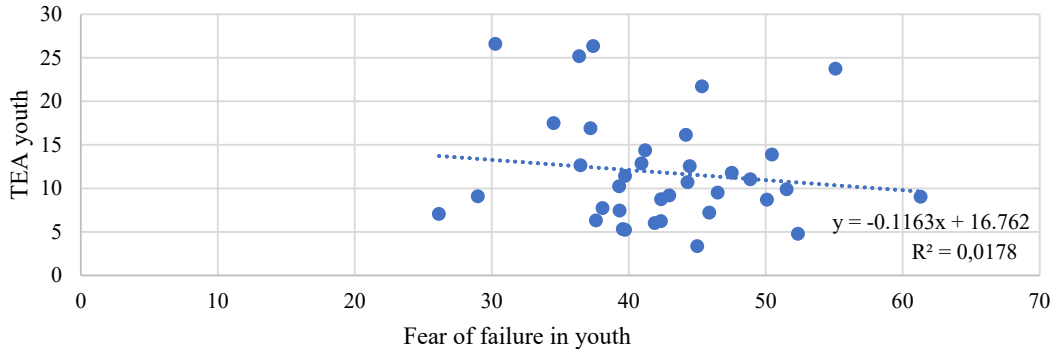
Model I	B	Std. error	Beta	t	Sig.
(Constant)	16.742	6.366		2.635	0.013
Perceived fear of failure	-0.116	0.148	-0.133	-0.786	0.440
R	0.133				
R square	0.018				
Std. error of the estimate	6.302				
F-test (Sig.)	0.612*				

Dependent variable: TEA index of youth

*Note: statistically not significant; p = 0.440

Source: Authors

Figure 8 Influence of fear of failure in youth on the TEA index of youth



Source: Authors

5. Discussion of the results

In the paper, we introduced the level of self-employment of youth in Slovenia and in the EU. We found that despite the fact that youth's interest in self-employment has increased in the EU over the last decade, the percentage of self-employed youth remains relatively low (in Slovenia, it is 5.5%; the EU average is 6.6%). The presentation of early-stage entrepreneurial activity of youth for the period 2016-2020 showed that Slovenia ranks 18th among the 34 countries studied. Therefore, the influence of the two most common barriers to entrepreneurship, namely perceived entrepreneurial knowledge, experience and skills, and fear of failure was examined. Interestingly, youth in Slovenia indicate that their previous education has provided them with knowledge that enables them to start and run their own business. As many as 31% of youth strongly agree with this statement. In 2010, the figure was 27%. According to the GEM survey data, Slovenia ranks third among the 21 European countries surveyed in terms of the indicator of perception of one's own knowledge and skills for entrepreneurship. Encouraging is also the fact that fear of failure, which is considered one of the strongest inhibiting factors for entrepreneurial activity, is relatively low. In Europe, a lower indicator was measured only in Germany, the Netherlands and Estonia.

The results show differences in perceived entrepreneurial skills between youth and the total population, with youth perceiving lower levels of entrepreneurial skills. In addition, we confirmed hypotheses H1 and H2, in which we found that perceived entrepreneurial skills have a positive, statistically significant influence on total early-stage entrepreneurial activity, which is true for both the total population and youth. Regarding the descriptive statistics, it is evident that youth are more likely be entrepreneurs

than the total population, but they have lower levels of entrepreneurial skills. The regression analysis results make a special contribution to this study. For model II, regression, correlation and determination coefficients are higher than for model I, suggesting that entrepreneurial skills required by youth (who typically have less work experience) have a stronger impact on entrepreneurial activity than the population as a whole. As entrepreneurial skills play a significant role in entrepreneurial activity of youth, they show great potential for future generations. This is why entrepreneurship education is a key measure that helps youth acquire and develop relevant skills. Entrepreneurial skills such as opportunity recognition, innovation, critical thinking, resilience, decision-making, teamwork and leadership are therefore beneficial for all youth to better overcome obstacles in the business environment as well as in different life situations.

In addition, the data also show that there are perceived differences in fear of failure between youth and the total population. We could not confirm hypotheses H3 and H4, which tested the impact of fear of failure on total early-stage entrepreneurial activity. We obtained a negative direction of the effect, but not statistically significant characteristics for the effect to be significant. Although fear of failure has often been cited in relation to previous findings on barriers to youth entrepreneurial activity, the data suggest almost the same level of fear in the total population. In this case, young people show even lower levels of fear of failure compared to the total population. The results also suggest that the current market situation makes entrepreneurship more accessible. Many young people today want to be their own bosses and have the freedom to work on projects they are passionate about. Entrepreneurship offers them side jobs, alternative options or the chance to create something of their own and be in control of their career. In addition, technology has made it easier and more cost-effective to set up and run a business, making entrepreneurship more attractive to young people.

6. Policy implications

According to the results, to encourage and support youth entrepreneurship, a wide range of policy instruments are used in the OECD/EU member states, including entrepreneurship education and teaching, various financial instruments and the development of entrepreneurial networks, which have been strengthened through substantial investments by national and regional governments, often with the support of the European Union. The findings of *The Missing Entrepreneur* study (OECD & European Commission, 2021) show that the quality of youth entrepreneurship policies varies widely across regions and countries, so there is still little knowledge sharing about "what works". In light of the severe consequences of the COVID-19 pandemic, governments have renewed their commitment to supporting youth, including increased attention to youth entrepreneurship policies. Evaluation findings show that youth entrepreneurship programs may play a role as part of government policy responses to growing youth unemployment during the economic crisis (Kajzer, 2020). However, it is less clear where governments should focus their efforts. Recent research shows that financial support typically has a greater impact on business sustainability, but evaluations show that young entrepreneurs often value training, coaching and mentorship more. In order to increase entrepreneurial skills for boosting entrepreneurial potential among youth, the government's priority measures should therefore:

— provide young entrepreneurs with mentorship, networking opportunities, and tailored entrepreneurship education and training, connecting them with experienced business owners and investors who can offer guidance and support. For example, in Slovenia, training and coaching for youth are offered by the SPIRIT Slovenia national agency, which gives training and support for teachers and professors as well, provides incentives to schools to carry out activities with youth, and encourages the development of young people's ideas with the support of mentors and funds in cooperation with support institutions at the national, regional and local level (Crnogaj, 2020). Such programs strengthen self-confidence in one's own abilities, broaden perspectives and knowledge about entrepreneurship, and could also encourage youth to see failure as an opportunity for growth and learning rather than a setback, emphasizing the value of taking risks and trying new things. In addition, governments should work on incorporating a national strategy addressing entrepreneurship education, which would incorporate entrepreneurship education into

school curricula, starting from an early age, to give young people the skills and knowledge they need to start and run successful businesses. In addition, digital support (integrating digital literacy into national curricula) will benefit youth in acquiring digital skills and help them to start and grow businesses, including in digital markets;

— promote youth entrepreneurship, as it is very close to youth preferences in the world of work, if the pitfalls of job security and the tendency to be "forced into self-employment" are properly addressed, which only leads to further insecurity among youth (Lavrič & Deželan, 2021). Providing an enabling environment and appropriate entrepreneurship support policies and programs would help actualize the intentions and lower the fear of failure in youth; and

— improve the attractiveness of support initiatives by better-considering youth perspectives when designing initiatives (OECD & European Commission, 2021). Governments can invest in infrastructure development, such as building incubators, accelerators, and co-working spaces, which provide youth with the resources and facilities they need to start and grow their businesses.

7. Limitations and future research directions

Since the field of study of youth entrepreneurship is extensive, we set certain limitations to our research. The first limitation was that we compared data for Slovenia and other countries studied based on panel data for the period 2016-2020. Between 2016 and 2020, all EU member states participated in the GEM survey, with the exception of Belgium, the Czech Republic, Denmark, Lithuania, Malta and Romania. However, the following countries did not participate in the survey every year (participation years indicated): Austria (2016, 2018, 2020), Bulgaria (2016-18), Estonia (2016-17), Finland (2016), France (2016-18), Hungary (2016), Ireland (2016-19), Latvia (2016-17, 2019-20), and Portugal (2016, 2019). The following OECD countries did not participate in the GEM survey between 2016 and 2020: Belgium, the Czech Republic, Denmark, Iceland, Lithuania, and New Zealand. The following countries did not participate in the survey every year (years of participation indicated): Australia (2016-17, 2019), Austria (2016, 2018, 2020), Estonia (2016-17), Finland (2016), France (2016-18), Hungary (2016), Ireland (2016-19), Japan (2017-19), Latvia (2016-17, 2018-19), Mexico (2016-17, 2019), Norway (2019-20), Portugal (2016, 2019), and Turkey (2016, 2018) (OECD & European Commission, 2021). In addition, youth entrepreneurship refers to youth of different age groups. In international studies, the term "youth" refers to people aged 15-24 years, but in the GEM survey, they are defined as the age group between 18 and 30.

In addition, the results suggest some possible directions for future research that could provide a more comprehensive understanding of the impact of perceived entrepreneurial skills and fear of failure on youth entrepreneurial activity. The study found that perceived skills have a positive impact on the TEA index of youth, but lacks an examination of the underlying mechanisms (indirect effects) that would explain this relationship. Future studies could explore the specific factors (including a wider range of independent variables) that contribute to the development of perceived skills and their impact on youth entrepreneurial intentions and activities. The same applies to factors that influence fear of failure. In addition, the relative prevalence of motivation for entrepreneurial activity would provide useful insights into the quality of early-stage entrepreneurial activity, i.e., whether youth early-stage entrepreneurial activity was driven by necessity or opportunity motives. The GEM has shown that enterprises founded by opportunity-driven entrepreneurs are much more likely to survive and employ people than firms founded by necessity-driven entrepreneurs (Schøtt et al., 2015).

Moreover, additional factors influencing the TEA index could be explored. The study only examined the impact of perceived skills and fear of failure (two common barriers for youth) on the TEA index. Future research could examine the impact of other factors such as personality traits, access to resources, social networks, educational level, and perceived risks on the TEA index of young people.

This study focuses on youth in the EU, with a particular focus on Slovenia. Future research could investigate the relationship between perceived skills and fear of failure and the TEA index in other segments, for example, young people in high, middle, or lower-income countries or in different cultural contexts.

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JEL: A19, C45, G20
Original scientific article
https://doi.org/10.51680/ev.36.2.5

Received: November 11, 2022
Revision received: March 19, 2023
Accepted for publishing: June 5, 2023

SMARTPHONE ACTIVITIES IN PREDICTING TENDENCY TOWARDS ONLINE FINANCIAL SERVICES

Abstract

Purpose: Considering the rapid progress of information and communication technology (ICT) and its influence on daily life, it is inevitable that its impact will also be visible in the financial sector, especially through efforts to present digital financial services as widely as possible and bring them closer to potential users. Therefore, the aim of this study is to investigate university students' smartphone activities, their use and attitudes towards digital financial services, and to build a neural network model capable of distinguishing students according to their awareness of the benefits related to using online financial services.

Methodology: An online questionnaire was applied to collect data on students' smartphone activity and their tendency to use online financial services. Depending on the variable type, the Kruskal-Wallis H test and Kendall's tau-b were used to assess the association between variables, while multilayer perceptron and radial basis function neural networks were used for the creation of the optimal model.

Results: Participants in this study achieved an average score of 6.56 (SD = 1.27) for smartphone activity, and the results showed that the optimal neural network model obtained had an overall accuracy of 70.73%. However, smartphone activity did not have an excessive effect on the efficiency of this model.

Conclusion: The obtained neural network model and its sensitivity analysis managed to reveal some hidden patterns which could be beneficial to educators in terms of improvements of students' digital and financial literacy as well as to the financial sector in terms of increasing performance and interest of this population in digital financial services.

Keywords: Smartphone activities, online financial services, neural networks, online payments

1. Introduction

Life to which we were accustomed has changed rapidly as a result of the COVID-19 pandemic and subsequent regulations and recommendations issued to prevent its further spread. As daily life has changed, so have common customer behavior and payment options (Liébana-Cabanillas et al., 2020, Hashem, 2020, Mišić, 2021, Toh & Tran, 2020), with online (European Central Bank, 2022) and mobile payments (m-payments) showing growth globally and with an even greater increase expected in 2024 (De Best & Calio, 2022). Nevertheless, the technology, infrastructure, and thus the security and complexity of using each payment method remained unchanged, and users of digital payments are still exposed to adverse effects, which remain one of the main concerns of users (Al-Qudah et al., 2020) and a reason for hesitation in their adoption.

Following a literature review and the identified research gap in the analysis of behavioral tendencies of the younger population in transition countries, the authors investigated the relationship between students' smartphone activities and their tendency to use digital financial services. In addition, a neural network model will try to recognise participants based on their awareness of the benefits of digital financial services based on their demographic characteristics (input variables).

The theoretical background for this research design includes several key concepts and theories. Firstly, the research design is based on the premise that smartphones have become ubiquitous in people's daily lives and have had a significant impact on various aspects of life, including financial activities. This is supported by research that has shown the increasing use of smartphones for financial transactions and services, particularly among younger and more educated populations (Fan et al., 2018; Khan et al., 2019; Lee & Lee, 2000; Rugimbana, 2007; Sun et al., 2017). Secondly, the research design relies on an expanded version of the Technology Acceptance Model (TAM) (Davis, 1989), with integrated security variables as suggested in recent research (Liébana-Cabanillas et al., 2018a; Fan et al., 2018). Thirdly, the research design utilizes the neural network model as an unconventional method for exploring the relationship between smartphone use and the use of digital financial services. This approach is based on the concept of machine learning, which involves training algorithms to learn from data and make predictions or decisions based on that learning. The use of neural networks in this research design allows the exploration of complex patterns and relationships that may not be readily apparent through traditional statistical analysis.

In customer behavior research, data mining, decision trees, and artificial neural networks are increasingly used due to large amounts of data that need to be processed to draw valid and useful conclusions. For example, Khan et al. (2010) used decision trees, logistic regression, and neural networks to identify the customers who are at high risk of churn. Mak et al. (2011) developed a financial data mining model to extract information about customer buying behavior and the impact on financial industry marketing. Neural networks are used to evaluate the influence of selected predictors on m-payment behavior. Rabaa'i et al. (2022) used neural networks to identify the most important factors influencing user adoption of m-payments, and identified attractiveness, trust, perceived ease of use, and security as most influential. Neural network models were used in predicting financial industry customer behavioral patterns, where the authors trained the model to detect abnormal customer transaction activities (Ogwueleka et al., 2012).

There are other studies examining the impact of demographic characteristics on mobile payment adoption. For instance, Yen and Wu (2016) developed a model to test gender differences and investigate how gender moderates the relationships between variables in the proposed model. They extended the Technology Acceptance Model (TAM) by adding new variables to predict the adoption of the use of mobile financial services. Their findings suggest that users of mobile financial services should not be treated as a homogeneous group, and that new surveys should adopt a more dynamic cross-environment perspective. Kanungo (2022) studied digital financial awareness among different age groups in Indian rural areas and found differences in terms of demographic characteristics such as age and living conditions. Sultana and Bousrih (2020) examined the relationship between student use of digital banking, penetration, and awareness with demographic variables among the student population. They found a relationship between digital banking penetration and benefit awareness, as well as an association between demographic variables such as age, gender, and education, and digital banking penetration. Sulaiman et al. (2007) em-

ployed Rogers' diffusion of innovation model to analyze consumer behavior and motivation for mobile banking. The study revealed that demographic and personal characteristics of mobile banking users are critical factors that affect their adoption decisions. The theoretical foundation for this study can also be found in behavior theory and Fogg's (1997) persuasive technologies theory.

Among the few recently developed scales to determine smartphone use (Harris et al., 2020), the smartphone usage subscale from the Media and Technology Usage and Attitudes Scale (Rosen et al., 2013) was used to determine the activity level of smartphone use. The Media and Technology Usage and Attitudes Scale (MTUAS) consists of 11 usage subscales in which a person self-assesses his or her frequency of use on a 10-point frequency scale, and four attitude-based subscales (15 items) in which the person indicates his or her agreement with the statement on a 5-point scale (ranging from strongly agree to strongly disagree). The authors suggested its use as a whole set of items (a 60-item scale) or as one or more subscale items (Rosen et al., 2013). The authors reported Cronbach's α as a measure of internal consistency, ranging from 0.60 to 0.97 for all MTUAS subscales. This scale, i.e., the smartphone use subscale, was selected because of the large number of participants (942 participants) who participated in the research to develop the MTUAS, its strong reported reliability, and the numerous studies that have used this scale to determine technology use.

Since this study examines the younger population's openness to the use of digital financial services, the general demographic questions used to profile respondents and the MTUAS smartphone subscale were expanded to include a series of questions about online financial services (financial services respondents have previously used or conducted online and statements about using online financial services). The questions related to digital financial services were based on previous research conducted by e.g. Shin et al. (2014), Statista (2019), Institutul Român pentru Evaluare și Strategie (2020), and Eurostat (2021). Prior surveys have investigated factors such as perceived usability, ease of use, and security risks, which are all important elements of the expanded version of the TAM model (according to Patil et al., 2019; Liébana-Cabanillas et al., 2018a; Fan et al., 2018).

Overall, the convergence of information and communication technology and finance serves as the theoretical foundation for this research design, with an emphasis on understanding the factors that influence young, educated people's adoption and use of digital financial services. The results of the survey and their analysis will fill the gap of an insufficient number of geographically distributed studies, especially in transition and developing countries, as well as for the financial industry in designing their promotion and sales activities in this market.

The paper consists of 5 sections. The next section presents a literature review of the Technology Acceptance Model (TAM) and the Unified Theories of Acceptance and Use of Technology (UTAUT and UTAUT2), which are most commonly used in empirical studies of consumer behavior in choosing mobile and other digital payment methods. The third section describes the materials and methods. It is followed by the section that presents the research results, while the last section provides a discussion and final conclusions.

2. Literature review

The Technology Acceptance Model (TAM) and the Unified Theories of Acceptance and Use of Technology (UTAUT and UTAUT2) are most commonly used in empirical studies of consumer behaviour in choosing mobile and other digital payment methods (Al-Okaily et al., 2020; Chopdar et al., 2018; Fan et al., 2018; Liébana-Cabanillas et al., 2018a; Patil et al., 2019; Tounekti et al., 2020; Ziwei et al., 2019). Using the UTAUT method, Venkatesh at al. (2003) present factors that influence information technology (IT) intention and usage, as follows: performance and effort expectancy, facilitating conditions, and social influence, whereas hedonic motivation, value for money, and habit were introduced later by UTAUT2 (Chang, 2012; Huang & Kao, 2015). The TAM, on the other hand, introduces the variables of perceived usefulness and perceived ease of use, which Davis (1989) considers as fundamental factors for user acceptance.

Patil et al. (2019) stated that the classical methods (UTAUT, UTAUT2, and TAM) have shortcomings in researching user behavior in choosing digital payment methods because these models were created to analyze the acceptance of novel technologies and do not consider security issues as impor-

tant factors in the research area of acceptance of digital payment methods. The security issues are emphasized by Shin et al. (2014) as an important factor influencing the frequency of smartphone payments. To address this issue, some authors (Liébana-Cabanillas et al., 2018a; Fan et al., 2018) integrated trust and perceived risk into traditional models, making the classical methods more suitable for this research area.

In recent years, other methods have been used to research the acceptance of digital payment methods. In studying users' intention to use digital payment models, Loh et al. (2020) used the push-pull-mooring factors model. The model introduces monetary value/price (a push factor), alternative attractiveness (a pull factor), and trust and perceived security and privacy (mooring factors). The authors found that all factors are positively related to the intention to use m-payment, while traditional payment habits and inertia have a negative relationship (Loh et al., 2020).

By using status quo bias theory and coping theory, Gong et al. (2020) found that inertia is an obstacle to the wider use of m-payment services. Fan et al. (2021) used push-pull factors to investigate customers to transfer from the Internet to m-payment in China. They found that "push factors (perceived switching costs and personal innovativeness) and pull factors (relative advantages of substituting information technology and critical mass) are affecting customer switching intention" (Fan et al., 2021, p. 155). If m-payment offers significant benefits to users and is highly innovative, users tend to accept and use it, but if this transfer to new technologies involves high switching costs, customers are reluctant to choose this option. Therefore, additional financial benefits in the initial phase may help to attract new users (Fan et al., 2021). These results are somewhat similar to those of Patil et al. (2019), who analyzed the influence of attitude, cost, mobility, affordability, and innovativeness on using m-payments, and found that all of them, except cost, were significant, with user attitude and innovativeness having the strongest positive influence (Patil et al., 2019).

Liébana-Cabanillas et al. (2018b) claim that perceived usefulness and security (as subjective norms) influence predicting factors of m-payment adoption. The results confirm the findings of Tounekti et al. (2020) and agree to some extent with the findings of Sun et al. (2017), who presented perceived security and perceived ease of use as the most important factors for most respondents. Comparable conclusions were also drawn by Al-Qudah et al. (2022), who studied the acceptance of m-payments during the COVID-19 pandemic in the UAE.

The categories related to the psychological dimension, as a social image, and the perceived usefulness influence the intention to use m-payments, while the categories related to perceived risk (including uncertainty and risk related to digital payment instruments and even online purchases) are negatively related (Liébana-Cabanillas et al., 2018a). Fear of COVID-19 virus transmission through currency exchange and physical contact has contributed to greater acceptance of digital payment methods, with perceived value, possibly including the convenience of 24/7 use, and perceptions of benefit and risk being the variables that most strongly influence intentions to use different forms of digital payments. Risk was found to have a strong negative impact, as even a small amount of risk significantly reduces the likelihood of using a digital payment. The higher the risk, the lower the probability that new digital payment instruments will be adopted (Liébana-Cabanillas et al., 2020).

Some studies point to the influence of cultural differences among users (Chopdar et al., 2018; Fan et al., 2018; Liébana-Cabanillas et al., 2020; Singla & Sardana, 2020/2021). Chopdar et al. (2018) found that the expressions of perceived risk were significant only for the countries with the highest Computer-Based Media Support Index (CMSI) value (India) compared to the countries with the lowest CMSI value (U.S.), suggesting that culture has a strong influence on the acceptance of m-shopping (Chopdar et al., 2018) and consequently m-payments.

When analyzing geographic distribution, only few countries are mainly represented, led by China and the U.S. Studies looking at other countries, particularly developing and emerging economies, are significantly less represented (Liébana-Cabanillas et al., 2020). China is dominant in m-payments as 25% of the population used a smartphone for at least one transaction (De Best, 2022), with trust, risk, perceived ease of use and perceived usefulness being important factors affecting m-payments adoption (Chin et al., 2020). There are also differences between China and the U.S., e.g., the effects of m-payment and perceived security on trust were significantly higher in China than in

the U.S. (Fan et al., 2018; Wiese & Humbani, 2019). In a study conducted in the eastern province of China using structural equation modeling and the artificial neural networks approach, Khan et al. (2019) found that the Big 5 personality traits have an impact on m-payment acceptance, with conscientiousness and agreeableness being the most important factors for m-payment acceptance, while neuroticism is a negative but insignificant factor (Khan et al., 2019).

Statista's (2019) study surveyed 1,012 individuals in the U.S. who use the Internet to examine their satisfaction with traditional and direct banking institutions, familiarity with FinTech and InsurTech services, and preferences and inclinations towards mobile payment. Eurostat's (2021) survey examines ICT usage in households and individuals aged 16 to 74 years old in the EU, focusing on perceived obstacles to making internet purchases and consumers' attitudes towards online shopping. The survey found that in Croatia, only 3.10% of respondents mentioned lacking skills as a reason for not purchasing online, while 5.82% had privacy concerns. Institutul Român pentru Evaluare și Strategie's (2020) research investigated the relationship between customers and banks in Romania during the COVID-19 pandemic, with 78% of respondents stating that they did not typically use mobile financial services and did not plan to do so in the future. The main reasons for not using mobile banking services were insufficient knowledge, age, and not needing or wanting to use the services. Singla and Sardana (2020/2021) found that convenience and perceived ease of use are the main motivations for using m-payments in India. Moorthy et al. (2019) found that neither social influence nor effort expectancy was important for working adults' intention to use m-payments in Malaysia, but effort expectancy, facilitating conditions, hedonistic motivation, and perceived security were positively and significantly related (ibid., 2019). In the acceptance of a new m-payment system in Jordan by public sector employees, social influence had the strongest influence, followed by performance expectancy, affordability, security, and privacy (Al-Okaily et al., 2020). In the survey conducted in 52 countries, Tounekti et al. (2020) found that perceived security and perceived ease of use were most important for the users. At the same time, the 18-45 age group is most concerned about the security of their digital payments.

To conclude, perceived ease of use and perceived usefulness are commonly studied categories related to the adoption of digital payment methods, followed by security and trust, and social influence (Al-Okaily et al., 2020; Fan et al., 2018; Khan et al., 2017; Liébana-Cabanillas et al., 2018a; Loh et al., 2020; Moorthy et al. 2019; Singla & Sardana, 2020/2021; Sun et al., 2017; Tounekti et al., 2020; Ziwei et al., 2019). The relationship between demographic characteristics and intensity of digital payments use was also explored, concluding that young and better educated consumers are more open to digital technologies and payment methods (Fan et al., 2018; Khan et al., 2019; Lee & Lee, 2000; Rugimbana, 2007; Sun et al., 2017). Despite the abundance of research on consumer behavior in relation to the adoption of digital payments, the geographic distribution of such studies remains limited. This is an important limitation given the notable variation in mobile payment usage rates across regions and countries (Bestvina Bukvić, 2021; Shin et al., 2014). While there are a few studies that focus on large economies (Patil et al., 2019; Fan et al., 2018; Khan et al., 2017), there is a lack of research on the adoption of digital payments in other regions. Therefore, further research was found to be needed to provide a more comprehensive understanding of the factors that influence digital payment adoption in different geographic locations. In addition, most studies just focus on user adoption of different payment methods (Humbani & Wiese, 2019; Patil et al., 2019), but few, relatively geographically narrowed, focus on awareness of the benefits of digital financial services, user attitudes towards digital financial services and demographic influence in relation to users' smartphone activities.

Based on previous research and existing gaps in the field, the authors aimed to investigate the relationship between smartphone activities and other variables, and develop a neural network model capable of distinguishing students according to their awareness of the benefits of using online financial services. The results are presented in the following sections.

3. Methodology

Responses were collected via an online questionnaire from 409 students at the Faculty of Education and the Faculty of Economics, University of Osijek, about their smartphone activity and tendency to use

online financial services, along with demographic data (see Table 1). The data were collected in the academic year 2021/2022. Data analysis and neural network modeling were performed using Statistica software. Regarding the profile of the participants, most of them were female (86.31%), between the ages 18 and 21 (47.67%), more than a third (37.41%) of them were enrolled in the second year of study, 59.66% attended the Faculty of Economics, and less than a fifth of them lived in their own apartment or house (19.80%).

Table 1 Structure of used data collection

Subgroup	Variables
General	Demographic variables (5 variables)
Smartphone activity	Smartphone usage subscale
Online financial services	Financial services provided online (10 variables), Statements about use of online financial services (7 variables)

Source: Authors

To determine the activity level of smartphone use, the smartphone usage subscale from the Media and Technology Usage and Attitudes Scale (Rosen et al., 2013) was used. This subscale consists of 9 statements in which participants indicate their smartphone activity on a scale from 1 (never) to 10 (all the time). Corresponding points are assigned to each participant's response to each statement, and the sum of the points corresponds to each participant's smartphone activity. The reported reliability for this subscale was 0.93.

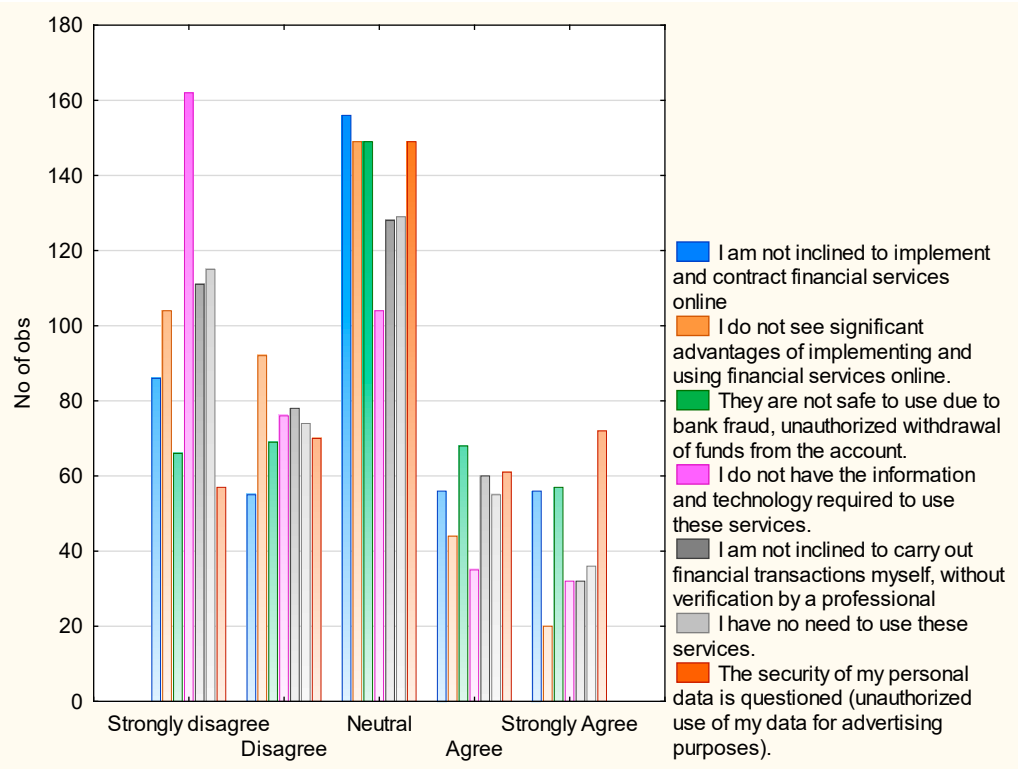
The authors created 10 variables to ask participants about their use or access to online financial services available on the market and 7 variables to gather information about participants' attitudes towards the use of online financial services. The variables were developed based on previous research by Shin et al. (2014), Statista (2019), Institutul Român pentru Evaluare și Strategie (2020), and Eurostat (2021).

4. Results

The results show that the mean smartphone activity of the entire group of participants is 6.56 (SD = 1.27), which is slightly higher than the mean reported by Rosen et al. (2013). At the 5% level of significance, the Kruskal-Wallis H test did not show a statistically significant difference in smartphone usage and demographic variables: gender ($\chi^2(1) = 1.48$, $p = .22$), faculty $\chi^2(1) = .85$, $p = .36$), age ($\chi^2(3) = 4.45$, $p = .22$), study year ($\chi^2(4) = 2.74$, $p = .60$), and accommodation ($\chi^2(4) = 3.48$, $p = .48$).

Regarding the online financial services statements, more than three eighths (38.14%) of participants neither agree nor disagree with the statement *I am not inclined to implement and contract financial services online.*, 36.43% remain neutral about the statement concerning the benefits of adopting and using online financial services, and the same percentage of participants neither agree nor disagree that it is unsafe to use them, 39.61% strongly disagree with the statement *I do not have the information and technology required to use these services.,* less than a third of them (31.30%) neither agree nor disagree that they are not inclined to carry out financial transactions and contract financial services on their own, 31.54% neither agree nor disagree that they do not have the need to use these services, and more than one third (36.43%) neither agree nor disagree that the security of their personal data is called into question (see Figure 1).

Figure 1 Agreement with the online financial services statements



Source: Authors

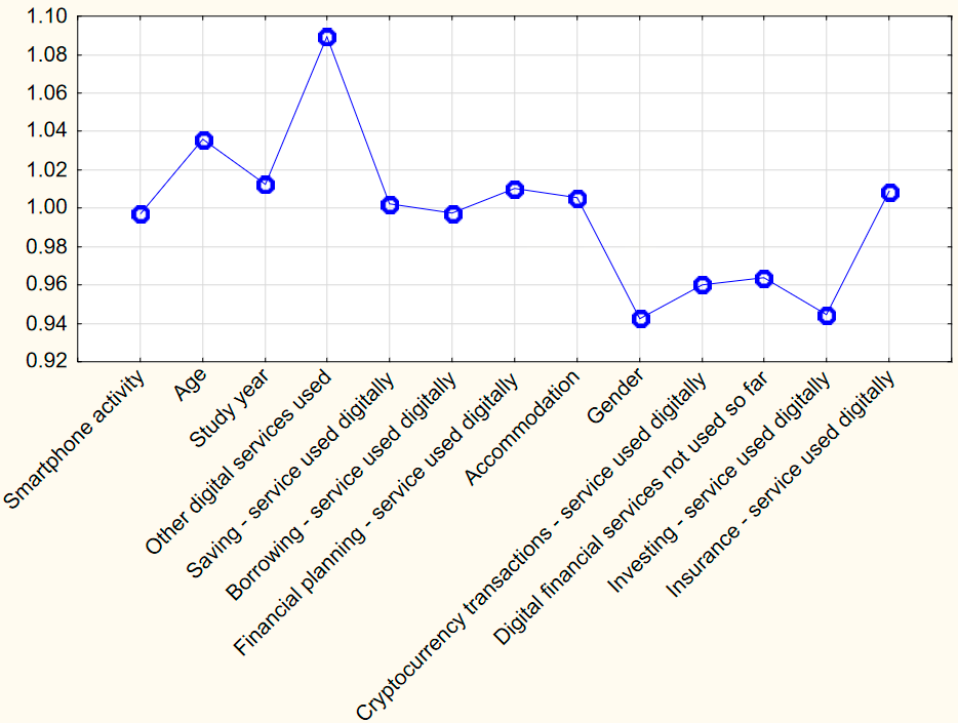
At a significance level of 0.05, Kendall's tau-b was used to assess the association between smartphone activity and statements regarding the use of online financial services, and it revealed that there are no statistically significant associations (*I am not inclined to implement and contract financial services online.* (τ_b = -.06, p > .05), *I do not see significant advantages of implementing and using financial services online.* (τ_b = -.02, p >.05), *They are not safe to use due to bank fraud, unauthorized withdrawal of funds from the account.* (τ_b = -.06, p >.05), *I do not have the information and technology required to use these services.* (τ_b = -.01, p >.05), *I am not inclined to carry out financial transactions myself, without verification by a professional.* (τ_b = -.01, p >.05), *I have no need to use these services.* (τ_b = -.01, p >.05), and *The security of my personal data is questioned (unauthorized use of my data for advertising purposes).* (τ_b = -.07, p >.05)).

To create an optimal neural network model, participants were divided into two categories depending on their opinion on the statement *I do not see significant advantages of implementing and using financial services online.* The category of students who are aware of the benefits of online financial services, which was labeled 0, consisted of students who strongly disagree or disagree with this statement (47.92%), and the rest of the participants were categorized as those who are not aware of the benefits of online financial services (52.08%). This variable was chosen as the output variable for neural networks and the total sample was divided into a training (70%), testing (20%), and validation (10%) sample.

The generalization ability of neural networks models was checked on the validation sample. Before the beginning of the process of neural network modeling, variables suited for the modeling process were selected, and the χ^2 test was used for the purpose of establishing if there is a relationship between the output variable and other collected variables. The χ^2 test revealed that at the level of significance of

5% there is a statistically significant association between the output variable and the following variables: the faculty that the respondents attend ($\chi^2(1) = 4.13$, p = .042), money transfer and online bill payments as services they have used so far ($\chi^2(1) = 9.32$, p = .002), and online shopping as a service they have used so far ($\chi^2(1) = 4.42$, p =.035), and statements: *I am not inclined to implement and contract financial services online.,* ($\chi^2(4) = 52.98$, p = .000), *They are not safe to use due to bank fraud, unauthorized withdrawal of funds from the account.,* ($\chi^2(4) = 75.74$, p = .000), *I do not have the information and technology required to use these services.,* ($\chi^2(4) = 69.68$, p = .000), *I am not inclined to carry out financial transactions myself, without verification by a professional.,* ($\chi^2(4) = 62.55$, p = .000), *I have no need to use these services.,* ($\chi^2(4) = 82.90$, p = .000), and *The security of my personal data is questioned (unauthorized use of my data for advertising purposes).,* ($\chi^2(4) = 45.02$, p = .000), so these variables were excluded from neural network design. A total of 13 input variables were used for modeling. To create a suitable neural network model, 600 neural network models with modified architecture were trained, tested and validated. A change in neural network architecture included changing the neural network type (multilayer perceptron (MLP) or radial basis function (RBF)), the number of hidden units, the training algorithm, the error function, the activation function for MLP neural networks, and the weight decay in the output and hidden layers. The best model was the MLP neural network with 13 input variables, 12 neurons in the hidden layer, 2 outputs, the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm as the training algorithm, entropy as the error function, the hyperbolic tangent function as the hidden activation, and Softmax as the output activation. This model had an overall classification of 70.73% and was able to detect 76.19% of participants who were not aware and 65% of participants who were aware of advantages of online financial services. As can be seen in Figure 2, the input variable *Other digital services used* had the greatest impact on model performance, while the variable *Gender* had the least impact.

Figure 2 Sensitivity analysis of input variables used by the best MLP model



Source: Authors

5. Discussion and conclusion

In today's digital world, a smartphone is a device most commonly used for online communication and socialization because it is so convenient and functional. As it permeates all areas of life, it was inevitable that it would also affect the financial activities of individuals that became even more evident during the COVID-19 pandemic (Al-Qudah et al., 2022; Liébana-Cabanillas et al., 2020; Hashem, 2020). Moreover, previous research has shown that the educated and younger population is more open to the use of new digital financial technologies (Lee & Lee, 2000; Khan et al., 2019; Fan et al., 2018; Sun et al., 2017; Garrett, 2014; Rosen et al., 2013; Rugimbana, 2007), which emphasizes the importance of researching the factors influencing their adoption of various digital financing services. Therefore, the study on smartphone activities of university students, their tendency to use digital financial services and their attitude towards them was conducted on the student population at the University of Osijek. Given the impact that the smartphone has on people's daily lives, this study investigated whether its use has an impact on the use of digital financial services and whether some interesting patterns could be found using neural networks. In line with Yen and Wu's (2016) recommendation that new studies in this area should adopt a more dynamic, cross-environmental perspective, a neural network model was used as an unconventional method to obtain information linking the variables used.

The research found that the majority of participants believe that they are sufficiently informed and possess the technology necessary for the implementation of mobile payments that are found to be important aspects of mobile payments adoption (Wisniewski et al., 2021; KPMG, 2020). The participants in this study had average smartphone activity of 6.56 (SD = 1.27). Using Kruskal-Wallis and Kendal's tau-b, no linear causal relationships were found between smartphone use and demographic variables, which differs from the results of previous studies (Kanungo, 2022; Sultana & Bousrih, 2020; Sulaiman et al., 2007; Suoranta & Mattila, 2004). Additionally, the impact of smartphone usage on the effectiveness of the model was not significant, contrary to the expectations. This finding is not consistent with the results of Shaw et al. (2019), who reported the influence of smartphone addiction on the acceptance of mobile wallet payments. Furthermore, it is interesting to observe that a substantial portion of the participants (36.43%) were neutral towards the security of their personal data and to risk of bank fraud, unauthorized withdrawal of funds from the account, which is surprising as previous studies have found that perceived risk is one of the key factors in the adoption of mobile payments (Yan et al., 2022; Liébana-Cabanillas et al., 2020; Tounekti et al., 2020; Loh et al., 2020; Chin et al., 2020; Liébana-Cabanillas et al., 2018a; Sun et al., 2017). The remaining respondents were almost equally divided between those who agreed and disagreed with the statement that there is a security risk associated with personal data misuse or the potential for fraud in mobile payments.

On the other hand, the developed neural network model successfully uncovered some hidden regularities with an overall classification accuracy of 70.73%. Sensitivity analysis showed that age, accommodation, the use of some other digital services, the use of savings, financial planning and insurance services by digital means have an impact on the accuracy of the model. There are numerous digital financial services that fall within the scope of the variable *Other digital services*, which showed the greatest impact on model accuracy. These can include financial services such as personal investment advice and services, e-money accounts and transactions, digital wallets, peer-to-peer lending, credit card operations, cryptocurrency withdrawals, and so on. Like previous research that used neural network models to predict customer behavior in the financial industry (Rabaa'i et al., 2022; Khan et al., 2010; Ogwueleka et al., 2012), this new information could be valuable for the financial sector, which wants to ensure that its online services are used by this population, but also for educators as a good starting point for their efforts to improve their students' digital and financial literacy.

The limitations of this study mostly relate to the sample used, i.e., some other students from other faculties or countries may use their smartphones more intensively and use more online financial services in general, so the results are limited to this sample. Since some researchers (e.g., Harris et al., 2020) believe that self-report scales are not objective and therefore cannot truly measure smartphone use, and all scales developed to date to determine smartphone use are self-report (Harris et al., 2020), other methods of obtaining more objective data (e.g., smartphone application usage data) could be used to address this issue. The study may

not be generalizable to other contexts or countries, as the factors influencing the adoption of digital financial services may vary depending on cultural and socio-economic factors (Chopdar et al., 2018; Fan et al., 2018; Liébana-Cabanillas et al., 2020; Singla & Sardana, 2020/2021). Future research could also apply some other theoretical models, discuss, and include other variables on which the intensity of smartphone use might depend, consider the role of some other online services in the use of online financial services, and include other data mining methods. For example, future studies could analyze the barriers to the adoption and usage of digital financial services for online payments among smartphone users, such as lack of trust in digital payment platforms, concerns about data privacy and security, and poor user experience. Furthermore, it could be interesting to explore the potential of mobile wallets and other innovative payment methods that are enabled by smartphones, and examine how they are used and accepted by consumers and merchants. Future research could examine the relationship between smartphone usage patterns (e.g., frequency, duration, purpose) and digital financial service usage for online payments, to determine whether heavy smartphone users are more likely to adopt and use digital financial services than infrequent users (expanding foundations set by Shaw and Kesharwani (2019)).

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JEL: A1, M15, M16, M30, O300
Original scientific article
https://doi.org/10.51680/ev.36.2.6

Received: December 7, 2022
Revision received: March 10, 2023
Accepted for publishing: April 10, 2023

HOTEL WEB SITE SEO ANALYSIS: SEGMENTATION AND VALORIZATION AS A PRECONDITION FOR DISCOVERING AND UNDERSTANDING INSIGHTS TO IMPROVE ONLINE VISIBILITY

Abstract

Purpose: The purpose of this article, in which the authors present the results of the scientific project "The relationship between the quality of the main SEO ranking factors and the position of a hotel brand's website in the SERP" ZIP-FMTU003-11-2021, is to (1) identify and segment SEO variables relevant for better online visibility, (2) define a valorization model of the SEO variables, (3) valorize and define the mutual relationships of the observed SEO variables, and (4) identify and interpret the influence of the quality of the observed SEO variables on the quality of the websites of the observed sample of hotels.

Methodology: The research was conducted in two main phases. In the first phase, the available scientific and professional literature was reviewed and examined. In the second phase, the analysis model was designed, the graphical interface of the analysis model was created, the hotel sample was defined, the necessary data of the observed variables were collected, and finally, data analysis and interpretation was performed.

Results: In this article, (1) an approach to creating an analysis model and its graphical interface is described and explained, (2) a graphical interface and the analysis model are presented, (3) the algorithm for valorization of selected SEO elements is explained, (4) and finally, the results of the conducted analyses are presented.

Conclusion: The results of the conducted research show the importance and complexity of researching the topic of online visibility, which opens numerous possibilities for conducting similar research.

Keywords: Hotel, website, SEO, segmentation, valorization

1. Introduction

The quality of websites is determined by a large number of variables. The quality of each of these variables impacts the overall quality of the website and online visibility. Google uses a variety of SEO ranking factors to determine where a particular hotel website will appear on search results pages. Not only are some of these ranking factors more important than others, but the degree of their importance changes as Google's algorithm evolves. Therefore, ensuring high quality in the presentation of online hotel information and maintaining high quality in the optimization of key SEO ranking factors is of great importance to the success of any business, including hotels, Law (2019). This is especially important in the hotel industry, where today more than 90% of sales activity ("booking" - sales) in Europe is done through online channels (D-edge hospitality, 2021; Phobs CRS, 2021). Today, when we talk about online sales in the hotel industry, sales through indirect sales channels dominate (Vukasović & Mihač, 2021). However, it is best for each hotel to realize as much of its sales as possible directly, i.e., through its own hotel website. Direct sales via the hotel website/website largely depend on the position in search engine results (visibility in search engines). The reason for writing this article is the increasingly complex influence and importance of SEO factors and search engine algorithms, artificial intelligence and machine learning on visibility in Internet search engines, which is especially evident when we talk about increasing direct sales through the hotel website.

Design/Methodology/Approach - Based on the available literature, preliminary research was conducted to obtain new scientific knowledge. After that, empirical research was conducted, which was divided into 2 parts. The first part of empirical research was conducted on a defined sample of websites of 5-star hotels in the Republic of Croatia (19 hotels - 45.24%), using one of the world's best commercial "all in one" software for analyzing and increasing search engine visibility. The second part of empirical research involved the creation of an analytical model and its graphical interface, as well as an algorithm for secondary data processing. This will provide a basis for relevant decisions in SEO activities. The first part of research (collection and processing of primary data) was conducted in the period from 11/2021 to 01/2022. The second part of research was conducted in 2 phases, namely: (phase 1) preparation and creation of an analytical model, graphical interface and software solution algorithms for secondary data processing from 01/2022 to 06/2022, and (phase 2) secondary processing, analysis and interpretation of the obtained data (06/2022 - 08/2022).

Hypotheses/Research question - The proof or rejection of the established hypotheses is based on the conclusions derived from the facts obtained from the interpretation of the results of theoretical research through the analysis of available literature and empirical research through the described research processes and their sub-processes on the websites of a selected sample of 5-star hotels in the Republic of Croatia. In the initial phase of research, 3 basic research hypotheses were established:

H1: The position of the hotel website in the search results of Internet search engines depends on the quality of optimization of the main SEO ranking factors for ranking,

H2: The segmentation and valorization of the main SEO factors provides a better basis for decision making with the aim of increasing online visibility in search engines.

H3: The online direct sales of hotels can be significantly increased through recognition and better optimization of Google ranking factors.

Thus, **the main objective of this research** is to (1) identify, segment and evaluate the most important SEO factors for ranking in order to achieve better online visibility – the position of the hotel website on the SERP, and (2) determine the relationship and interpret the relationship between the quality of SEO factors for ranking and the position in search results based on search engine queries.

2. Preliminary research - theoretical and conceptual background/framework

As mentioned in the introduction, preliminary research included an analysis of the literature and previous research on the described topic. In this sense, Yalçın & Köse (2010) emphasized the importance of SEO and examined the interdependence of search engine optimization, page rank, backlinks, meta tags, and social media. They concluded that SEO is a dynamic process that needs to be continuously monitored to track positive or negative changes to improve the website. Dean (2020) explains and comments on Google's 200 ranking factors that were relevant in 2020 based on his practical experi-

ence in e-business for many years. Yu (2018) writes about the importance of measuring website quality. In his research, he highlights the following factors as the most important qualitative factors to be analyzed: content, features, structure, usability/usability, the quality of navigation, technical performance in terms of compatibility with different platforms, interoperability in terms of testing the quality of interaction with applications and databases, security, and configuration in terms of testing the quality of work with complex hardware and software systems. In addition, knowledge is also expanded by the articles that deal with research on SEO analysis tools such as Google Trends, SEMRUSH, SimilarWeb, Alexa, Moz-Open Site Explorer, etc. (Vyas, 2019), and the importance of individual Google ranking factors for achieving a better position/visibility in search engines (Pan, 2015). Shaolang et al. (2019) highlight the importance of data analysis when drawing relevant conclusions and conducting future SEO activities. In their research, they propose a framework that uses machine learning and search indexes to predict tourist arrivals by comparing the predictive performance with Google and Baidu generated search results. Furthermore, Konidaris et al. (2022) emphasize that selecting appropriate keywords is a fundamental task for all SEO and SEM activities. Iqbal et al. (2022) investigate the key factors to achieve a better SERP position. In their study, they highlight the following 7 main groups of factors that should be considered when developing and maintaining websites: website design, performance, target market, responsiveness, security, fresh content, and SEO usage. In their article, they present an interesting SERP equation for predicting the ranking of business websites. Garcia et al. (2022) present the application of different SEO techniques to improve the indexation of websites on Google, where the implementation of the implemented strategy ensures the improvement of the position within the SERP. For this article, the work of Rodlej (2020) is interesting, in which the author, in the article entitled "Hotel SEO: How to guide", describes modern SEO, its importance and the way of using and implementing it in the modern hotel industry. Sengar (2022) explores the advantages, disadvantages and difficulties of the commercial application of search engine optimization. After completing preliminary research, during which a large number of articles were examined (the most relevant ones are all listed in the literature section), the authors compared previously selected articles with their previous research and, taking into account the new findings, conducted the rest of the research, which is described in the introductory part of the article under the design/methodology/approach part.

3. Empirical research process and methodology

The first part of empirical research was conducted on a defined sample of hotels in the Republic of Croatia using Semrush SaaS – "all in one" software for website optimization analysis. The value of Semrush lies precisely in the fact that it contains a wide range of available analytical tools - the software contains over 40 tools for SEO as well as for content, advertising, competitive research, reporting and social media management. The analysis by means of the aforementioned tools allows us to gain new insights for the purpose of better management of the online presence of hotel websites.

The tasks in this part of research were as follows:

1. define individual projects for data processing,
2. parameterize the processes in the defined projects,
3. monitor the processes within the projects in the defined period,
4. collect, analyze and isolate the data defined for primary research, and
5. group and prepare primary data for secondary processing.

In the second part of empirical research it was necessary to:

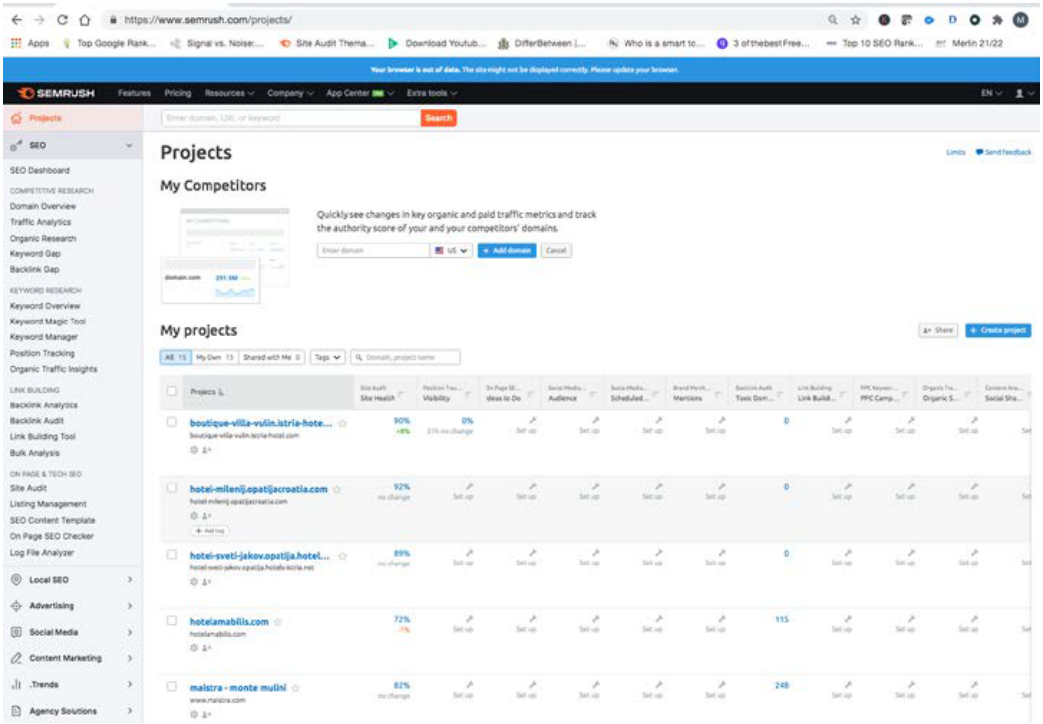
1. define the approach and design and create a graphical interface for data segmentation and exploitation,
2. define the required functions and procedures,
3. define and develop an algorithm for secondary data analysis and processing,
4. analyze and evaluate the obtained data,
5. interpret the research results, draw sound conclusions and present our own views and opinions.

In this way, the basis for relevant, scientifically sound conclusions is established. Such an approach not only brings new scientific knowledge, but ultimately ensures the possibility of application in modern hotel management theory and practice.

3.1 Empirical research - the first part

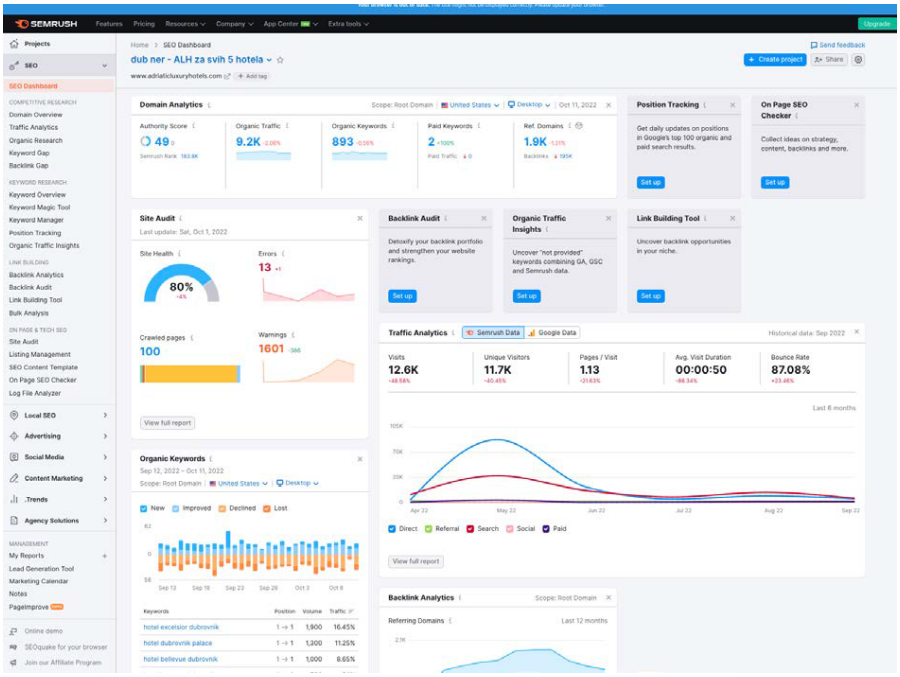
For the first part of empirical research, a sample for conducting research was determined at the beginning. The sample consists of 19 5-star hotels in the Republic of Croatia, which represents 45.24% of the total number of 5-star hotels in the Republic of Croatia. In addition, a license (2-month plan GURU) was purchased for the use of Semrush SaaS, so that a detailed analysis of the quality of the websites of the hotels selected in the sample could be performed. Then, based on the procedures available in Semrush SaaS, (1) a new analysis project was defined for each observed hotel (Figure 1), (2) analysis parameters for each analysis project were defined (Figure 2), (3) based on the preliminary research results, Semrush components and functions/analytical interface (dashboard) were analyzed in order to create a relevant model for secondary data processing, and (4) the data were isolated in order to develop and create a graphical interface and algorithm for secondary analysis.

Figure 1 Defining analytical projects within Semrush SaaS (each hotel – one project)



Source: Authors - Screenshot – Semrush graphical interface

Figure 2 Semrush SEO Dashboard - displaying analytical reports for a hotel (Definition of analytical parameters for each project, where each hotel represents one project)



Source: Authors - Screenshot – Semrush graphical interface

As shown in Figure 2, a complex SEO analysis was performed for each hotel. Based on the analysis performed in this way, a very large amount of data related to SEO, PPC: pay-per-click ad campaigns, social media marketing, keyword research, competitive research, PR, content marketing, marketing insights and campaign management were collected for each hotel. Since the focus of this research is on the study of algorithmic (organic) search in the context of online search engines, the rest of the article focuses on the analysis of the data obtained through the segment of SEO analysis. Semrush SEO toolkit contains over 20 tools and reports that are very helpful in optimizing the parameters for better online visibility of the hotel website. The result of the first phase of empirical research is a huge amount of data, from which it was necessary to extract the most relevant ones for the further course of research.

3.2 Empirical research - the second part

Based on the findings from preliminary research and the data collected in the first phase of empirical research, the second phase of empirical research began. The most relevant data were isolated from the Semrush GUI. The isolated data formed the basis for the creation of an analysis model and graphical user interface for secondary data analysis (a new analysis model and user interface design for data analysis). The isolated data model for secondary analysis was realized by 3 main analytical modules (M_1, M_2, M_3) , and 1 valorization module (M_V) for the final analysis, which includes 1) the interpretation of the obtained absolute values of the observed variables - *where absolute value* $Av \in 1,2,3,...n\}$, 2) the definition of the range and class of the absolute values of the variables - X_{imax} - X_{imin}, 3) in terms of the absolute values of the variables - the association of the score/point value - y_j, and 4) the analysis of the impact of the values of each variable on a) the total value of each analytical module, and b) overall, on the search engine optimization, giving measures of dispersion, arithmetic mean $\overline{xi}$, standard deviation σ, variance σ^2 and Spearman's rank correlation coefficient - R_s. The data analysis model was created by isolating and segmenting the most relevant data obtained by performing defined analytical projects using Semrush

SaaS. The created analytical model is based on the analysis of 337 variables for each analyzed hotel in the selected sample - $h_r \in 1,2,3,...19\}$. Since the subject of this study is a sample of 19 5-star hotels in the Republic of Croatia, 6,403 analytical variables were treated in this study. Based on their independent interpretation and the interpretation of their mutual relationships, the final conclusions of the study are drawn and their own opinions and attitudes are presented. The modules of the analytical data model are described below.

Module 1: M_1 - Domain overview

This module contains a total of 81 analytical fields analyzed for each hotel. Module M_1 analyzes:

(1) Authority Score: a metric used to measure the overall domain quality and SEO influence. The score is based on the number of backlinks, referring domains, organic search traffic, and other data. 100 is the highest possible authority score.

(2) Organic search traffic: The organic search section displays widgets related to the domain's organic traffic, the keywords for which the domain ranks in the top 100 of Google organic search results, the distribution of keyword rankings, and the domain's organic competitors.

(3 Backlinks: These data provide information about the number of backlinks the domain has.

(4) Distribution of organic traffic of the domain and keyword by country.

(5) Organic research (includes keyword analysis, organic position distribution analysis, and keyword analysis by intent). Additional analyses allow the study of the relationship between organic/algorithmic domain traffic and keywords by the analyzed countries.

The aforementioned analyses were used to examine the qualitative values of the observed variables of the observed hotel sample. $M_1TP_{(hr)}$ - M1TotalPoints represents the total qualitative value of the domain whose quality is examined by analyzing the variables for the hotel (hr) just observed. This value was determined based on the sum of the individual qualitative point values of the observed variables x_i f_j within this module:

$$M_1TP_{h_r} = \sum_{i=1}^{3} x_i \ f_j \qquad (1)$$

Module 2: M_2 - Backlink analytics overview

This module contains 97 analytical fields. The data are analyzed using 7 main analyses and 9 auxiliary analyses, namely:

(1) Authority Score: A metric used to measure the overall quality and SEO influence of a domain. The score is based on the number of backlinks, referring domains, organic search traffic and many other data. 100 is the highest possible authority score.

(2) Referring domains: the total number of referring domains that have at least one link pointing to the analyzed domain/URL. Only referring domains from the last few months are considered.

(3) Backlinks: the total number of backlinks pointing to the analyzed domain/URL. Only backlinks from the last few months are taken into account.

(4) Monthly visits: the total number of unique visits to the root domain in the past month.

(5) Keywords: a number of keywords that lead users to the root domain via the top 100 Google organic search results.

(6) Outbound domain: the total number of domains the analyzed domain is linked to. Only domains referred to by the analyzed domain in the last few months were taken into account.

(7) Toxicity: The toxicity rating of a website is based on the number of toxic backlinks leading to the analyzed website and the importance of the detected toxicity markers. This applies only to the root domain and subdomains. In the analysis, n/a means that the number of reference domains is too low.

Other 9 additional analyses relate to analyses such as New and lost referring domains in the observed time unit, Relationship between referring domains by Authority Score - Backlink Quality, New and lost backlinks in the observed time unit, Top anchors, Analysis of backlinks by type, Analysis of link attributes and backlink top countries.

The analyses within this module show the total backlink analytics qualitative score explored by the M_2TP (h_i) module and are rated as follows:

$$M_2TP_{h_r} = \sum_{i=4}^{10} x_i \ f_j \qquad (2)$$

based on the sum of individual qualitative scores/ point values of the observed variables X_i f_j within this module.

Module 3: M_3 - Website audit overview

This module contains a total of 159 analytical fields distributed among 11 main analytical procedures. The M_3 module is used to examine the quality of the following data/parameters:

(1) website health level: the score of the quality (health) of the website is based on the number of errors and warnings found on the website and their uniqueness. The higher the score, the fewer problems the website has, the better it is optimized for search engines, and the easier it is to use;

(2) crawled pages: this analysis shows the total number of pages indexed by SiteAuditBot and analyzes the distribution of pages according to their status;

(3) Robots.txt file status: the robots.txt file is used to tell search engines which content on a web page to index;

(4) crawlability: analysis of website navigation, search and indexing;

(5) HTTPS: HTTP status codes refer to requests made to a web server by search engines or website visitors to a web server. Many pages on a website that return 4xx or 5xx status codes can have a negative impact on the website's usability and crawlability, which can lead to a decrease in visitors;

(6) international SEO level: international SEO helps optimize a website for search engines to better understand which countries and languages which part of the website is intended for;

(7) core web vitals metrics: this metric consists of three key measurements to evaluate a website's loadability, interactivity, and visual stability, i.e., Largest Contentful Paint (LCP) - the time it takes for a browser to load the largest block of content on your homepage, Total Blocking Time (TBT) - indicates the amount of time your homepage is unavailable for input, and Cumulative Layout Shift (CLS) - detects content shifts on the homepage by combining the shifts of all elements as they load. Percentage of good pages - a page is considered good if all three metrics (LCP, TBT, CLS) are above or equal to the recommended values. The result does not include n/a pages;

(8) website performance score level: this metric deals with the loading speed of the website;

(9) internal linking score: a metric that analyzes the internal links of a website;

(10) top issues: the top issues discovered on the website based on their number and priority level;

(11) markup score: the markup score is based on the "Invalid Structured Data Elements" check and uses the Site Health algorithm. Using markup data in website analytics is a powerful way to increase a hotel's online visibility.

The analyses within the M_3 module show the total qualitative score of the website audit analysis M_3TP (h_i) explored by this module and it is calculated according to the following formula:

$$TP_{(h_r)} = \sum_{j=1}^{3} M_j \; TP \tag{3}$$

based on the sum of the individual qualitative scores of the observed variables x_i f_j within this module.

The overall qualitative hotel website score (h_r) of the observed hotel sample (N) is the sum of qualitative scores of individual modules and it is described as follows:

$$M_3TP_{h_r} = \sum_{i=11}^{26} x_i \; f_j \tag{4}$$

Module 4: M_V - Valorization module for final analysis

The valorization module provides a segmented view of the main variables monitored in the M_1, M_2 and M_3 modules. Through these modules, a total of 26 summary variables are extracted and evaluated, of which M_1 - (3 cumulative variables), as part of M_2 - (7 cumulative variables), and within M_3 - (16 cumulative variables). M_V module consists of two main parts: (1) the part/column that represents the extracted cumulative data most suitable for valorization, and (2) the part/column that represents the valorization of the extracted data. The valorization part is based on an independently created algorithm. The algorithm of the valorization module is based on (a) determining the range of determined absolute values of the variables, (b) defining classes within the determined ranges of absolute values of

the variables, and (c) defining the point values of the created classes. Since the ranges (from min-value to max-value) of the absolute values of the variables are very different for the evaluation of the variables, the model of assigning a point value to the variables was used in terms of assigning the absolute value of the variable to a certain class within the observed ranges of the absolute values. Table 1 shows the minimum and maximum absolute values of each variable and the distribution of points according to the observed classes.

Table 1 Range classes & class values (variables from x_1 to x_{26})

X_i	X_i min	X_i max	Range classes & class values *in points* (y_j)												
			y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	y_9	y_{10}	y_{11}	y_{12}	y_{13}
M_1 Domain Analytics															
X_1 Authority Score:	0	62	0	1	2	3	4	5	6	7	8	9	10		
X_2 Organic Search Traffic:	45	12,700	0	1	2	3	4	5							
X_3 Backlinks:	0	4,400	0	1	2	3	4	5							
M_2 Backlink Analytics															
X_4 Authority Score:	19	82	0	1	2	3	4	5	6	7	8	9	10		
X_5 Referring Domains:	6	550	0	1	2	3	4	5	6	7	8	9	10	11	12
X_6 Backlinks:	28	22,900	0	1	2	3	4	5	6						
X_7 Monthly Visits:	0	611,000	0	1	2	3	4	5							
X_8 Keywords:	0	135,000	0	1	2	3	4	5	6						
X_9 Outbound Domains:	0	36	0	1	2	3	4	5							
X_{10} Toxicity Score:	$L_{(Low)}$	$H_{(High)}$	0	1	3										
M_3 Website Audit Analytics															
X_{11} Website Health Level	61%	0.92	0	1	2	4	5	6	7	8	9	10			
X_{12} Crawled pages	6	100	0	1	2	3									
X_{13} Healthy	0	7	0	1	2	3	5								
X_{14} Broken	0	17	5	3	2	1	0								
X_{15} Have issues	3	96	5	3	2	1	0								
X_{16} Redirects	0	53	55	3	2	1	0								
X_{17} Blocked	0	23	5	3	2	1	0								
X_{18} Robot.txt File Status	0=(NA)	3=A	0	3											
X_{19} Crawlability	0%	1	0	1	2	3	4	5	6	7	8	9	10		
X_{20} Non-indexable pages	1	100	10	9	8	7	6	5	4	3	2	1	0		
X_{21} Indexable pages	0	97	0	1	2	3	4	5	6	7	8	9	10		
X_{22} HTTPS implementation	0%	100%	0	1	2	3	4	5	6	7	8	9	10		
X_{23} International SEO level	0%	100%	0	1	2	3									
X_{24} Core Web Vitals Metrics	0%	100%	0	1	2	3	4								
X_{25} Website Performance	73%	100%	0	1	2	3	4	5	6	7	8	9	10		
X_{26} Internal Linking Score	84%	100%	0	1	2	3	4	5	6	7	8	9	10		

Note: (NA – Not Available), A - Available
Source: Authors

With regard to the position (X_8) of the absolute data field of the Authority Score variable within the analytical model for secondary analysis, the algorithm for assigning the score/point value of the Authority Score variable (X_1) within the M_1 module is presented below:

$$X_{1\ Pts\ =}\ IF(X_8=0;"0";IF(X_8<=10;"1";IF(X_8<=20;"2";IF(X_8<=30;"3";\ IF(X_8<=40;"4";IF(X_8<=50;"5";IF(X_8<=60;"6";IF(X_8<=70;"7";\ IF(X_8<=80;"8";IF(X_8<=90;"9";IF(X_8<=100;"10")))))))))) \quad (5)$$

From the presented *if* algorithm, it appears that 11 classes are defined for the assignment of the Authority Score variable. For each class, a score value ranging between 0 and 10 points is assigned.

In the next step of the research, the absolute values of the observed variables x_i are assigned point values. In this way, the monitoring of the variable values and a uniform addition of the values are ensured. At the same time, the analysis of the dominant keywords and search queries revealed that in almost 100% of the cases the word hotel is among the top 3 keywords. In the top 5 organic search terms, the word hotel is combined with the name of the city or the name of the hotel in more than 90% of the cases through various phrases. It can be concluded that potential guests mainly use these words or the phrase "hotel - hotel name - city". Thus, (1) considering the search queries from the perspective of potential buyers (from the country and abroad), (2) taking into account the results and findings obtained in the course of previous research, and (3) understanding what a 5-star hotel represents in the context of supply, the 3 most relevant search engine queries are derived based on demand. The fourth search query was to research the online visibility of hotels using the phrase "hotel - hotel name - Croatia". The rest of the research is based on the following search queries: search query 1: five-star hotel Croatia, search query 2: hotel in Croatia, search query 3: luxury hotel in Croatia, and search query 4: syntax: hotel - hotel name - Croatia. Based on the above search queries (based on the most relevant common important terms), the online visibility of each hotel was studied in terms of 4 search queries. The achieved positions (online visibility) based on the defined search queries were evaluated as shown in Table 2.

Table 2 Evaluation of the online visibility of the hotel websites of the observed sample

SERP POSITION	Score / points
into **1st** page of organic (algorithm) results	5
into **2nd** & **3rd** page of organic (algorithm) results	3
into **4th** & **5th** page of organic (algorithm) results	1
other	0

Source: Authors

4. Research results and discussion

Table 3 below provides the summarized results of the values of variables of the analyzed modules, as well as the points awarded based on the achieved position within the SERP for the observed search queries. Measures of dispersion of the variables are also provided, showing dispersion of the numerical characteristics of the variables from the arithmetic mean. Dispersion of the analyzed numerical characteristics is presented using absolute measures of dispersion, namely, range of variation, variance and standard deviation.

Table 3 Point values of the observed analytical modules

Hotel (hr)		Analytical modules				
		M1TP (hr)	M2TP (hr)	M3TP (hr)	TP (hr)	SERPp
H1		11	24	78	113	11
H2		13	35	55	103	9
H3		5	15	80	100	5
H4		7	34	85	126	5
H5		9	25	77	111	5
H6		10	24	88	122	6
H7		8	21	79	108	5
H8		6	24	78	108	5
H9		11	28	91	130	5
H10		12	28	78	118	5
H11		12	28	90	130	6
H12		7	25	73	105	5
H13		6	14	73	93	5
H14		8	24	74	106	5
H15		4	38	68	110	5
H16		9	16	88	113	5
H17		11	26	81	118	5
H18		11	27	86	124	5
H19		12	30	91	113	18
Dispersion measurement	Min	4.0	14.0	55.0	93.0	-
	Max	13.0	38.0	91.0	130.0	-
	$\overline{xi}$	9.1	25.6	79.6	114.3	-
	Range of variation	9.0	24.0	36.0	40.0	-
	St.dev. σ	2.7	6.3	9.0	11.1	-
	Variance σ2	7.2	40.1	80.8	123.0	-

Source: Authors

Using Spearman's rank correlation coefficient, the relationship and influence of each module and its variables (M_1 Domain Analytics - M_1TP (h_r), M_2 Backlink Analytics - M_2TP (h_r), M_3 Website Audit Analytics - M_3TP (h_r)) on the overall qualitative value of the website was examined. The relationship between the overall qualitative value of the website and online visibility was also examined by analyzing the position within the SERP for specific search queries. Spearman's rank correlation coefficients between the above variables were as follows: (1) rs_1 [M_1TP (h_r) : TP (h_r)] = 0.50131579, (2) rs_2 [M_2TP (h_r) : TP (h_r)] = 0.44780702, (3) rs_3 [M_3TP (h_r) : TP (h_r)] = 0.74429825, and (4) rs_4 [TP (h_r) : SERPp] = 0.31491228. Spearman's coefficients were obtained by observing a sample of hotels (N = 19), and therefore these values are compared with the critical value of the rank correlation coefficient (= 0.391) based on the significance level of 5% (0.05). For the interpretation of Spearman's coefficients, 2 additional hypotheses were made, i.e., (1) independence hypothesis $h_0 : r_s = 0$, and (2) alternative hypothesis $h_1 : r_s \neq 0$. If Spearman's rank correlation coefficient (r_s) is greater than the nominal table value (α =

0.391), independence hypothesis h_0 is rejected and alternative hypothesis h_1 is accepted, implying that there is dependence between the observed modules. Otherwise, hypothesis h_1 is rejected, which assumes that a relationship exists, and independence hypothesis h_0 is accepted.

(1) $rs_1 [M_1TP (h_r) : TP (h_r)] = 0.50131579 > 0.391$

(2) $rs_2 [M_2TP (h_r) : TP (h_r)] = 0.44780702 > 0.391$

(3) $rs_3 [M_3TP (h_r) : TP (h_r)] = 0.74429825 > 0.391$

(4) $rs_4 [TP (h_r) : SERPp] = 0.31491228 < 0.391$

Since rs1 > α and rs2 > α, and the value of the variables ranges between ±0.40 and ± 0.70, indicating a truly significant relationship, independence hypothesis h_0 is rejected for M_1 and M_2 and the alternative hypothesis h_1 is accepted. A truly significant correlation of the influence of quality is shown for the M_1 Domain Analytics module and the M_2 Backlink Analytics module on the overall quality of the website TP (hr).

Moreover, rs3 > α, and the value of the variable ranges between ± 0.70 and ± 1.00. These data show a very high correlation between the quality of the M_3 Website Audit Analytics module and the overall quality of the website. In this case, independence hypothesis h_0 is also rejected and alternative hypothesis h_1 is accepted.

Since $rs_4 < \alpha$, hypothesis h_1, which assumes that a relationship exists, is rejected, and independence hypothesis h_0 is accepted. Thus, the analysis of the influence of the overall quality of the website on the position of the website on the SERP shows that there is no strong direct correlation between the points obtained based on the qualitative analysis of the websites and the points awarded based on the position obtained within the SERP for the specified search queries. It can be noted that the analyzed hotels did not pay enough attention to general search queries, but the focus of the keywords and search phrases was exclusively on the name of the hotel. Indeed, search queries in which the name of the hotel was not entered in over 90% of the cases did not result in the hotel's website being listed on the first 5 pages of the search engine results. This fact indicates a relatively weak online visibility of the observed hotels in algorithmic/organic search queries. In this way, hotels are missing an important opportunity for a direct positive impact on website visits and positive action to improve business results. We should also mention the limitations of this research due to the sample size and a geographic definition. The research results show that there is a problem and a relevant space for the extension of the existing research, and at the same time, open the possibility of conducting similar research. In addition to the scientific aspect, knowledge gained based on the research results can be applied in modern business practice.

5. Conclusion

Nowadays, the quality of the website is a very important factor for a successful hotel business. The intention of every hotel is to sell as many products and services as possible through direct sales channels. Visibility in search engines is very important for selling through the hotel brand website. Visibility in search engines in the context of organic/algorithmic search is the result of the treatment by the Google algorithm. The Google algorithm treats a large number of variables. As highlighted in the introduction, **the aim of the research** in this article was to identify, segment and evaluate the most important SEO ranking factors to achieve better online visibility/positioning of the hotel website on the SERP, and investigate the relationships between the quality of SEO ranking factors and the position in search results based on search engine queries. In this context, the hypotheses of the article were also formulated. Starting from the first part of research (based on the study of the problem and the analysis of the latest theoretical findings), the assumptions that the position of the hotel website in the search results on the Internet search engines depends on the quality of optimization of the SEO ranking factor as a variable crucial for placement on the SERP (Search Engine Result Pages). However, at the same time, the analysis of the influence of the overall quality of the website on the position of the website on the SERP (rs4) shows that there is no strong direct relationship between the points obtained on the basis of the qualitative analysis of the websites and the points awarded on the basis of the analysis of search queries. This only partially confirms the first hypothesis of the article. This result is due to the main **limitations** of this research, namely the sample size (in this article, only 5-star hotels in the Republic of Croatia were studied) and the geographical determination (the search queries were conducted from Croatia, and Google's SERP algorithm also takes into account the location of the user making the search query). Bearing this in mind, and for more

meaningful results, **recommendations** for future research should be: (1) to increase the size of the sample, (2) to expand the sample to include the study of hotels from multiple countries, and (3) to conduct analysis of search queries based on queries from multiple locations/countries. In addition, for future research, it is recommended to increase the time period for analyzing the search queries and to compare the search queries with the demand market trends (Google Trends). By segmenting and valorizing the variables, the interrelationships of the variables were investigated. In the empirical part of the study, the variables were observed through defined analytical modules. By examining the relationships between each of the modules studied (and their associated variables), it was found that the M_3TP (h_r) module (Website Audit) had the greatest influence on the overall quality of the hotel website TP (h_r). In addition, the influence of the variables of M_1 and M_2 modules on the overall quality of the website was evaluated. In this way, new and more detailed findings were obtained, providing a better basis for decision making to increase online visibility in search engines. Hypothesis 2 of this thesis is thus proven. The article introduces the concept of a more detailed analysis of variables/data (segmentation and valorization of variables) obtained through Semrush SaaS. Such an approach provides a better insight into the shortcomings in the quality of variables and a better understanding of the relationship between the variables that influence the online visibility of the hotel website. The research results indicate the qualitative deficiencies in the optimization of the variables, which at the same time shows that there is a significant potential to increase online direct sales of hotels through better detection and optimization of the most important Google factors for ranking. This confirms the third hypothesis of this article. The **scientific contribution** of the article is evident in the original approach of identifying, segmenting and evaluating the most important SEO factors with the aim of improving online visibility in search engines. By exploring the relationship between the quality of SEO ranking factors and the position in the research results, new scientific knowledge was gained and at the same time room was opened for new scientific research, especially related to the analysis of the impact of the quality of a website on the position of a website on the SERP. Apart from the above limitations, the results of the conducted research show that there are a wide range of approaches to this topic, which open up numerous possibilities for conducting this or similar research.

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JEL: A20, H83, M41
Original scientific article
https://doi.org/10.51680/ev.36.2.7

Received: June 22, 2023
Accepted for publishing: September 14, 2023

ARE HIGHER EDUCATION INSTITUTIONS PREPARING STUDENTS FOR THE PUBLIC SECTOR ACCOUNTANT POSITION? – CASE OF CROATIA

Abstract

Purpose: The requirements for information in the public sector are continuously changing and there is a need for accountants who are capable to respond to these challenges. Universities, i.e. higher education institutions (HEIs), are recognized as institutions that provide fundamental knowledge, and a discussion of education in the field of public sector accounting is required. The purpose of this paper is to present the opinions of public sector accountants and expectations of students regarding education in the field of public sector accounting at HEIs in Croatia.

Methodology: A survey was conducted among accountants employed in public sector entities and among students of faculties of economics at public universities in Croatia. The results of the aforementioned survey are analysed in the SPSS software package using descriptive and inferential statistics.

Results: Results showed that students as well as public accountants agree that formal education is not enough for the position of public accountant. Furthermore, students are not interested in the position of public accountant. Therefore, public universities should rethink modifying the structure and programs of courses related to public sector accounting.

Conclusion: The results are an invitation to public policy creators to work on the attractiveness of the position of public sector accountant by offering better conditions. The authors of the paper therefore highlight the necessity for better cooperation between accountants and the academic community in order to improve education in the field of public sector accounting and meet the needs for professional and trained accountants who are the future of the profession.

Keywords: Public sector accounting, education, reforms, accountants, students, survey

1. Introduction

Definition of accounting presents the basis for the identity of the accounting profession. According to Carnegie et al. (2021), accounting is a technical, social and moral practice concerned with the sustainable use of resources and appropriate accountability to stakeholders to enable progress of organizations, people and nature. Therefore, it is not surprising that there is a growing demand for professional and trained accountants in the private as well as in the public sector given the fact that accountants, by preparing and providing accounting information for different categories of stakeholders, are the cornerstone (International Accounting Education Standards Board, 2019) of good financial management.

The accounting profession has faced demands to provide additional information beyond financial information, including information on sustainability, in order to achieve transparent and standardized reporting (Caruana & Dabbicco, 2022). Although accountants can improve knowledge through training during their careers, universities have been recognized as places that play a key role in providing students with appropriate basic knowledge (Thom, 2019), preparing them to become experts in the field of public sector accounting (PSA) and to be able to support successful implementation of PSA reforms. Previous studies, however, have shown that PSA is a rather neglected course (Fox, 1977). Moreover, previous studies showed that PSA often remains on the periphery of business schools (Neves et al., 2022).

Since reforms and changes have taken place in PSA, including the implementation of new accounting basis and additional reports, higher education institutions (HEIs) should recognize the need to improve education in the field of PSA, because PSA and related education should go hand in hand (Heiling, 2020). Previous studies have shown that HEIs were not focused on the public sector (Adam et al., 2019), so there is a gap in knowledge caused by inadequate formal university education of students (Chan, 2022).

In addition, HEIs should seek to motivate students to work in PSA. Previous studies also showed that there is a gap in that area, because there was a limited interest of students in the public sector accountant positions (Martin & Waymir, 2017).

This paper investigates whether higher education institutions provide sufficient education for the position of public sector accountant from the perspective of both students and accountants. Moreover, this paper explores how attractive the field of PSA is to students for their career development.

This paper is divided into five sections. After the introduction, the paper gives a review of existing literature. The following section presents the research problem by analyzing the main characteristics of formal education in Croatia. The methodology, research results and analyses are presented in the fourth section, which is followed by the concluding section that summarizes the main findings and proposes some future research.

2. Literature review

Public sector accounting is extremely complex (Beights, 1954) and requires adequate study programs, training and experience at a highly intellectual and professional level. However, PSA courses appear to be a rather neglected in the last 40 years (Fox, 1977, Neves et al., 2022), and university offerings are limited (Egenolf & Willis, 1983, Henry, 2005).

Namely, Fox (1977) discussed the problems in PSA education and concluded that PSA course offerings are limited, while a similar study conducted in the USA five years later pointed to a limited interest of universities in offering courses in the areas of PSA due to the lack of financial resources and qualified personnel (Egenolf & Willis, 1983). While researching the coverage of governmental accounting at universities in the USA Henry (2005) found that only marginal progress in the coverage of governmental accounting at certain universities was observed. By researching study programs at four European universities (Germany, Italy, Portugal, and Spain) Adam et al. (2019) concluded that although the integration of PSA into study programs and curricula of higher education institutions has increased in recent years, there are both a limited number of academics who teach those courses and a small number of students who attend such courses. The same study shows that public accounting topics are limited and that there are several differences in program offerings. Brans and Coenen (2016) concluded that, although there are attempts to harmonize higher education in Europe, there is no European model for teaching public sector ac-

counting and public administration. Furthermore, some academics (Cordery, 2013, Neves et al., 2022) highlighted that accounting education is primarily focused on teaching about the private rather than the public sector. Therefore, some studies have indicated a low level of PSA in university curricula (Huy, 2019). The reasons for low levels were lack of financial resources, a narrow faculty interest (Henry, 2005), limited teaching experience and research interest in PSA, and lack of PSA content in accounting textbooks (Sciulli & Sims, 2008). This points to the fact that graduates in the field of accounting do not have adequate knowledge about accounting requirements in the public sector. A previous study has also shown that PSA courses do not follow the changes in the real world, i.e., changes in the public sector, especially in reference to non-financial reporting and teaching about IPSAS and EPSAS (Adam et al., 2019). Therefore, there is a gap in public sector accounting education (Heiling, 2020). A study conducted by Neves et al. (2022) at universities in Brazil pointed to the fact that, although the implementation of IPSAS is carried out at all levels of government, the departments of accounting at higher education institutions have not changed their curricula and have not included teaching about the fundamentals of accrual accounting in their courses. Moody and Marlowe (2009) show that what was taught in the USA some 25 years ago was still taught in 2009 and was focused on budget execution, budget analysis, budget preparation etc., with no accrual accounting. Furthermore, the authors concluded that most accounting courses are focused on the preparation of financial data, rather than on understanding how to use these data (Ahmed, 2019).

Heiling (2020) also emphasizes that the growing complexity of PSA and its interdisciplinarity create the need to develop study programs at graduate level. To make these improvements, it is necessary to identify common educational goals and practices in PSA teaching and prepare textbooks for accounting in the public sector, including international comparative perspectives as well (Chan, 2022).

Although some studies (Cohen & Karatzimas, 2022; Heiling, 2020) emphasize that it is necessary to increase the understanding of PSA for public administration students who will be future managers, it is also essential to improve the education system for accounting students because they are likely to be future implementers of reforms who will participate in the processes of preparing financial reports.

Henry (2005) also emphasized that one of the limiting factors for developing PSA courses is the lack of interest among students. More recent research conducted by Martin and Waymir (2017) investigated undergraduate and graduate accounting students' perceptions of careers in governmental accounting and whether there are differences in perceptions among students who studied elective courses in governmental and non-profit accounting. Their results show that students' perceptions of monetary and non-monetary benefits associated with a career in the public sector increased if they studied elective courses in governmental and non-profit accounting.

3. *Development of the research problem – case study of Croatia*

Through the analysis of previous studies, it was observed that higher education institutions play a key role in providing formal education for work in public sector accounting. However, it is also evident that education in the field of public sector accounting is limited (Jafi & Youssef, 2021), with outdated curricula and teaching skills, causing the circular effect, i.e., students' interest in the position of public sector accountant is consequently also limited.

Education and training are very important issues in the social life of any country, and governments have recognized education and training as an important task for sustainable economic development (Huy, 2019). Accounting has always been an area of interest for society and universities. In addition to the rapid development of businesses, a significant part of the development relates to public sector entities in a country. The Republic of Croatia consists of a total of 20 counties and the capital (the City of Zagreb), 127 cities and 428 municipalities (Ministry of Justice, 2010). In addition, Croatia has a large number of government organizations, ministries, departments, institutes, and budgetary and extrabudgetary users that contribute to the development of the country. Thus, the challenge in PSA in Croatia is to harmonize all data in order to increase transparency. But reporting by public sector entities in Croatia is complex and dual. Namely, budget execution reports are prepared on a cash basis, while financial reports are prepared on a modified accrual basis (Vašiček et al., 2022). The economic

crisis as well as the COVID-19 crisis resulted in the need for transparent information to improve public sector accountability. Croatia is a member of the EU and has faced the requirements for harmonizing the public sector reporting system by implementing the accrual accounting basis in PSA. All of these factors resulted in the fact that in Croatia there is a need for trained students with specialized knowledge in the field of PSA who will work in this changing environment.

In the Republic of Croatia, of the total number of students enrolled in universities in the 2021/2022 academic year, 81.3% were enrolled in faculties, 13.0% in polytechnics, and 3.9% in colleges. In the 2020/2021 academic year, of the total number of students enrolled in university (i.e., 82.9%), 39.1% of students were enrolled at the University of Zagreb, 11.6% at the University of Split, 9.7% at the University of Rijeka, 9.0% at the University of Osijek, 3.2% at the University of Zadar, 2.7% at North University, Koprivnica, 2.1% at the University of Pula, 1.6% at Libertas International University, 1.4% at the University of Slavonski Brod, 0.9% at the University of Dubrovnik, 0.8% at the Croatian Catholic University of Zagreb, and 0.8% at Vern University. The remaining 17.1% of students were enrolled outside the university (Croatian Bureau of Statistics, 2022a). Since 69.4% of the students are enrolled in the first four public universities, we decided to analyze in detail the education system in the field of public sector accounting at the universities of Zagreb, Osijek, Rijeka, and Split and the associated faculties of economics. Analyzing the education system at the four largest public universities in Croatia, it is observed that courses related to public sector accounting are offered very rarely at faculties of economics, and that there is generally only one course related to the field of public sector accounting. Undergraduate and graduate study programs at these universities are oriented towards private sector accounting, while public sector curricula receive limited attention.

Learning goals and outcomes at the Croatian universities are similar, and at undergraduate and graduate level they are focused on teaching an institutional and professional framework of accounting, budget classifications, a chart of accounts and accounting rules, interpretation of financial statements and annual reports of budgetary users, as well as the application of the government chart of accounts. Therefore, these courses are adapted to learning about national budgets and accounting rules and focused only on the preparation of financial data, rather than on data use (for further information, see Table 1).

In addition, courses related to public sector accounting are offered at postgraduate studies. Learning goals and outcomes at postgraduate level are similar to learning goals at undergraduate and graduate level; however, they are also focused on teaching the International Framework of Public Sector Accounting with emphasis on International Public Sector Accounting Standards (IPSAS), the dual reporting system, budgetary and financial reports, Croatian taxation regulation and effects on budgetary and non-profit organizations, accounting information for internal users with emphasis on performance measurement and cost management. As can be seen, postgraduate studies teach students how to use information, but the number of people pursuing postgraduate studies in accounting in the Republic of Croatia is very small. In the 2021/2022 academic year, a total of 1,707 students were enrolled in postgraduate studies, 121 of whom were enrolled in the faculties of economics in Osijek, Zagreb and Rijeka (Croatian Bureau of Statistics, 2022b).

Table 1 PSA offer at four public universities in Croatia

University	Course	Degree	Topics
			Institutional and functional coverage of the public sector - The budget system and the basics of the financial accounting information system of the budget - State accounting - accounting concepts and budget classifications - International accounting standards for the public sector - Legal framework of budget accounting in Croatia - Application of the accounting plan and posting of typical business events of budgetary entities - Financial reports in the budget system - Report on budget execution - Accounting system of private non-profit organizations - Application of the accounting plan and recording of typical business events of non-profit organizations - Financial reporting system of private non-profit organizations
University of Zagreb (Faculty of Economics and Business)	Compulsory course: Non-profit Accounting	Integrated university study	
	Accounting for Non-profit Organizations	University postgraduate specialist study	Accounting for Budgetary and Non-profit Organizations - - institutional and professional framework of accounting - budget classifications - a chart of accounts and accounting rules, financial statements and annual reports - International Public Sector Accounting Standards
	Public Sector Accounting	University postgraduate specialist study	Accounting for Budgetary Organizations - International Public Sector Accounting Standards - scope of public sector - public financial management cycle - general accounting in the public sector - financial statements and annual reports - accounting information for internal users - performance measurement - cost management
	Financial Reporting for Non-profit Organizations	University postgraduate specialist study	Accounting for Budgetary and Non-profit Organizations - general accounting in the public sector - international framework of PSA (IPSAS, EPSAS) - institutional and professional framework of accounting in Croatia - dual reporting system - budgetary and financial reports - performance measurement and cost management - system of internal controls in the public sector - auditing in the public sector
J.J. Strossmayer University of Osijek (Faculty of Economics and Business)	Accounting for Budgetary and Non-profit Organizations	University graduate study	Budgetary accounting and governmental accounting information system - non-financial assets - expenses - revenue - receipts - expenditures - own sources - financial reports - preparing financial reports and recording of transactions
University of Split (Faculty of Economics, Business and Tourism)	Compulsory course: Accounting for Governmental Entities	Graduate professional study	The content and the objective of accounting for governmental entities - Development and the basics of accounting for governmental entities - System of financial reporting - Application of the chart of accounts - Accounting systems in Croatia - Financial statements in accounting for governmental entities - Recording of transactions and preparing financial reports

University	Course	Degree	Topics
	Elective course: Accounting for Non-profit Organizations	University undergraduate study	Accounting for Budgetary and Non-profit Organizations - institutional and professional framework of accounting - budget classifications - a chart of accounts and accounting rules, financial statements and annual reports
	Accounting for Non-profit Organizations	University postgraduate specialist study	Accounting for Budgetary and Non-profit Organizations - types of organizations - institutional and professional framework of accounting - budget classifications - a chart of accounts and accounting rules, financial statements and annual reports - Application of the chart of accounts
	Accounting for Budgetary and Non-profit Organizations	University postgraduate specialist study	
University of Rijeka (Faculty of Economics and Business)	Elective course: Accounting for Budgetary and Non-profit Organizations	University graduate study	Institutional and functional coverage of the public sector - The budget system and the basics of the financial accounting information system of the budget - State accounting - accounting concepts and budget classifications - International accounting standards for the public sector - Legal framework of budget accounting in the Republic of Croatia - Application of the accounting plan and posting of typical business events of budgetary entities - Financial reports in the budget system - Report on budget execution - Non-profit organizations in the economic environment - Accounting system of private non-profit organizations (NGOs) - Application of the accounting plan and recording of typical business events of non-profit organizations - Financial reporting system of NGOs
	Financial Management and Control in the Public Sector	University postgraduate specialist study	Budget system: elements and processes, a system of financial management in the public sector - Internal and external supervision and control in the public sector - Accounting-information system as accounting support to management, liquidity and asset management system, measuring and monitoring performance in the public sector - fiscal responsibility
	Management Accounting in the Public Sector	University postgraduate specialist study	New Public Management - Accounting and reporting in the public sector - liquidity and asset management system, measuring and monitoring performance in the public sector, fiscal responsibility - auditing in the public sector
	Accounting for Budgetary and Non-profit Organizations	University postgraduate specialist study	Accounting for Budgetary and Non-profit Organizations - general accounting in the public sector - international framework of PSA (IPSAS, EPSAS) - institutional and professional framework of accounting in Croatia - dual reporting system - budget and financial reports -accounting information for internal users with emphasis on performance measurement and cost management - Croatian taxation regulation and effects on budgetary and non-profit organizations

Source: Authors

In order to enhance the quality and recognition of European higher education systems and improve the conditions for exchange and collaboration both within Europe and internationally, the Bologna Process was introduced in 49 European countries as an intergovernmental higher education reform process. Over the years, the Bologna Process has grown into a Europe-wide policy platform for coordinated higher education reform. It addresses new topics, such as fundamental values and learn-

ing and teaching as well as its long-standing commitments, which require continued attention (European University Association, 2023). Before the Bologna Process (2001), courses related to public sector accounting did not even exist in Croatia (Vašiček et al., 2022). Therefore, it is possible to conclude that some progress in public sector accounting is taking place. New trends including accrual accounting and IPSAS are only taught at postgraduate level, which is a disadvantage given that most students start working after completing their graduate studies, and only a smaller percentage of students decide to continue their education at postgraduate level.

Therefore, this paper aims to answer the following research questions:

RQ1: Are public universities providing sufficient knowledge for a student's future position of public sector accountant in Croatia?

RQ2: Are students interested in public sector accountant careers in Croatia?

4. Methodology, analyses and research results

In order to provide answers to the first research question, questionnaires were prepared and sent to public sector accountants and to students studying at four public universities in Croatia. The questionnaires contained mostly close-ended questions. In order to analyze the data, we used descriptive and inferential statistics. Questionnaires were sent to accountants by e-mail. The accountants in our sample are accountants employed in the public sector - in a state unit, an institution of a local or regional self-government unit, a budget user of the state budget, and a budget user of local self-government units, i.e., the population of 3,742 accountants (Ministry of Finance, 2023). E-mail addresses of the accountants in our sample were obtained in cooperation with a professional journal for accounting in the public sector in the Republic of Croatia. Thus, all accountants interviewed are subscribers to this journal. Using the random selection method, the questionnaire was sent to 500 e-mail addresses of public sector accountants, and 151 responses were received, which is a response rate of 30.2%. In the 2020/2021 academic year, there were 13,141 students enrolled in the faculties of economics at four universities, i.e., 57% in Zagreb, 16% in Rijeka, 14% in Osijek, and 13% in Split. We decided to survey the students studying at the Faculty of Economics and taking an accounting course. Questionnaires for students were prepared in online form, and academics from the field of accounting were asked to forward the questionnaire to students. According to academia, 489 students were contacted and 135 student responses were collected, which is a response rate of 27.6%. To provide the answer to the second research question, data were collected from questionnaires answered by students.

Do public universities provide sufficient knowledge for the future careers of public sector accountants in Croatia?

Our sample consisted of students from the faculties of economics, of whom 75% were accounting students, and 25% were students of other economics majors. In terms of their years of study, 58% of participating students were fourth-year students, 17% were fifth- year students, 16% were third-year students, and a small number of students were in their second or first year of study.

At the beginning, we asked students if they had taken and PSA-related courses. Of 135 respondents, 75% or 101 students took PSA courses, while 25% did not take any PSA-related course. They were asked to evaluate concepts and contents of these courses. Some 10% of them assessed these courses as extremely complex, 38% as complex, 28% as neither complex nor simple, 4% as simple, while 20% could not provide any assessment. Then the students were asked to evaluate their knowledge of accounting and public sector accounting. As many as 72.6% of students assessed their knowledge of accounting as sufficient. In the case of PSA, 40% of students consider that their knowledge is at a minimal level, while 36% consider it as sufficient. Moreover, our intention was to determine whether studying PSA courses affected their evaluation of their knowledge. Results are presented in Table 2. Of those who studied the PSA-related courses, 34% consider their knowledge to be at a minimal level, 46% consider their knowledge to be sufficient, 3% consider themselves experts, while 17% could not provide any assessments. Of those who did not study PSA-related courses, 58% considered their knowledge at a minimal level, 9% as sufficient, while 33% could not provide any assessment. Based on these results, it is evident that the evaluation of knowledge is related to attending PSA-related courses, and this was further confirmed by Cramer's V correlation test.

Table 2 Correlation between the evaluation of knowledge in the field of PSA and studying PSA-related courses

		Did you attend any PSA-related courses?	
		Yes	No
		Percent	Percent
Evaluation of knowledge in the field of PSA	Minimal	34.0	58.0
	Enough	45.0	9.0
	Expert	3.0	0.0
	Can't assess	17.0	33.0
Total		100.0	100.0
		Value	Approximate Significance
Cramer's V		0.356	**0.001**

Source: Authors

When asked if they thought that the knowledge they would acquire in PSA courses would be sufficient for work in public sector accounting, 44% of students considered their knowledge insufficient, 29% believed it is sufficient, while 27% of respondents did not provide any assessment.

We also asked the accountants whether the knowledge acquired at the university prepared them sufficiently for the position of public sector accountant. The opinions of respondents about education in public sector accounting depend, among other things, on their personal characteristics such as their level of education, time spent in a particular position, their age and experience in the position. We examined these personal characteristics of public accountants who responded to our survey and the results are presented in Table 3.

Table 3 Personal characteristics of public sector accountants

Gender		**Age**	
Male	13.9%	25-35	15.2%
Female	86.1%	36-45	25.8%
		46-55	31.8%
		56-65	26.5%
		Older than 65	0.7%
Education		**Field of education**	
High school	17.9%	Economics - accounting	35.8%
Bachelor's degree	15.9%	Economics - other fields	60.9%
Master's degree	50.3%	Social sciences	3.3%
Postgraduate specialist studies	10.6%	**In a position**	
Master of Science	4.6%	Less than 1 year	2.6%
PhD	0.7%	1-5	13.2%
		6-10	22.5%
		11-15	15.2%
		More than 15	46.4%

Source: Authors

Most respondents were women (86%) and 1/3 of the respondents were aged between 46 and 55. As for the period of time in the position, 46.4% of respondents stayed in their positions for more than 15 years, while only 15.8% of respondents stayed in their positions up to 5 years. In terms of education, 50.3% of respondents completed graduate study programs, while 17.9% of respondents finished high school. Most respondents have an education in the field of economics, 35.8% of whom in accounting.

We also asked accountants to evaluate their knowledge in the field of PSA. Two thirds of respondents consider their knowledge sufficient, while 23% of respondents consider themselves to be experts in field of PSA. When age is compared to their evaluation of knowledge in the field of PSA, it is noticeable that 40% of respondents aged 25-35 consider themselves to be experts in the field of PSA, while only 25.6% of respondents aged 36-45 consider themselves to be experts, and 12.5% of those aged 46-55 consider themselves to be experts. In addition, 35.3% of accountants who have been in their positions for the period of 6 to 10 years consider themselves to be experts, 26.1% of respondents who have been in their positions for the period of 11 to 15 years consider themselves to be experts, and 20.0% of respondents who have been in their positions for more than 15 years see themselves as experts. Therefore, the older the respondents are and the longer they have been in their positions, they see themselves to be less of experts in the field of PSA. These results are in line with the study conducted by Budding et al. (2022), who found that there are differences between age groups of management accountants in terms of how they assign their competencies and their actual skills. Budding et al. (2022) found that older accountants scored higher in their technical skills, while for younger accountants their actual skills and importance of technical competencies were equal. Their study indicated that older accountants perceive their technical skills to be better than the skills of younger accountants. In our study, we can conclude that younger accountants seem to be less self-critical and that they considered themselves to be greater experts in the field of PSA.

Accountants were also asked whether they attended PSA courses, and 62% of them gave a positive answer, while 38% of respondents gave a negative answer, i.e., they did not take any PSA courses. Of those respondents who did not take any public sector accounting courses, 33% were aged 46-55, 30% were aged 36-45, 26% were aged 56-65, and 10% were aged 25-35. These results are in line with the fact that before the Bologna Process there were no PSA-related courses in Croatia.

In addition, we asked accountants if they needed additional forms of education for their daily work as accountants in the public sector. As many as 98.7% of respondents answered that it is necessary to have additional forms of education, and only 1.3% of respondents disagreed.

Finally, accountants were asked if they think it is necessary to introduce additional forms of training in the field of PSA (e.g., lifelong education, specialist programs) through universities. Results are presented in Table 4. Of 151 accountants, 113 or 74.8% of respondents agree that it is necessary to introduce additional forms of training in the field of PSA at universities, while 6% of respondents disagree, and 19.2% of respondents are unable to assess whether there is a need for PSA courses. Ninety percent of respondents in the position from 1 to 5 years, 82% of respondents in the position from 11 to 15 years, 70% of respondents in the position for more than 15 years, and 73% of respondents in the position from 6 to 10 years agreed that it is necessary to introduce additional training at universities. Although younger accountants perceive themselves as greater experts in the field of PSA than older accountants, results in Table 4 indicate that accountants with less experience agree that there is a need to introduce additional forms of training in the field of PSA at universities. These results indicate that there are differences in training needs among public sector accountants with diverse experiences. Budding et al. (2022) also highlight differences in the age groups of accountants and their training needs.

Table 4 Need for additional forms of training at universities

Is it necessary to introduce additional forms of training in the field of PSA at universities?			Percent
In the position	Less than 1 year	It is necessary	50.0
		Can't estimate	50.0
		Total	100.0
In the position	1-5 years	It is necessary	90.0
		It is not necessary	5.0
		Can't estimate	5.0
		Total	100.0
In the position	6-10 years	It is necessary	73.5
		It is not necessary	8.8
		Can't estimate	17.6
		Total	100.0
In the position	11-15 years	It is necessary	82.6
		It is not necessary	4.3
		Can't estimate	13.0
		Total	100.0
In the position	More than 15 years	It is necessary	70.0
		It is not necessary	5.7
		Can't estimate	24.3
		Total	100.0

Source: Authors

As a conclusion for the first research question, it is evident from the perspective of both students and accountants that public universities have not provided sufficient knowledge for the position of public sector accountant. By analyzing the results in our paper, we observe that in our sample 75% of fourth-year accounting students attended a course in PSA, which points to the fact that PSA courses are not offered in other years of study. These results indicate that limited space is given to PSA at public universities. This is in line with previous studies (Cordery, 2013; Huy, 2019; Jafi & Youssef, 2021; Neves et al., 2022). Furthermore, when evaluating their PSA knowledge, over 40% of students believe that their knowledge is at a minimal level, and 58% of students who did not take a PSA course share this opinion, as well as 1/3 of those who took a PSA course. This indicates that in students believe that they are not confident about their knowledge. Although students have no practical experience, 40% of them believe that universities do not provide them with enough knowledge for the position of public sector accountant. The same opinion is shared by the surveyed accountants, who confirmed that they need additional education for the position of public sector accountant. Therefore, although the results show that there are PSA-related courses at public universities, practitioners and students agree that these are not sufficient for the position of public sector accountant. Moreover, accountants express the need to introduce additional forms of education at public universities. Although we can see from the results that the Bologna Process was introduced only after 2001 and that some accountants had no contact with PSA-related courses at all, we asked them for their opinion because we believe that their long experience can assess whether younger colleagues have a sufficient level of knowledge that they acquire at university or whether it is still insufficient.

Are students interested in career public sector accountant careers in Croatia?

The second research question addressed whether students were interested in pursuing careers as public sector accountants. We asked students if they were thinking about enrolling in postgraduate specialist studies in the field of PSA. The results presented in Table 5 show that 62% of respondents do not think about attending postgraduate specialist studies. We linked that question with the ques-

tion of whether they had attended any PSA-related courses to see if their previous PSA studies motivated them to continue studying in that field. The results show that, although they took a PSA-related course, they are not interested in attending postgraduate specialist studies in the field of PSA.

Table 5 Possibility of attending postgraduate specialist studies in the field of PSA

Are you considering the possibility of attending postgraduate specialist studies in the field of PSA?	Yes	38.00%
	No	62.00%
Total		100.00%
Cramer's V - Value		0.041
Approximate Significance		0.637

Source: Authors

The students were then asked where they would like to work. Out of 135 students, 61.5% would like to work in the field of accounting. But it can be seen in Table 6 that only 21.69% of respondents consider a career in the field of public sector accounting.

Table 6 Where students would like to build their career

	Percent
Public sector	21.69%
Private sector	60.24%
Non-profit sector	3.61%
Own business	14.46%
Total	100.00

Source: Authors

Therefore, it is possible to observe that although students are interested in working in the field of accounting, only one fifth of them would consider a career in the public sector. Therefore, as a conclusion for the second research question, we can infer that the results are worrying and the question arises whether Croatia will face a lack of public sector accountants in the future. If we look at the age of current accountants, we can notice that in our sample accountants are aged 46 years and above. The research results in this paper are in line with previous studies, i.e. previous research has shown that students' interest in the field of public sector accounting is limited (Beights, 1954; Engstrom, 1979; Henry, 2005). In our case, there is also a negative attitude towards continuing education in the field of public sector accounting. Since the curriculum at public universities in the field of accounting is primarily designed around private sector accounting, similar to other countries (Cordery, 2013; Huy, 2019; Neves et al., 2022), it is evident that this also affects students' choices of building a career in private sector accounting rather than in public sector accounting.

5. Concluding remarks

The aim of this paper is to determine whether public universities in Croatia provide sufficient knowledge for the position of public sector accountant. Analyzing the results of our research, we found that both students and accountants believe that public universities do not provide enough knowledge of public sector accounting. More than one third of the students in our sample rated their knowledge of public sector accounting as minimal. Furthermore, the students agree that the knowledge acquired in public sector accounting courses is not sufficient

for the position of public sector accountant. By researching available courses at public universities in Croatia, we also confirmed this fact, because PSA is taught less than private sector accounting. Also, the PSA curriculum in Croatia is mainly focused on national legislation, while new principles, standards and reporting systems are not taught. The accountants who have been working in the public sector in Croatia for a long period of time emphasize that additional education is necessary for their daily work needs and agree that public universities should offer additional education programs.

The results of this research show an interesting fact, i.e., accountants who are older and have more years of experience at their workplace consider themselves less expert in the field of public sector accounting than their younger colleagues. This is in line with the fact that before the Bologna Process there were no specific courses related to public sector accounting. Based on these results, we can observe that universities provide some basic education, but there is still a lot of room for further development and improvement. Although younger accountants perceive themselves as greater experts in the field of PSA than older accountants, the results additionally show that accountants with less experience in the position agree more that there is a need to introduce additional forms of training in the field of PSA at universities. Therefore, the formal education system in the field of PSA should follow trends in reporting on the one hand, and increase or introduce the offer of additional and informal education on the other hand.

The second goal of this paper was to determine whether students are interested in starting a career as accountants in the public sector. The research results in this paper show that only one-fifth of students are interested in starting their careers as accountants in the public sector. Therefore, it is obvious that education at public universities in Croatia does not motivate students enough for a position in PSA. This could become a problem and challenge in the future with the shortage of qualified accountants in the public sector. We believe that it is time to review and change the curriculum of PSA courses at universities and introduce additional forms of education that would provide students and professional accountants with skills needed to meet future challenges.

The significance of this work is multifaceted. Namely, we can state that the Bologna Process has brought changes in the higher education system in Croatia. If we compare the results with the research conducted by Adam et al. (2019) in 4 European countries and with Croatia, we will establish that there are similarities. In all the countries mentioned, even if the offer is limited, there are courses in public sector accounting that focus on the study of national legislation until the needs of practitioners are not recognized and new trends are not studied. The Bologna Process has led to a positive change with the introduction of a specialized course in public sector accounting. However, changes are still needed, as it can be observed that new trends are not being followed, which ultimately leads to students not having sufficient knowledge and skills to work as accountants one day. The Bologna Process certainly provides an opportunity to create cooperation between universities in the European Union in order to influence, through joint action, the improvement of courses, and perhaps entire study programs, which focus on public sector accounting. In addition, the distinctive feature of this work is that we were the first to survey accountants and students about education, contributing to the literature in the field of public accounting education, while Adam et al. (2019), for example, surveyed professors in their study. This study also has certain limitations. The research was conducted in only one country - Croatia - which limits the generalizability of the results. Future research may expand the sample and consider other research methods such as in-depth interviews in order to better understand public accountants' and students' attitudes towards PSA education. Despite these limitations, our paper contributes to the scientific literature related to PSA education and highlights the need to improve the existing PSA curriculum.

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JEL: Q50, Q56
Original scientific article
https://doi.org/10.51680/ev.36.2.8

Received: June 29, 2023
Revision received: July 26, 2023
Accepted for publishing: August 05, 2023

MARKET CAPITALISATION AND ENVIRONMENTAL, SOCIAL AND GOVERNANCE RATINGS IN THE EUROPEAN UNION

Abstract

Purpose: The paper aims to study the relationship between market capitalisation and environmental, social and governance (ESG) ratings of the companies in the European Union (EU).

Methodology: The authors analysed a sample of 1,456 companies over five years, from 2016 to 2020. The ESG combined score and market capitalisation of the companies were observed. Spearman's correlation coefficient was used to determine the relationship between the observed variables. The companies from twenty-one EU Member States have been analysed due to data availability.

Results: The results showed that a negative correlation is statistically significant, which confirms the results obtained in previous research. Since the ESG scores are measured on a scale where a higher value means a lower rating, the results can be interpreted as valid, and they show that higher ESG ratings positively correlate with the company's market capitalisation.

Conclusion: According to the analysis results, the correlation between ESG ratings and market capitalisation has improved over the years. In the first two years of the analysis, the correlation was weak, while it became stronger in the last three years of analysis. It is crucial for companies to understand this information since it gives them recommendations for future actions. ESG reporting can improve their market position. Since ESG reporting is still voluntary, companies which incorporate ESG reporting into their business strategy can become market leaders.

Keywords: ESG ratings, market capitalisation, the European Union

1. Introduction

Climate change and global warming have been at the centre of studies among professionals and scientists across different industries. A rapid temperature increase has devastating consequences for the world itself; therefore, studies are trying to find the best solution to slow down global warming. According to Godet (2020), the EU developed the first internal policies to respond to the problem of

climate change in the 1980s. Since the 1980s, the EU has been the leader in addressing the issue of climate change, implementing more climate policies than any other national or supranational entity. Sustainability has emerged as a solution to the problems mentioned above. The importance of sustainability as a solution is underscored by the United Nations (UN). The UN proposed 17 Sustainable Development Goals (SDGs) as a solution to combat climate change, global warming, and poverty. Over the years, different proposals have emerged in response to climate change and global warming. Since 2014, the EU has been developing ESG ratings within EU Directive 2014/95/EU. This Directive is known as the "Non-Financial Reporting Directive" (NFRD) and it was adopted on 22 October 2014. The NFRD requires large public-interest companies with more than 500 employees to disclose certain non-financial information regarding environmental concerns, social and employee-related aspects, respect for human rights, anti-corruption, and bribery. The purpose of these disclosures is to provide stakeholders with a greater understanding of the governance procedures of a corporation, as well as the influence that the organisation has on society and the environment. As the EU was the first to propose internal policies in the fight against climate change, it has also acknowledged that updating and improving the current framework for non-financial reporting is crucial. As a result, in 2021, the European Commission proposed a new Corporate Sustainability Reporting Directive (CSRD). The CSRD has replaced the NFRD and extended the scope and specifications for ESG reporting in the EU.

Since the CSRD requires only large public-interest companies to report on ESG, the authors study the relationship between market capitalisation of the companies and their ESG ratings. Based on the conducted analysis, the authors propose recommendations for further research. Market capitalisation represents public market valuation of a company and provides an estimation of its size and worth in the eyes of investors. The relationship between a company's ESG ratings and its market capitalisation is complex and can be influenced by various factors. Factors that can influence this relationship are investor perception, access to capital, brand reputation and customer preference, risk management and resilience, regulatory compliance, and stakeholder expectations. These factors can influence ESG ratings and, therefore, can influence market capitalisation of the companies. Companies with better ESG ratings may be more appealing to institutional investors, impact investors, and socially responsible investment funds that take ESG considerations into account when making investment choices. Increased investor demand and interest may make it easier for businesses to get financing, opening doors for development and potential increases in market capitalisation.

2. Theoretical background

In the EU, ESG reporting constantly changes as part of broader initiatives to support sustainable finance and corporate responsibility. The authors describe the following events that have shaped ESG reporting in the EU. Except for the CSRD that was introduced in 2021, the EU Taxonomy Regulation is a classification system for figuring out whether economic activities are environmentally sustainable, and it has been in operation since July 2021. It establishes standards for recognising and disclosing sustainable actions, assisting businesses and investors in integrating their processes with environmental goals. By offering a framework for disclosing and assessing the environmental sustainability of assets, the taxonomy will impact ESG reporting. In addition, the Sustainable Finance Disclosure Regulation (SFDR), which has been applicable since March 2021, imposes transparency and disclosure obligations for financial market participants and advisors regarding their ESG integration and the sustainability features of financial products. It guarantees investors access to consistent ESG data, encouraging comparability and avoiding greenwashing. Moreover, the European Single Access Point (ESAP) is a future digital portal that will be accessible across the entire EU and that is designed to simplify access to financial and sustainability data of companies listed on EU marketplaces. It will act as a central platform for analysing and accessing ESG data, making it easier for stakeholders, analysts, and investors to assess how sustainably a company is performing.

Two important frameworks are globally known as the Sustainability Accounting Standards Board (SASB) and the Global Reporting Initiative (GRI). Both the GRI and the SASB are well-known ESG reporting frameworks. To improve uniformity and comparability in ESG disclosures, the EU has brought its reporting requirements in line with

these global standards. The initiatives proposed in the EU show that the EU is improving sustainable finance and ESG reporting. The EU seeks to facilitate the shift to a more sustainable economy by unifying reporting standards, enhancing transparency, and incorporating sustainability factors into financial decision-making. ESG ratings are essential for companies and investors, but there are challenges in understanding what they mean. Different institutions provide data on ESG ratings for companies. Since the companies have not been required to report on ESG, they have many opportunities.

Eccles and Viviers (2011) reviewed 190 academic papers from 1975 to 2009 and concluded that ESG governance was very important for stakeholders. In recent years, ESG governance has been an important factor to investors, and a greater ESG rating benefits investors. Tarmuji et al. (2016) concluded that ESG ratings have a positive and significant impact on a company's transformation toward sustainability. The company's responsibility towards the environment and society is generated from ESG ratings. A higher ESG rating indicates a company's commitment and a positive result in relation to climate change mitigation.

Ermakova and Finogenova (2023) argue that ESG ratings should be more industry-specific to assess companies' ESG performance accurately. Dorfleitner (2015) found a lack of convergence in ESG measurement concepts, and that stakeholders should critically evaluate the validity of particular ESG scoring models. Street (2020) examined the MSCI ESG ratings of US companies, and Fortune 500 Global companies domiciled in Europe, finding differences in ESG ratings across industries and regions. Billio et al. (2021) analysed ESG rating criteria used by prominent agencies and found a lack of commonality in the definition of ESG characteristics, attributes, and standards, leading to disagreement among rating agencies and affecting sustainable investments. Overall, the papers suggest that ESG ratings are important for companies and investors, but there is a need for more industry-specific and standardised approaches to assess ESG performance accurately.

ESG ratings have become important for companies, stakeholders, investors, and buyers as they provide insights into a company's sustainability practices, risk management capabilities, reputation, access to capital, and ability to meet stakeholder expectations. Integrating ESG considerations into business strategies can contribute to long-term value creation, resilience, and competitiveness in today's evolving business landscape.

2.1. Environmental ratings

According to Jasch (2006), stakeholders have shown greater interest in the environmental performance of the firms due to greenhouse gas (GHG) emissions and their negative impact on the environment. As a result of negative consequences that GHG emitting companies have, they should reduce their emissions by employing best environmental practices.

McWilliams and Siegel (2000) showed that good environmental performance can be associated with the positive financial performance of the company. In addition, King and Lenox (2001) studied the effects of decreasing the inputs in the production process and energy. If a company can reduce its use, it improves profitability and decreases production costs.

Lakoff (2010) argues that the way society frames environmental issues in the media can shape public opinion and policy decisions. Fransson and Gärling (1999) suggested that increasing environmental concern and knowledge can lead to more environmentally responsible behaviour. Akdoğan and Hicyorulmaz (2015), as well as Şenol and Özçelik (2012), argued that businesses have a responsibility to protect the environment and that environmental accounting can help them do so. Akdoğan and Hicyorulmaz (2015) also noted that environmental issues threaten the sustainability of ecological balance, and that national and international regulations are needed to address them. Overall, environmental ratings are important for shaping public opinion, promoting environmentally responsible behaviour, and helping businesses fulfil their environmental responsibilities.

2.2. Social ratings

Social ratings are important as they enable stakeholders to assess a company's social performance, support responsible investment decisions, manage social risks, enhance brand reputation, attract talent, and contribute to sustainable development. They provide a comprehensive view of a company's approach to social responsibility and its impact on various stakeholders and society as a whole.

Carroll (1991) argued that companies have a responsibility to society beyond just maximising

shareholder wealth, and this has become increasingly clear with the creation of regulatory agencies. Bird et al. (2007) found that the market values companies that engage in positive corporate social responsibility (CSR) activities, particularly in the areas of diversity, environmental protection, and employee relations. Şerban (2013) highlighted the importance of CSR for companies in Romania, as it can lead to increased involvement in the community and support for economic development. CSR can benefit companies financially and socially, making social ratings an important consideration for companies. Social ratings of companies are important for various reasons. Nilsson and Strand (2015) found that social CSR ratings are value-relevant and associated with lower market values, while Attig et al. (2013) found that credit rating agencies tend to award relatively high ratings to firms with good social performance. Cellier and Chollet (2016) showed that announcement of social ratings generates a strong positive stock market reaction regardless of whether the rating is good or bad compared to the Fortune Reputation Survey and the Socrates Social Rating Database, and found that both databases are useful for evaluating corporate social performance. Finally, Chatterji et al. (2009) examined the accuracy of Kinder, Lydenberg, Domini Research & Analytics (KLD) ratings and found that KLD "concern" ratings are fairly good summaries of past environmental performance, while KLD environmental strengths do not accurately predict pollution levels or compliance violations. Overall, the papers suggest that social ratings of companies are important for investors, credit rating agencies, and other stakeholders interested in evaluating a company's social performance.

2.3. Governance ratings

Governance ratings in ESG are important as they promote transparency, accountability, and risk management within companies. They inspire investor confidence, support long-term performance, protect stakeholders, ensure regulatory compliance, and contribute to a company's reputation and brand value. Strong governance practices are crucial to sustainable and responsible business operations.

Lysandrou and Parker (2012) argued that the importance of these ratings lies in providing institutional investors with information that accurately summarises corporate loyalty to shareholders rather than accurately predicting corporate performance. Spellman and Watson (2009) found that corporate governance ratings, specifically those provided by Governance Metrics International (GMI), are statistically significantly related to corporate characteristics, prior performance, and future returns. This suggests that GMI ratings may be of significant relevance/value for investor decision-making. However, Daines et al. (2010) found that commercially available corporate governance rankings do not provide useful information for shareholders and do not predict governance-related outcomes with the precision or strength necessary to support the bold claims made by most of these firms. Holm et al. (2014) suggest that rating providers can improve the screening of companies according to governance quality by selecting relevant attributes in an intelligent way, but it seems questionable that weighting, aggregation, and classification of corporate governance attributes considerably improve discrimination according to governance quality.

2.4. Market capitalisation

Market capitalisation serves as a significant indicator of a company's attractiveness to investors. In the EU, companies with higher market capitalisation often have greater access to capital and resources, enabling them to invest in sustainable initiatives and innovations. This creates a positive feedback loop, as companies that prioritise ESG factors tend to attract investors seeking sustainable investments. As a result, market capitalisation and ESG ratings are interconnected, with sustainable practices contributing to increased market value. Ugwuanyi (2012) argues that an appropriate capital structure is important for maximising shareholder wealth and increasing the market value of companies. Stoica (2002) emphasises the role of the capital market in contributing to economic development. Reinganum (1999) highlights the importance of market capitalisation in portfolio management, as it is one of the most important determinants of portfolio returns. Finally, Frank and Goyal (2007) examine the factors that are reliably important in capital structure decisions, finding that the market-to-book assets ratio, tangibility, profits, log of assets, and expected inflation are all important factors in explaining market leverage. Overall, the papers suggest that market capitalisation is important for maximising shareholder wealth, contributing to economic development, and making informed portfolio management decisions.

According to Boffo and Patalano (2020), the rate of ESG rating availability is significantly higher when measured by market capitalisation. Their study indicates a trend in favour of larger market capi-

talisation companies. The trend is recognised as improved investment interest in companies with larger market capitalisation since they have ESG scores, and, therefore, companies with smaller market capitalisation are facing difficulties in resource access to sustainability implementation and reporting. In addition, as the availability of ESG ratings has increased, certain tendencies have emerged. According to Boffo and Patalano (2020), market capitalisation of ESG-rated companies in the EU reached 89% in 2019, whereas the number of companies covered was only 10%. While there are multiple explanations relating to the availability of data, increased resource allocation, and investor coverage, the absence of ESG scoring imposes significant limitations on smaller capitalisation companies, which drift further from the investment considerations of investors seeking sustainable investments.

3. Methodology

The authors used secondary data on the ESG ratings of the companies in the EU provided by Refinitiv. Yearly data from 2016 until 2020 for 1,457 companies were taken into consideration. Due to the process of leaving the EU, the companies from the United Kingdom were excluded from the sample. In addition, companies from Bulgaria, Croatia, Estonia, Latvia, Lithuania, and Slovakia were not analysed since there were no reported ESG ratings from companies from these countries. The authors analysed 1,456 companies in 2020, 1,071 companies in 2019, 944 companies in 2018, 633 companies in 2017, and 554 companies in 2016. The different number of companies analysed is the result of missing values in market capitalisation or ESG combined score ratings.

To analyse the relationship between the ESG combined score and market capitalisation of companies the authors used Spearman's rank correlation since the ESG combined score was measured on an ordinal scale from 1 to 12, where one represents an A+ rating, and twelve represents a D- rating. On the other hand, market capitalisation was measured in millions of dollars. According to Hauke and Kossowski (2011), Spearman's rank correlation, also known as Spearman's rho, is a non-parametric statistical method used to measure the strength and direction of the monotonic relationship between two variables. It assesses the association between two sets of ranked data and does not assume a linear relationship between the variables. Spearman's rank correlation is commonly used when data are measured on an ordinal or ranked scale. According to Schober et al. (2018), if the correlation coefficient is between 0.00 and 0.10, the correlation is negligible. If the coefficient is between 0.10 and 0.39, it is weak, and when the coefficient is between 0.40 and 0.69, it is moderate. A strong correlation is between 0.70 and 0.89. A very strong correlation is between 0.90 and 1.00. To conduct the analysis, the authors used IBM SPSS 25 software.

The ESG combined score, issued by Refinitiv (2022), is an overall score based on the reported information in ESG pillars with an ESG controversies overlay. According to Refinitiv (2022), ESG controversies measure a company's exposure to ESG controversies and negative events reflected in global media.

Descriptive statistics are given in Table 1, showing information about the number of analysed companies (N), minimum and maximum values, and means.

Table 1 Descriptive statistics of the analysed sample

	Market capitalisation				ESG combined score			
Year	**N**	**Minimum**	**Maximum**	**Mean**	**N**	**Minimum**	**Maximum**	**Mean**
2020	1,456	2	269,582	5,755.20	1,457	1	12	6.56
2019	1,071	2	269,582	7,479.17	1,074	1	12	6.23
2018	944	2	269,582	8,219.48	945	2	12	6.18
2017	633	2	269,582	11,464.21	634	1	12	5.82
2016	554	2	269,582	12,497.29	555	2	12	6.02

Source: Authors' own calculation

Based on descriptive statistics, the number of companies that have ESG ratings has increased in the observed time period. Even though minimum and maximum values of market capitalisation have been the same during all years, the mean of market capitalisation has decreased over the years. A decrease in the mean of market capitalisation can be justified by an increase in the number of companies that have been analysed throughout the observed time period. The ESG combined score shows a slight increase in the mean score over the years, but it represents a negative trend since the increased mean represents a lower ESG combined score of the companies.

4. Results

The authors used Spearman's correlation to test the relationship between the ESG combined score and market capitalisation of the companies. The results are shown in Table 2.

Table 2 Spearman's correlation test results

2020 2019			ESG combined score				
			2018	2017	2016		
Market capitalisation	2020	ρ	-.544**				
		N	1,456				
	2019	ρ		-.440**			
		N		1,071			
	2018	ρ			-.436**		
		N			944		
	2017	ρ				-.348**	
		N				633	
	2016	ρ					-.344**
		N					554

Note: **Correlation is significant at the 0.01 level

Source: Authors' own calculation

Based on the conducted correlation analysis, Spearman's Rho Coefficient (ρ) shows a statistically significant relationship between market capitalisation and the ESG combined score during the observed time. The correlation is significant at the 0.01 level with negative values. As the ESG combined score increases, market capitalisation of the company decreases. A moderate correlation between the two variables was recognised in 2018, 2019 and 2020. At the early beginning of the ESG rating, in 2016 and 2017, the correlation was weak. The correlation between the two variables has been negative over the years, meaning companies with better ESG ratings have higher market capitalisation.

The authors did not include industry type or company size in their study; therefore, they suggest further research to include these characteristics of the companies to study differences between companies in detail. These results can be beneficial for companies to change their environmental policies and use them as a benchmark. Testing the differences between companies in their ESG ratings according to industries helps companies to mitigate risks and to incorporate environmental, social and governance practices into their business strategy. By incorporating the ESG framework, companies have greater opportunities to enhance their market position and attract new customers and investors.

5. Discussion

ESG ratings in the EU have gained prominence as they assess a company's environmental impact, social responsibility, and governance practices. These ratings provide stakeholders, including investors, employees, customers, and regulatory bodies, with

valuable information to make informed decisions. Investors increasingly consider ESG factors when allocating their capital, as sustainable investments are seen as more resilient and better aligned with long-term value creation. Companies with favourable ESG ratings are likely to attract responsible investors, enhance their reputation, and gain a competitive edge in the market. The EU has recognised the importance of ESG ratings and market capitalisation in driving sustainability. The EU Sustainable Finance Action Plan, launched in 2018, aims to mobilise private capital towards sustainable investments and integrate ESG considerations into the financial system. It includes measures such as the development of a sustainable taxonomy, standardised ESG disclosures, and the establishment of the EU Ecolabel for financial products. The EU has also introduced regulations to enhance transparency and comparability of ESG information. The SFDR, effective since 2021, requires financial market participants to disclose how they integrate ESG factors into their investment decisions. This promotes consistency and reliability in ESG ratings, enabling investors to make informed choices based on harmonised information. Moreover, the EU's focus on sustainable finance and ESG ratings is aligned with its broader sustainability goals. The European Green Deal, announced in 2019, aims to make the EU the world's first climate-neutral continent by 2050. Sustainable finance and robust ESG ratings contribute to achieving this objective by channelling investments towards green projects, fostering responsible business practices, and supporting the transition to a low-carbon economy.

Based on the results of the conducted analysis, the authors showed that when market capitalisation increases, the ESG combined score decreases, but it is a positive outcome since the ESG combined score is measured on a scale from one to twelve, where one is A+, and twelve is D-. These findings are aligned with previous research conducted by Buallay (2019), who also observed a positive impact of ESG reports on firm performance. Similarly, Lo and Sheu (2007) found a significant positive relationship between corporate sustainability and market value, suggesting that being sustainable can enhance firm value. The results obtained by the authors, along with these earlier studies, highlight the importance of ESG ratings in influencing market perceptions and capitalisation. Fatemi et al. (2018) and Ting et al. (2019) examined the impact of ESG disclosure and combined scores on firm value and market performance, respectively. Both studies reported positive associations, with ESG disclosure and higher ESG combined scores linked to increased firm value and improved market performance. The findings obtained by the authors corroborate these results, reinforcing the notion that companies that prioritise ESG practices and transparently disclose their sustainability efforts are more likely to enjoy positive market outcomes. Overall, the convergence of the results obtained by the authors with those of previous research supports the idea that ESG ratings play a significant role in influencing market capitalisation and firm value. Companies that perform well on ESG metrics and actively communicate their sustainability efforts to stakeholders are likely to attract more interest from investors who consider ESG ratings in their investment decisions. This increased investor interest can lead to higher demand for company stock and, consequently, an uplift in market capitalisation.

Drawing on the insights from prior studies and findings obtained by the authors, this research has two primary limitations. Firstly, it does not consider factors like company size or a specific industry in which the companies operate. Secondly, the study relies solely on aggregated ESG scores without assessing each individual rating separately. The authors have two recommendations for future research based on the identified limitations. The first recommendation is to investigate the moderating effect of company size and industry. Future research could explore the potential moderating effect of company size and the specific industry in which companies operate on the relationship between market capitalisation and ESG combined scores. By incorporating these additional factors into the analysis, researchers could gain a more detailed understanding of how the impact of ESG ratings on market capitalisation varies across different company sizes and industries. The second recommendation is to conduct individual ESG rating assessments. By examining the influence of each specific ESG rating on market capitalisation independently, researchers can gain deeper insights into which aspects of ESG ratings drive the observed effects. This approach would allow for a better understanding of the importance of each ESG category in shaping market perceptions and capitalisation, and it could inform companies about which ESG areas to focus on for the purpose of maximising market value.

6. Conclusion

ESG reporting has become integral to a company's market capitalisation. ESG ratings give investors insights into a company's sustainability practices, risk management capabilities, and long-term viability. Higher ESG ratings enhance investor perceptions, attract a broader investor base, and potentially impact a company's market capitalisation. ESG reporting also contributes to effective risk management, access to capital, long-term sustainability, and compliance with evolving regulatory requirements. Companies that prioritise ESG reporting and integrate sustainability into their business strategies are better positioned to capture opportunities, mitigate risks, and achieve long-term success in a rapidly changing business landscape. Embracing ESG reporting is not only a responsible business practice but also a means of driving financial performance and creating value for all stakeholders involved.

ESG ratings have several advantages for companies, investors, and society. Companies can use ESG ratings to demonstrate their dedication to sustainability, ethical corporate conduct, and a beneficial social effect. Customers, workers, communities, and regulators are just a few of the stakeholders it helps to create trust with. This improves the company's reputation and brand value. Companies may demonstrate their ability to create long-term value by receiving higher ESG ratings, which lowers their cost of capital and improves access to funding. ESG ratings assist businesses in identifying and controlling risks connected to environmental, social, and governance issues, such as those brought on by climate change, resource shortages, supply chain management, and labour practices. Companies can increase their resilience and reduce any negative effects on their finances, legal standing, and reputation by developing plans to mitigate these risks by tracking and responding to their ESG ratings. By receiving higher ESG ratings, companies can highlight their sustainable practices, ethical supplier chains, and beneficial societal consequences, setting themselves apart from competitors. Customers concerned about the environment and the community may be drawn to companies with higher ESG ratings, increasing market share and cultivating customer loyalty. Additionally, businesses with high ESG ratings could be able to attract and retain top people, providing them with an advantage in the job market. ESG ratings encourage businesses to take a long-term approach to decision-making, considering both financial and environmental aspects. Companies can find new business possibilities, promote innovation, and build long-term value by incorporating sustainability into their plans, all while helping to build a more sustainable economy. ESG ratings assist businesses in meeting the changing regulatory standards for sustainability and ethical business conduct. Companies can reduce legal risks, preserve good standing with regulators, avoid potential fines or reputational harm, and keep ahead of regulatory changes and reporting requirements. ESG ratings support international sustainability objectives like the SDGs of the UN. Companies can demonstrate how they contribute to sustainable development and positive societal results by receiving higher ESG ratings, disclosing their efforts to address environmental concerns, promote social inclusion, and enhance governance standards.

Acknowledgement: This paper was supported by the Croatian Science Foundation under the project IP-2020–02-1018.

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JEL: E00, G21, C01
Original scientific article
https://doi.org/10.51680/ev.36.2.9

Received: July 14, 2023
Revision received: September 17, 2023
Accepted for publishing: October 3, 2023

INTERDEPENDENCE OF MACROECONOMIC ENVIRONMENT AND CREDIT RISKS IN CROATIA

Abstract

Purpose: The relationship between the macroeconomic environment and banking risks is one of the basic conditions for the stability of the state financial system. The purpose of this paper is to show the interdependence between the macroeconomic environment and the financial system, i.e., to highlight the importance of various macroeconomic factors and their impact on the banking system in Croatia.

Methodology: Statistical data for the period from 2010 to 2022, obtained from publicly available databases, are analysed. Correlation analysis was performed to determine the intensity and direction of the relationship between macroeconomic and banking variables. Regression analysis was conducted to determine if macroeconomic variables could explain some of the changes in banking variables.

Results: The results of the analysis show a significant correlation between the macroeconomic variable unemployment rate and all banking variables, as well as between the macroeconomic variable inflation rate and the banking variables: non-performing loans (NPL) and bank loans. Gross domestic product (GDP) is not correlated with any of the observed variables, which is a very interesting result. The unemployment rate is the predictor that is significant for all banking variables, while the inflation rate is the predictor that is significant only for non-performing loans.

Conclusion: The conducted analyses show that economic development plays a role in the business policies of banks. These results can be particularly useful for bank management and the government, as they provide all stakeholders with important information about the role of macroeconomic policies of financial institutions in Croatia and, consequently, the Croatian economy.

Keywords: Macroeconomic variables, banking variables, banking risk, regression analysis

1. Introduction

The performance of the banking system depends on the impact and direction of macroeconomic aggregates. Stability problems in banking can be triggered by various factors, but most often they are caused by a combination of macroeconomic insta-

bility in the environment and weak business profitability (Miletić, 2008).

In a stable macroeconomic environment, banks operate with positive financial results, while in a situation with unfavourable or unstable macroeconomic trends, when the economy faces recession and high real interest rates, banks face losses due to loan repayment problems.

An increase in GDP, as one of the components of economic growth, should have a positive impact on bank profitability. Inflation can have a positive or negative impact on profitability, depending on the ability of bank management to efficiently manage the bank's funds under inflationary conditions. A decline in financial indicators triggered by the instability of the macroeconomic environment leads to an increase in the share of non-performing loans in bank balance sheets, which in turn affects bank profitability and the level of capital adequacy.

According to Miletić (2008), macroeconomic instability, i.e., high and variable interest rates, sudden upturns and downturns in economic activity, and unsustainable fiscal and foreign positions are the most obvious and direct macroeconomic factors that negatively affect the allocation of funds and cause price fluctuations. Negative trends in macroeconomic aggregates directly or indirectly affect the quality of the banking system. The profitability and stability of the financial system depend on each individual financial institution and its internal organisation, but also on macroeconomic trends.

In recent banking literature, Sovilj (2020), Lazić (2020), Antoun et al. (2021), Gregoriou et al. (2021) have analysed the relationship between the business cycle and credit risk (the so-called cyclicality of credit risk) for the needs of macro-financial stability and for micro-risk management. Since the potential impact of economic trends on bank portfolios is important for predicting and preventing bank instability under adverse economic conditions, as well as for planning potential risks within banks, this paper examines the impact of macroeconomic trends on credit risk in commercial banks. Therefore, the following hypothesis was formulated: "Macroeconomic trends affect credit risk in commercial banks."

The main objective of this paper is to identify the interdependence between the macroeconomic environment and the financial system, that is, to show the importance of various macroeconomic factors and their impact on the banking system. Statistical data are analysed for the period from 2010 to 2022 to cover the period before, during and after the financial crisis. The sources include the databases of the Croatian National Bank (CNB) and of the Central Bureau of Statistics. In order to determine the intensity and direction of the relationship between macroeconomic variables (gross domestic product - GDP, inflation rate, unemployment rate) and banking variables (non-performing loans - NPL, interest rate margin, loans), time series analysis and correlation analysis were performed. Regression analysis was performed to determine whether the macroeconomic variables can explain part of the changes in the banking variables.

The paper is organised as follows: After the introduction, the second section reviews previous empirical research on the relationship between economic growth and the financial system. The third section explains the sample and the methods used. The fourth section presents the results of the study, and the last section concludes the paper.

2. Theoretical and conceptual background

Previous research on the relationship between macroeconomic factors and the financial system, with a focus on the banking system, presented in this paper includes the work of Levine (1997), Granville & Mallick (2009), Castro (2013), Agnello & Sousa (2013), Ashraf & Shen (2019), Karadima & Louri (2021), Tran et al. (2021), and other authors who have studied the relationship between macroeconomic variables such as GDP, inflation, unemployment rate, and financial system stability.

Numerous hypotheses assume that financial factors cause economic changes (Goldsmith (1969); McKinnon (1973); Huang & Lin (2009)) and they have therefore been the subject of numerous analyses. Danisman et al. (2020) analysed the interaction of economic policy and the banking system and its impact on credit growth. The analysis used a sample of 2,977 private and listed banks in the EU-5 countries (the United Kingdom, Germany, Spain, Italy, and France) in the period from 2009 to 2018. The paper examines economic policy uncertainties and their impact on credit growth. The results suggest that economic policy uncertainty is a drag on European banks' credit growth. The negative effect of economic policy uncertainty on loan growth in-

creases with debt maturity and weakens for banks with a larger number of employees.

Karadima & Louri (2021) examined the impact of economic policy instability on NPL growth in banks. In their study, the authors analysed data from 507 banks in four major Eurozone economies (France, Germany, Italy, and Spain) from 2005 to 2017. They found that uncertain economic policies have a positive effect on NPLs, but the effect decreases significantly in countries with higher bank concentration. Sporta (2018) confirmed the interdependence of financial performance and capital adequacy. Correlation and panel regression analyses revealed that NPLs have a significant impact on commercial banks' asset quality. The results of the study suggest a positive relationship between poor bank asset quality and poor financial performance, indicating the need to set additional guidelines for banks to prevent the proportion of non-performing loans.

Using bank-level data in 19 major economies, Hu & Gong (2019) examined theories of bank lending, economic policy uncertainty, and national prudential regulations. They found that economic policy uncertainty significantly inhibits growth, but the effect varies across banks. In particular, the negative effect of economic policy uncertainty on loan growth is bigger for large and riskier banks, while it is smaller for liquid and diversified banks. Moreover, the impact of volatile economic policies on bank lending depends crucially on national prudential regulations, so the negative effects appear to be mitigated by macro- and microprudential measures.

The impact of economic instability on bank risk was studied by Wu et al. (2020). They used bank-level panel data from 1,500 banks in 34 developing countries from 2000 to 2016 and found consistent and strong evidence that bank risk increases as economic uncertainty increases. They also examined the mechanisms through which economic uncertainty affects bank risk, and presented evidence that the relationship between uncertainty and bank risk is due to the option value of wait-and-see, return strategies, and bank behaviour rather than various side effects.

Mahmood et al. (2019) examined the effect of external factors on bank liquidity in the period from 2000 to 2017. In their analysis, they used macro-specific factors: GDP, inflation, monetary policy and unemployment, and for banking factors they used banking crises, bank size, total deposit and bank profitability. The results of the analysis reveal that macroeconomic factors significantly affect bank liquidity. Empirical results show that total deposits, GDP, bank size and unemployment have a negative effect on bank liquidity, while monetary policy, banking crisis and profitability have a positive effect on liquidity. Inflation has an insignificant relationship with liquidity.

Klein (2013) explains in his work that the level of problem loans can be attributed to macroeconomic conditions and bank-specific factors. While NPLs are found to respond to macroeconomic conditions, such as GDP growth, unemployment and inflation, the analysis also shows that there is a strong feedback loop between the banking system and the real economy, suggesting that a high proportion of NPLs in many CESEE countries has a negative effect on the pace of economic recovery.

Analysing a sample of data collected in 75 countries, Beck et al. (2013) confirm that the following variables produce an effect on NPL ratios: real GDP growth, stock prices, exchange rates and interest rates on loans.

By analysing quarterly data from banks in the euro area for the period from 1990 to 2015, Dimitrios et al. (2016) found that macro variables such as the unemployment rate and economic growth are interconnected. In addition, bank-specific variables related to management within banks affect the future movement of NPLs.

Ashraf & Shen (2019) use the economic policy uncertainty index to analyse bank-level data from 17 countries for the period from 1998 to 2012 and find that state-level economic policy uncertainty has a significant positive relationship with gross bank loans. More specifically, a one standard deviation increase in the economic policy uncertainty index leads to a 21.84 basis point increase in average interest rates on gross bank loans. It can be assumed that economic policy uncertainty increases the price of bank loans, thereby increasing the risk of loan default. The results suggest that government economic policy uncertainty is an economically important risk factor in the pricing of bank loans.

3. Methodology

Following the authors who have studied the relationship between macroeconomic variables and the financial system, including Messai et al. (2015), Ahmad et al. (2016), Mazreku et al. (2019), Levine (1997), Granville & Mallick (2009), Castro (2013), and Agnello & Sousa (2013), and others, empirical analysis was conducted of selected macroeconomic and banking variables: NPL, GDP, inflation, interest rate trends, bank loans trends, and unemployment rate.

In order to achieve the intended goal, variables from publicly available databases on the business activity of banks in Croatia in the period 2010 to 2022 were used in the analysis, as well as the trends in macroeconomic variables in the period 2010 to 2022. The sources include the Croatian National Bank (CNB) and the Central Bureau of Statistics databases. Data were collected for the period from 2010 to 2022 to cover the period before, during and after the financial crisis. This quantitative information is based on independent and dependent factors that reveal the banking, industrial and macroeconomic determinants of banking system profitability in Croatia.

For the purpose of analysis in the category of macroeconomic variables, the following variables were used:

- gross domestic product (GDP),
- inflation rate, and
- unemployment rate.

In the category of banking variables, the following indicators were used:

- share of NPLs in the total bank loans,
- trend in the interest rate margin, and
- trend in bank loans.

The data on GDP trends and the relation to the previous quarter were taken from the Central Bureau of Statistics database. For the analysis, the quarterly changes in the trend of GDP compared to the previous quarter are presented. The data on the trend of inflation on a quarterly basis were taken from the website of the Central Bureau of Statistics.

Data on the trend of the unemployment rate were taken from the website of the Croatian Bureau of Statistics, also on a quarterly basis.

Data on the trend of NPLs over the years were taken from the CNB official online statistical database on the trend of partially and fully recoverable loans relative to total loans (data available from 2008 to 2016). Data on the ratio of NPLs to total loans for the period from 2016 to 2022 were also taken from the CNB official website (the methodology changed). Quarterly NPL trends by year were used for data analysis.

A variable bank loan is a financial asset in the form of granted loans, debt instruments and other receivables, classified by a credit institution into categories of financial instruments, in accordance with its business policies, and according to the International Accounting Standard 39 Financial Instruments: Recognition and Measurement (hereinafter: IAS 39). Data on bank loan trends were obtained from the CNB official online statistical database on monetary and credit aggregate trends. Loan trends are reported on a monthly basis, and only quarterly figures are used for this analysis. The calculation was made by averaging the absolute monthly amounts.

The interest rate margin also affects bank liquidity. For the analysis in this paper, the differences in interest rates for newly approved loans and deposits were used.

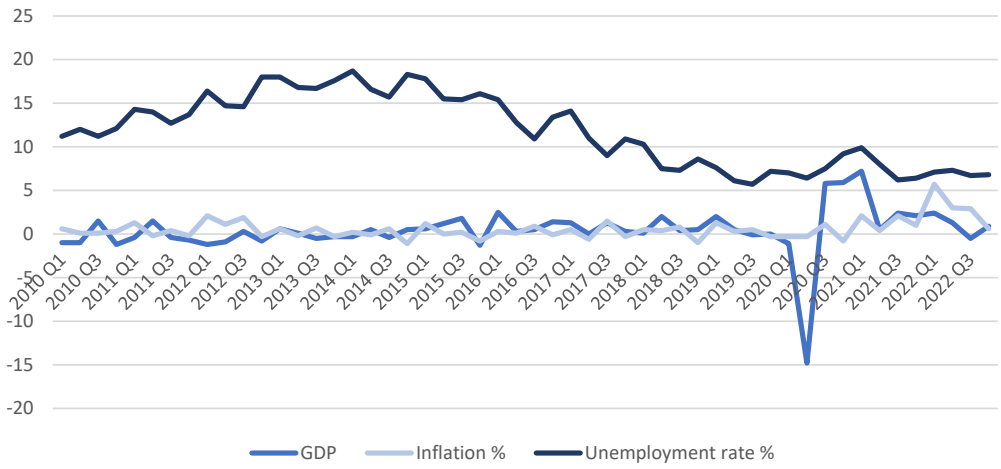
After calculating the quarterly margin indicators, the changes in the margin compared to the previous quarter were calculated for the analysis of the interest margin. Data on changes in interest rates on loans and deposits were taken from the database on the CNB website.

To determine the intensity and direction of the relationship between macroeconomic variables (GDP, inflation rate, unemployment rate) and banking variables (NPL, interest rate margin, loans), time series analysis and correlation analysis were performed. Regression analysis was performed to determine if the macroeconomic variables could explain some of the changes in the banking variables. Data analysis was performed using Microsoft Office Excel and the statistical software IBM SPSS (Statistical Package for Social Sciences).

3.1 Empirical data and analysis

The movement of selected macroeconomic variables, i.e., GDP, inflation and unemployment rate in Croatia by quarters from 2010 to 2022, is shown in Figure 1. Observing the movement of the aforementioned variables in the mentioned period and comparing the individual movements gives a detailed insight into possible relationships between the individual variables and their movements.

Figure 1 Movement of macroeconomic variables in Croatia by quarter (from 2010 to 2022)

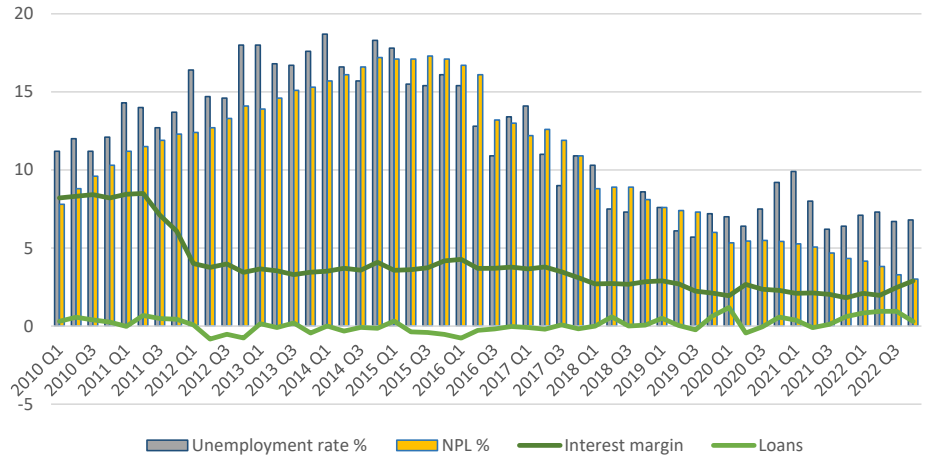


Source: Authors, 2023

A more significant deviation from the trend for all three variables was recorded in the last quarter of 2010 - a negative GDP growth rate (-1.2%), a 12.1% increase in the unemployment rate, and a 0.3% increase in inflation. After 2010, the unemployment rate recorded an upward trend (with minor deviations) and peaked in the first quarter of 2014 (18.7% growth). After 2014, a downward trend was recorded, and in the third quarter of 2019, a decrease of 5 percentage points in the unemployment rate was observed. Regarding inflation trends, the highest growth rate was recorded in the first quarter of 2012 at 2.1%, while the lowest inflation rate was measured in the fourth quarter of 2014, after the economic recovery from the global crisis. From 2014 to 2020, the inflation rate shows a relatively steady trend before rising sharply in the third quarter of 2021 and reaching its highest level in the last decade in 2022. After the third quarter of 2010, minor deviations in the movement of GDP were recorded until the first quarter of 2016, when GDP fell by 2.5%. The most significant drop was recorded in 2020, when it fell by 14.8% due to the coronavirus pandemic, but by the end of Q1 2021 it recorded the highest growth of the last decade, at 7.2%. Due to COVID-19 in 2020, many countries had to take measures to limit economic activity, and the movement of people affected quarterly national accounts aggregates and the quality and availability of many data sources commonly used to assess gross domestic product (GDP). The data show that the pandemic had a strong impact on the slowdown of the Croatian economy in 2020. In fact, 2020 was characterised by the implementation of a series of measures aimed at preserving economic activity and, in particular, measures aimed at preserving jobs due to developments in the labour market that did not follow a sharp decline in the level of overall production. This, of course, had a significant negative impact on public finances and movement of public debt in Q1, Q2 and Q3 2020. GDP growth in Q3 and Q4 2020 is partially the result of the weakening of restrictive measures caused by COVID-19 and the structure of the Croatian economy. In Croatian GDP, tourism has a major impact on the movement of GDP, which had a positive effect on the movement of GDP in Q3 2020 (Croatian Chamber of Economy, 2021). In Q4 2020 and Q1 2021, the continuation of the positive GDP growth trend was partially caused by the measures taken by the European Union to stimulate the stability of the Croatian economy.

In parallel with the movement of the macroeconomic variables over time, a time series for the movement of the banking variables was created for the same period, i.e., from 2010 to 2022, which can be seen in Figure 2.

Figure 2 Movement of banking variables and unemployment in Croatia by quarter (from 2010 to 2022)



Source: Authors, 2023

In the last quarter of 2010, significant trend deviations were observed for all four variables, especially for NPL. Since 2010, there has been an increase in NPL, with a peak in the third quarter of 2015, followed by a downward trend that is still ongoing.

In the third quarter of 2011, a significant movement of the interest rate margin in the negative direction was recorded. The main cause of an imbalance in interest rates in 2011 is the result of a sharp increase in the interest rate on kuna deposits (HRK, Croatian currency) in 2009, when the average interest rate was 9%. The consequence of this rapid increase is a reaction to the crisis that began. The deterioration of the international and domestic macroeconomic environment due to the impact of the global financial crisis had a significant impact on financial stability in 2009. To prevent the withdrawal of deposits, banks were forced to raise interest rates. These high interest rates remained in effect until the 3rd quarter of 2011.

In 2009, bank lending reached 4%, the lowest level in recent years. This is not shown in Figure 2, but it is important because it explains the movement of the variable in the coming years. After 2009, the volume of bank loans increased, as did the other observed variables. The positive trend continued until the end of the third quarter of 2015, and after 2015 it turned into a negative trend, which was also observed in the last quarter of 2019. The period from 2009 to 2015 was characterised by an economic crisis, and the demand for liquid assets was high. As of 2016, demand for bank placements decreased due to deleveraging after the Great Crisis, while the period after 2019 saw a sharp decline in interest rates, which led to an increase in investment and, consequently, an increase in placements.

Linear movements of the unemployment rate and the NPL shown in Figure 2 are fully aligned. An increase in the unemployment rate reduces liquidity and thus increases non-performing loans on bank balance sheets.

In his paper, Sam (2014) observed a relationship between the federal funds rate, business confidence, and unemployment. Reduced business confidence and a reduced federal funds rate contribute to higher unemployment rates. Reducing the unemployment rate can help businesses hire more employees, starting with lower interest rates on loans. This implicitly leads to an increase in the volume of loans granted to businesses (Hashima et al., 2021).

When unemployment is high, the population has liquidity problems, which limits bank lending. Banks do not have enough creditworthy customers because unemployment is high. Monetary policy, together with policymakers, play a dominant role in controlling the interest rate on loans, the volume of NPLs and the unemployment rate (Nițescu &

Anghel, 2023). Unemployed people are insolvent because they do not have regular income and therefore do not meet the basic criteria for borrowing, i.e., they lack creditworthiness, which is the basis for repaying the borrowed funds. Therefore, when unemployment is high, bank lending is restricted, leading to a decrease in bank loans.

4. Results

Correlation analysis was performed for the macroeconomic variables (gross domestic product - GDP, inflation rate, unemployment rate) and the banking variables (non-performing loans - NPL, interest rate margin, loans) described in the previous chapter and presented in Table 1 using descriptive statistics, as can be seen in Table 2.

Table 1 Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
GDP	52	-14.800	7.200	.448	2.764
Inflation rate	52	-1.100	5.700	.587	1.162
Unemployment rate	52	5.700	18.700	11.815	4.115
NPLs	52	3.010	17.300	10.652	4.463
Interest rate margin	52	1.817	8.497	3.838	1.904
Bank loans	52	-.830	1,190	.090	.457

Source: Authors, 2023

The gross domestic product size is not significantly correlated with any of the observed banking variables. The Pearson coefficients show that there is a statistically significant positive relationship between the variable "unemployment rate" and the variables "NPL" ($r = .890$, $p < .001$) and "interest rate margin" ($r = .361$, $p < .01$). This means that an increase in the unemployment rate leads to a significant increase in the NPL, but also in the interest rate margin. On the other hand, there is a statistically significant negative relationship between the variable "unemployment rate" and the variable "loans" ($r = -.477$, $p < .001$). This means that an increase in the unemployment rate leads to a significant decrease in loans. According to the Pearson coefficient, there is a statistically significant negative relationship between the variable "inflation rate" and the variable "NPL" ($r = -.385$, $p < .01$) and a statistically significant positive relationship between the variable "inflation" and the variable "loans" ($r= .335$, $p < .05$). This means that an increase in the inflation rate leads to a significant decrease in NPL but an increase in loans.

Table 2 Illustration of correlations between macroeconomic and banking variables

Variables	NPLs	Interest rate margin	Loans	GDP real growth rates	Inflation	Unemployment rate
Interest rate margin	.280*					
Loans	-.604***	.031				
GDP real growth rate	-.079	-.142	.221			
Inflation	-.385**	-.202	.335*	.218		
Unemployment rate	.890***	.361**	-.477***	-.050	-.290*	

Statistical significance: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Source: Authors, 2023

Regression analysis was performed to determine whether macroeconomic variables can explain some of the changes in the interest rate margin, bank loans, and NPLs. To meet the assumptions

for calculating regression analysis, the collinearity results (tolerance and the variance inflation factor) were checked and they were within acceptable values. The tolerance values ranged from .874 to .952 (according to the general rule, the assumption of collinearity of independent variables is violated when the tolerance indicator is less than 0.2 (Horvat & Mijoč, 2019)), whereas the variance inflation factor values ranged from 1.050 to 1.444 (according to the general rule, the assumption of collinearity of independent variables is violated when the variance inflation factor is greater than 10 (Horvat & Mijoč, 2019)). Although the value of the Durbin-Watson indicator depends on the number of independent variables in the model, according to the general rule, values below 1 and above 3 are assumed to indicate a violated assumption (Field, 2018). Testing the assumption about the correlation of the residuals using the Durbin-Watson criterion yielded an acceptable result of 1.20.

Three analyses were conducted in which the predictor variables were the unemployment rate, the movement of gross domestic product and the inflation rate, while the criterion variables were NPLs, bank loans, and interest rate margins (Table 3).

Table 3 Overview of the regression analysis results

	Model 1	Model 2	Model 3
	Interest rate margin	**NPLs**	**Bank loans**
GDP	-.107 (.094)	-.007 (.104)	.161 (.021)
Inflation rate	-.083 (.233)	-.137* (.258)	.179 (.051)
Unemployment rate	.331* (.064)	.850*** (.071)	-.418** (.014)
R^2	.151	.900	.543
Adjusted R^2	.098	.798	.295
F	2.852*	68.251***	6.693***

Statistical significance: *p < 0.05; **p < 0.01; ***p < 0.001. Standard errors are reported in parentheses.

Source: Authors, 2023

Model 1 examined the relationship between the criteria and the predictors to determine the extent to which changes in the predictors (GDP, inflation rate and unemployment rate) affect changes in the criterion (interest rate margin). A significant regression equation was found ($F(3, 48) = 2.852$, $p < .05$), with an R2 of .151. Data analysis yields a coefficient of determination of 0.151, which means that 15.1% of the variance in the interest rate margin can be explained by the variability of the predictors included in the model. The remaining variability in the criterion is likely to be explained by other factors not included in this model. The predictor found to be significant is the unemployment rate ($\beta = .331$, $p < .05$). There is a statistically notable relationship between the unemployment rate and the interest rate margin, which in turn means that there is a positive linear relationship between the unemployment rate and the interest rate margin. Specifically, for every unit by which the unemployment rate increases, the interest rate margin increases by 0.331 units, holding all other variables in the model constant. The other variables in the model do not contribute significantly to the interest rate margin. This could mean that when the unemployment rate increases, demand for loans is also lower. However, banks could respond by raising the interest rate, which would probably widen the interest rate margin compared with the period prior to the lower unemployment rate.

Model 2 examined the relationship between the criteria and the predictors to determine the extent to which changes in the predictors (GDP, inflation rate and unemployment rate) affect changes in the criterion (non-performing loans – NPL). A significant regression equation was found ($F(3, 48) = 68.251$, $p < .001$), with an R2 of .810. The analysis indicates a very high coefficient of determination, that is, 81% of the variance of non-performing loans can be

explained by the unemployment rate, the level of gross domestic product and inflation. The remaining 19% of the NPL variance remains unexplained in this model. Observing the independent contributions of individual variables, the inflation rate and the unemployment rate are significant predictors. A smaller but significant contributor to the inability to pay loans is the inflation rate (β = -.137, $p < 0.05$), implying that there is a negative linear relationship between inflation and NPL. Specifically, each one-unit increase in the inflation rate is associated with an expected 0.0137-unit decrease in the value of the NPL. On the other hand, as expected, the unemployment rate is a positively significant predictor and also the highest predictor in this model (β = 0.850, $p < .001$), which in this case means that the non-performing loan rate increases by 0.850 units when the unemployment rate increases by one unit. This result is quite expected given that the inability to repay the loan is likely indicative of a permanent income loss.

Model 3 examined the relationship between the criteria and the predictors to determine the extent to which changes in the predictors (GDP, inflation rate and unemployment rate) affect changes in the criterion (bank loans). A significant regression equation was found ($F(3, 48) = 6.693$, $p < .001$), with an R2 of .295. The results of the analysis show that the coefficient of determination is 0.295, which means that the independent variables (unemployment rate, GDP and inflation) explain 29.5% of the variance of bank loans in the market, while the remaining 70.5% of the variance is not explained by these variables. Looking at the independent contributions of each variable, only the unemployment rate is a significant predictor (β = -.418, $p < .01$). The beta weight for the unemployment rate is -0.418, indicating that there is a negative relationship between the unemployment rate and bank loans in the market. When the unemployment rate is higher, bank loans in the market will be lower, while a decrease in the unemployment rate will lead to an increase in bank loans. In addition, a beta weight of -0.418 means that bank loans change by 0.418 units for every one-unit increase in the unemployment rate.

5. Discussion and conclusion

To investigate the economic relationship between macroeconomic and banking variables, various estimates were conducted. The short- and long-term dynamics of active and passive interest rates, the movement of NPLs and bank loans, and the impact of movements in the inflation rate, GDP and unemployment rate on the business policies of banks in Croatia were examined. The aim of this paper was to show the interdependence between the macroeconomic environment and the financial system, i.e., to highlight the importance of various macroeconomic factors and their impact on the banking system in Croatia.

The analyses conducted show that some economic trends play an important role in the bank business policies. Of the total six indicators used, the empirical model showed a relationship between economic trends and the financial system for five variables. The results of the analysis show a significant correlation between the macroeconomic variable unemployment rate and all banking variables (NPL: $r = .890$, $p < .001$; interest rate margin: $r = .361$, $p < .01$; loans: $r = -.477$, $p < .001$), and between the macroeconomic variable inflation rate and the banking variables: NPL ($r = -.385$, $p < .01$) and loans ($r = .335$, $p < .05$). These findings are aligned with previous research, such as the studies of Makri et al. (2014), Beck et al. (2013), and Dimitrios et al. (2016). One macroeconomic variable, GDP, has no influence on the bank policy. None of the banking variables showed a relationship with the GDP movement which is a very interesting discovery. These findings are not aligned with previous research, such as the studies of Ashraf & Shen (2019), Castro (2013), and Mahmood et al. (2019), which examined the relationship between macroeconomic variables and the financial sector and found that GDP is an important influencing variable. In this work, no correlation was found between the movement of GDP and the movement of the banking variables. The unemployment rate is the predictor that is significant for all banking variables (interest rate margin: $\beta = .331$, $p < .05$; NPL: $\beta = .850$, $p < .001$; loans: β = -.418, $p < .01$), while the inflation rate is the predictor that is significant only for non-performing loans (β = -.137, $p < .05$).

In this analysis, no direct relationship was found between GDP movements and banking variables. This implies that internal bank policy is more likely to be affected by changes in inflation and unemployment rates than by GDP movements. Other factors like unemployment and inflation have a direct impact on bank operations, while GDP has an indirect impact through the unemployment rate and lower

economic activity, which leads to constraints on the provision of new bank loans and margins.

Since the GDP formula is composed of private consumption, gross private investment, government investment, government spending, and exports and imports, it stands to reason that all of these variables should affect banking. Whether all GDP variables or only some of them have an impact on banking variables is beyond the scope of this study. The question is how large should the variation in any one GDP variable be and how long (how many quartiles or years) it takes to affect the banking variables. This could be a recommendation for further research.

The analyses conducted show that economic development plays a role in bank business policies. The macroeconomic indicators discussed influence both the business policy of banks and the stability of the financial system. Positive, stable macroeconomic development creates financial security. In a stable economy, commercial banks, driven by the desire to maximise profits, will pursue an expansionary credit policy to increase bank assets. Due to the increased demand for credit, the expansionary credit policy leads to a decline in interest rates, which has a positive effect on investment growth and boosts economic activity, especially investment.

The analysis conducted in this paper shows that credit risk on bank balance sheets declines when certain macroeconomic conditions improve. This, in turn, helps reduce the stock of non-performing loans (NPLs) on the bank balance sheets, allowing better credit conditions for productive firms and households. Bank profitability creates additional capital, which positively affects the ability to raise additional funds to finance the economy. The success of monetary policy and its impact on real economic development depend on the quality of the credit channel. Changes in monetary policy can affect prices and the availability of credit to the real sector, which directly affects economic growth and development.

The research findings contribute to the theory of the relationship between macroeconomic and banking trends in a broader context and confirm their important role in shaping the country's economic development, in which bank credit risks play a crucial role. The results can be particularly useful for bank management and the government, as they provide all stakeholders with important information on the role of macroeconomic policies of financial institutions in Croatia and, consequently, the Croatian economy. Bank management is recommended to use models for monitoring changes in the development of macroeconomic variables that have a proven direct impact on the banking system when creating and developing tools that lead to an improvement in the functioning of financial institutions and the stability of the financial system. Finally, the reader should keep in mind that the study is somewhat limited due to the specifics of the Croatian banking system, as it is based on a small sample. Future studies could overcome this limitation by using a larger sample that includes more banks from different Eurozone or Central and Eastern European countries. A potential problem with such an analysis is the wide range of comparable data that must be collected from many different sources for many different countries for which data are often not publicly available.

It would also be interesting to investigate in further research whether, conversely, changes in bank business policies affect economic development, i.e., to what extent banks as the main actors in the Croatian financial market can influence changes in macroeconomic variables with their business policies. For the purposes of analysis, it is advisable to observe the variables over a longer period of time before, during and after the economic crisis.

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JEL: M21, L84
Original scientific article
https://doi.org/10.51680/ev.36.2.10

Received: August 10, 2023
Accepted for publishing: October 10, 2023

CAREER SWITCH: CONSULTANCY SUPPORT FOR NEW ENTREPRENEURS

Abstract

Purpose: This paper examines the consultancy process in small and medium-sized enterprises (SMEs), focusing on consulting entrepreneurs at the beginning of their entrepreneurial career chosen out of necessity due to a terminated long-term employment contract in a public company.

Methodology: A qualitative study design was adopted to look into the consultancy process with five new entrepreneurs who participated in a program that combined trainings and consultancy sessions. Text analysis of written feedback from consultants was conducted to understand the challenges entrepreneurs faced and progress they made. Evaluation sheets with closed and open questions were analyzed to explore the effects of the program and the entrepreneur satisfaction with the program. Five years after completing the program, semi-structured interviews were conducted to identify the current status of the entrepreneurial ventures.

Results: In this study, the success of the consultancy process was threatened by time constraints and a lack of comprehensive reasoning behind client motivation to become entrepreneurs. These were the most detrimental factors for the client-consultant relationship, which ended up lacking transparency and thoroughness.

Conclusion: Research results indicate the importance of consultant's efforts to contextualize the client's decision to become an entrepreneur. Investing time in building a client-consultant relationship as well as providing long-term follow-up support proved to be crucial to ensuring a positive impact of consultancy support for entrepreneurs starting a new business.

Keywords: Consultancy support, consultancy process, new entrepreneurs, SMEs

1. Introduction

Consultancy started to appear as a research topic in scientific circles in the middle of the 20th century. During the 1940s, in the early stage of development, consultation "was viewed as a direct service to clients or to client systems" (Kurpius & Robinson, 1978, p. 321). In that early stage of consultancy developing into a profession, but also an important research topic, consultancy was associated with solving difficult problems, and there was no effort put in building a relationship between the consultant and the client. It was believed that a good consultancy job would mean that the client will never need the help of a consultant again. By the end of the 1950s, researchers and practitioners concluded that the client should take an active part in the consultancy process to increase their ability to solve similar problems in the future (Kurpius & Robinson, 1978). During the 1970s, according to Chandler (1973), being a trainer was identified as one of

the important roles of the consultant in a consultancy process. In the early 1980s, consultancy was usually seen as a collaborative process in which a consultant assumes the role of a change catalyst or a change agent. Because of different roles that a consultant can take, there is a continuous "struggle over the definition" (Fincham et al., 2013, p. 5), but most of the researchers agree that consultants should not only react to existing problems but take a more proactive role in shaping a desired future.

O'Mahoney & Markham (2013, p. 11) provide a definition of consultancy as "the creation of value for organizations, through the application of knowledge, techniques and assets to improve business performance", while Stroh (2019, p. 3) defines a consultant as "someone who either advises a client on the desirability of taking some action, or who assists the client in making a decision and then helps the client in planning or implementing action as determined by the client".

Recent research results also point to consultancy as a professional service that helps clients in planning and implementing actions that they come up with (Biech, 2019; Stroh, 2019; Cerruti et al., 2019; da Costa et al., 2020). The role of a consultant is to provide guidance and professional knowledge, while a client is responsible for the goals and vision. Hence, the relationship between the consultant and the client affects the anticipated plan of reaching the goals determined by the client. In that sense, the whole consultancy process depends on the relationship built between the consultant and the client, but also on the determination of the client to implement the proposed professional or expert advice.

According to Fincham & Clark (2002), the consultancy industry experienced tremendous growth, but knowledge about this industry was sparse. "To date, detailed conceptual and empirical research into the work of consultants has been slight. Much, therefore, remains to be done if we are to develop a more penetrating and nuanced understanding of this activity" (Fincham & Clark, 2002, p. 3). More recent studies confirm the importance of consultancy but a complete understanding of the industry is still lacking (Cerruti et al., 2019). Most of the literature is focused on Anglo-Saxon experiences, while little is known about the role of consultants in SMEs and emerging markets (Cerruti et al., 2019).

The purpose of this paper is to contribute to existing knowledge, focusing on identified knowledge gaps. The paper follows the consultancy process and identifies crucial determinants for a successful consultation process for employees dismissed from a public company who had to change their careers and decided to start their own companies. The paper especially focuses on the roles of consultants and a relationship built during the consultancy process among consultants and new entrepreneurs as clients.

The structure of this paper is as follows: a review of relevant literature on the role of consultants is given in Section 2, while Section 3 provides a review of literature on the consultancy process, which is then followed by Section 4 examining the specific role of consultants in the development of SMEs. The focus then turns to the methodological issues related to the study in Section 5. The empirical results of the research are analyzed in Section 6, where key determinants are identified for a successful consultation process with entrepreneurs at the beginning of their entrepreneurial career. Section 7 concludes the paper, suggesting potential avenues for future research on the consultancy process and support for senior entrepreneurs, and offering some early policy recommendations.

2. The role of a consultant

Previous literature provides a multidimensional overview of the role of consultants in problem-solving and solution-finding situations. Werr & Styhre (2002) argue that clients usually ask for a knowledge-based service from a more objective point (outside of the enterprise). Consultants can, according to Kubr (1996), provide a fresh perspective given that they are not a part of the organization. Consultants bring unique and independent aid aimed at solving problems (Drucker, 1979). Fincham & Clark (2002) highlighted the role of consultants as the role of "expert outsiders" that play a role of "sector specialists". Da Costa et al. (2020) see the role of consultants as influential and powerful for organizational changes, while Crucini & Kipping (2001) emphasize the role of consultants as global change agents.

Business consultants are expected to improve performance, solve problems, and find new and better ways of doing things in private and public enterprises (Cerruti et al., 2019). Turner (1982) clustered the role of consultants into eight fundamental objectives: (1) provide requested information to a client, (2) provide a solution to a given problem, (3) conduct an investigation that may redefine the problem, (4) provide recommendations, (5) assist with the implementation, (6) build a consensus and commitment, (7) facilitate client learning, and (8) improve organizational effectiveness. Considering that consultants play many roles and help clients

solve major challenges, they are usually presented in a positive light, and portrayed as "wizards" or "agents of stability" (Furusten, 2009). However, some researchers question glorification of the role of consultants. O'Shea & Madigan (1998), Fincham & Clark (2003), Hicks et al. (2009) and Sturdy (2011) see consultants as "shock troops", "capitalism's commissars", "promoters of new management fashions", "pre-eminent knowledge brokers" and "corporate puppets". Negative connotations arose mainly from ethical and sensitivity concerns (Sturdy, 2009).

The role of the consultant mainly depends on the client. According to Schein (1978) and Stroh (2019), there are two main roles of consultants – they act as content experts or process facilitators. A content expert provides expert help or advice, without involving clients in the process. That role is explained and described in literature as a "doctor-patient" consultancy process. A process facilitator implies client involvement in the process, where the role of the consultant is to assist the client through the problem-solving process. Research by Werr & Styhre (2002) and da Costa et al. (2020) suggests that the "doctor-patient" type of relationship does not provide the maximum benefit that consultancy could provide to clients.

The relationship between the consultant and the client is a focal issue in consultancy work (Werr & Styhre, 2002). The value of consultancy work is "to a large extent produced in the client-consultant relationship" (Clark, 1995, p. 12). This relationship is the key issue in all consultancy literature, with two opposite streams (Werr & Styhre, 2002).

The first one, called "functionalist" literature, presents the client as a buyer of a knowledge service where the consultant has superior knowledge and expertise. This stream is focused on how to construct a successful client-consultant relationship (Kubr, 1996; Block, 2000). Their relationship is contractual, and the client controls the relationship and the process. The success of this relationship lies in the ability of the consultant to "understand and accommodate the client's professional, psychological, and social needs" (Bergholz, 1999, p. 29). The second one, known as "critical" literature, portrays clients as victims of impression management. According to the critical approach, consultants have to convince clients of their value, despite the lack of a formal knowledge base (Clark, 1995). Critical literature is focused on the "impression management" where consultants present the problem in a way that allows the problem to be solved (Bloomfield & Best, 1992). According to Clark & Salaman (1998), consultants, their ideas and techniques play a central role in problem identification and consultancy process implementation by controlling and solving them, thus reinforcing their positive image. In critical literature, the client is a victim of an exploitive relationship, controlled by consultants. This relationship is dependent on repeat sales, the character of inter-firm and managerial structures, but also on the knowledge and expertise of the client (Werr & Styhre, 2002).

Despite different approaches to the client-consultant relationship, both streams of literature and researchers agree on the importance of that relationship for a successful consultancy process and results. Regardless of the position of the client in the client-consultant relationship (the leader or the victim), determinants that will decide on a successful relationship and project results are the same (Table 1).

Table 1 Most important determinants of the client-consultant relationship

Source	Determinant of a successful client-consultant relationship
Kubr, 1996	rational and competent buyer (client)
Schein, 2002	doubt about consultants' work
Kubr, 1996; Schein, 2002; Werr & Styhre, 2002; Connely et al., 2012; Salvador et al., 2019	trust
Fincham, 1999; Fincham, 2010; Schein, 2002	professional, psychological, and social needs of the client
Clark & Salaman, 1998; Fincham, 1999	competence and self-confidence of the client
Maister, 1993; Kubr, 1996	fear of dependence
Kipping, 2002	cultural context (norms)
Karantinou & Hogg, 2001; Nikolova et al., 2015	empathy and honesty of the consultant
Sartain, 1998; Newton, 2019	characteristics of the consultant
Curran, 2000; Damanpour & Schneider, 2009	lack of understanding of client needs and requirements

Source: Authors

Czerniawska (2004) noted the following determinants of good consultancy work: clients want consultants to do what they said they will do, when they said they will do and according to the budget. According to Czerniawska (2004), the best consultants will bring wealth of experience, have the courage of their convictions and a good reputation, and build strong relationships with the client.

3. The consultancy process

The consultancy process is usually seen as "a sequence of typical activities from the beginning of the consultancy project to the end" (Haslam, 2017, p. 33) or "a chain of intangible activities" (Christensen & Klyver, 2006, p. 309) that lead the consultancy project from the beginning to the end. Although literature revealed limited knowledge of understanding the consultancy process and a lack of understanding of the key determinants in the process, most researchers define the process similarly and have a unified view of the process activities.

Haslam (2017) identified the following six phases of the consultancy project: new business, agree contract, diagnosis/problem definition, development of the solution/insight, delivery of objectives, and exit and debrief. Stroh (2019) defines the process similarly, but emphasizes the first step in which she proposes setting goals and expectations. Kurpius et al. (1993, p. 601) provide the most comprehensive approach to the consultancy process. According to them, the consultancy process requires a multidimensional approach, stressing "high-quality process skills".

The consultancy process commonly occurs in six phases (Kurpius et al., 1993), i.e. preentry; entry, problem exploration and contracting; information gathering, problem confirmation and goal setting; solution searching and intervention selection; and evaluation and termination. The preentry phase is explained as regular self-assessment of the consultant and their ability to solve the problem. This phase is seen as a critical aspect in a consultant's approach toward clients' personal beliefs and creation of a conceptual framework for solving the problem. The entry phase, i.e. the phase in which the problem is explored and the process is contracted, is crucial to the success of the consultancy process. This is the phase in which, according to Czerniawska (2006), promises are made. Promises are the basis for a successful client-consultant relationship, client satisfaction and a good reputation of the consultant (Czerniawska, 2006). Without a clear purpose and goals, the consulting project will fail (Werr & Styhre, 2002). The entry phase should provide a better understanding of the problem and the culture around the problem. Every stage of change (development, maintenance, decline and crisis) requires a different approach, but also an understanding of the clients' readiness to embrace change. If the client does not accept change, Kurpius et al. (1993) suggest not to accept the project, since there is little opportunity for making some changes and the end results will not satisfy either the client or the consultant. The consultancy process continues with information gathering and solution searching. The last phase, evaluation and termination, provides further development of the relationship between the client and the consultant, but also building a good reputation for consultants.

According to Kurpius et al. (1993), determinants of the successful consultancy process are: a system or a client open to change, an effective working relationship, good data, supportive change culture, accurate problem definition and accurate implementation of the solutions. A successful consultancy process will ensure optimal results for both parties, clients and consultants.

4. Consultancy process in SMEs

The consultancy process is rarely seen as an important topic among researchers, especially those researching SMEs (Sturdy, 2011; Glodek et al., 2016). According to Sim & Rogers (2008), despite the importance of SMEs, there has been scant research on their demand for external advice that would increase their competitiveness. Furthermore, there is a lack of theory about SMEs and their requirements in the consultancy process (Curran, 2000).

According to Bennett & Robson (1999), SMEs have a greater need for external advice than larger enterprises, but they are also more reluctant to ask for advice. Because of that reluctance to seek external advice, there are a considerable number of government initiatives and business support institutions aimed at encouraging SME demand for consultancy services (Bennett & Robson, 1999; Gibb, 2000; Delic & Alpeza, 2017).

In SMEs, researchers have found evidence that consultancy enables "a closer link between the business

and technical part, better use of skills, knowledge and accountability of people" (da Costa et al., 2020, p. 672). Consultants' work is closely related to high productivity, a higher level of performance and improved knowledge flow through client-consultant connections (Fincham, 2010). Consultants are associated with shaping new perspectives, enabling changes, but also, according to Bergh & Gibbons (2011), with increased profitability. Research results suggest the necessity of training owners/managers while providing advice (Soriano et al., 2002; Salvador et al., 2019).

Interactive processes between consultants and clients in the SMEs are poorly understood (Engwall & Kipping, 2006). Although the consultancy process in SMEs will follow the same phases as the one in big enterprises, the relationship between the client and the consultant is more emphasized. Clark (1995) argues that this relationship should be very close, personal and trustful, and allow exchange of information on problems to be solved between the client and the consultant. Berry and Sweeting (2006) proved that among the determinants in the consultancy process for SMEs, the key roles are played by the "soft" ones: trust, relationships and professional ethics in the provision of business advice. Trust and reputation of the consultant can reduce information asymmetry (Clark, 1993). However, building reputation and trust is a process that takes time and requires repeated interactions (Salvador et al., 2019).

Although relationship appears to be the most important determinant in the consultancy processes, a critical view of consultants reveals one more "bottleneck" in the process, which is especially important for SMEs. Haas & Hansen (2005) argue that knowledge transfer should be thoroughly designed, since using knowledge can reduce task performance. Their findings suggest that in certain situations advice can increase the chances of losing projects, while the experience of the team increases them. Their conclusion was that knowledge utilization has an inverted U-shape specification, where effective design of knowledge transfer, together with carefully tailored promises, can bridge major bottlenecks in the consulting process.

5. Methodology

This paper is focused on the identification of the key determinants of a successful consultancy process when advising new entrepreneurs who started their business after being laid off from long-term employment in a public company. Considering the nature of the research topic, the study relies on qualitative research in attempt to understand the social and cultural context of the researched phenomenon (Silverman, 2011; Maxwell, 2013). A layoff in this case was a consequence of a large restructuring process of the company. Through contracting an external company, as part of the layoff support scheme, the company provided different kinds of support for employees who lost their jobs. Those who opted for self-employment were supported through training and consultancy in the first phase of their new venture creation. Consultants were contracted based on their previous experience of working with entrepreneurs, especially in terms of supporting processes of starting new businesses.

This research follows the training and consultancy process of five entrepreneurs in Eastern Croatia, which began in 2018 (Table 2). The most recent follow-up of their businesses was conducted in 2023, and is included in this paper.

Table 2 Main characteristics of entrepreneurs who participated as clients in the consultancy process

Code	Age	Work experience (years)	Business idea	Key competencies
C1	59	40	transportation service	willing to learn, conscientious
C2	51	33	transportation of firewood	willing to learn
C3	51	34	dried meat production	persistent, willing to work
C4	56	35	handyman services	good communication skills
C5	50	35	retirement home	experience in the sector and industry

Source: Authors

All clients were over the age of 50, with more than 30 years of work experience. Clients participated in 3 workshops, lasting for 4 hours each, on entrepreneurial process, strategy and planning, small business management, financial planning, negotiation skills and marketing. After completing the training, the consultancy process started with each of the five entrepreneurs choosing one of the trainers to work with in the consultancy process. The consultancy process lasted for three sessions during a two-month period.

Information on the progress made during the consultancy process was documented in the form of a questionnaire, where consultants described in detail the progress and challenges their client faced, as well as recommendations for the client and next steps in the consultancy process. In this research project, written observations of consultants were analyzed by using the interpretative approach where researcher focused on the wider context of the analyzed text (Johnson & Duberley, 2000).

In addition to data collected in the form of questionnaires filled in by the consultants, data were also collected from the five entrepreneurs who participated in the training and consultancy process. They filled in an evaluation sheet about their satisfaction with the training and consultancy process they participated in. The evaluation sheet combined both open-ended questions and numeric evaluation. Numeric evaluation provided an insight into the most and least successful aspects of the training and consultancy process.

Data collection also included telephone interviews conducted in July 2023 with trained entrepreneurs, where researchers identified the current state of their ventures. The information was double-checked by researching the database of the active companies and crafts in Eastern Croatia in July 2023.

6. Results

Prior to consultancy sessions and trainings, consultants were familiarized with the socio-demographic data of the five new entrepreneurs who participated in the program. The consultancy process followed the five-phase cycle (Kurpius et al., 1993) adjusted to the peculiarities of SMEs (Table 3).

Table 3 Phases of the consultancy process tailored to new entrepreneurs who have decided to start their businesses

Phase	Activities
Preentry	In this phase, consultants were contacted and chosen according to their experience in consulting SMEs, especially start-ups. Based on the socio-demographic data of participants shared with consultants prior to the initiation of the training program, consultants prepared a personalized plan for training. Consultants agreed to provide written reports (questionnaires) with their observations after each consulting session for the purpose of analyzing the progress of the participants and effects of the consultancy process.
Entry	The entry phase was a first contact between clients and consultants. All clients presented their business idea and explained why they have decided to start pursuing a career as entrepreneurs instead of trying to find a job, which was an alternative option they could opt for and get support. Clients were introduced with the training schedule, which was the first part of the consulting process. The training program consisting of 3 workshops was implemented during a two-month period.
Information gathering, problem confirmation and goal setting	After the training program was completed, consultancy sessions started, with the idea to work one-on-one on developing client's business ideas. The main task of this phase was to collect all information and data that could affect development of their business ideas. Clients also explained their goals and together with consultants they prepared an oral agreement on their deliveries (promises). Clients needed help in early development phases of their ventures where they secured the initial capital from their previous employer (severance pay). During the consultancy process it became apparent that all five program participants opted to become entrepreneurs, while their family members were already involved in entrepreneurial activity, in most cases in the informal market.

Phase	Activities
Solution searching and intervention selection	Consultants provided advice regarding strategy, marketing, and financial management. After completing the training and consultancy process that lasted for four months, entrepreneurs were left on their own. Since that was not part of the contract, consultants did not monitor future venture development.
Evaluation and termination	After completing the training and consultancy program, clients completed evaluation sheets to provide feedback on the usefulness of the training and consultancy support. Five years after completing the program, clients were contacted again to check if their enterprises were still operating and to which extent the program was helpful.

Source: Authors' research

Consultants' observations on the consultancy process

Preentry and entry phases in the consultancy process were carried according to the recommendations and results of previous research. The information gathering and problem definition phase revealed that four out of five clients are already helping their family enterprises. That phase helped consultants better understand professional, psychological, and social needs of the clients. Based on the analysis of the consultants' questionnaires, motivation for starting a business of new entrepreneurs was identified, as well as key challenges new entrepreneurs faced at the beginning of their entrepreneurial journey (Table 4).

Table 4 Client needs and problem identification

Code	Age	Motivation to start a business	Client challenges
C1	59	Working together with their son, who already has experience in the transport industry	How to formalize the ownership and management structure with their son? How to reach financial sustainability?
C2	51	Previous education on a topic relevant to the business idea	How to reach financial sustainability? How to find customers? How to research a low-budget market?
C3	51	Developed quality product	Pricing strategy How to reach the break-even point and how to calculate it?
C4	56	Helping their son in the realization of his business idea in managing his own business	How to find a niche? How to ensure consistency in product quality?
C5	50	Being one's own boss	What are the key regulations that need to be followed in the industry? How to become financially sustainable? What is my competitive advantage?

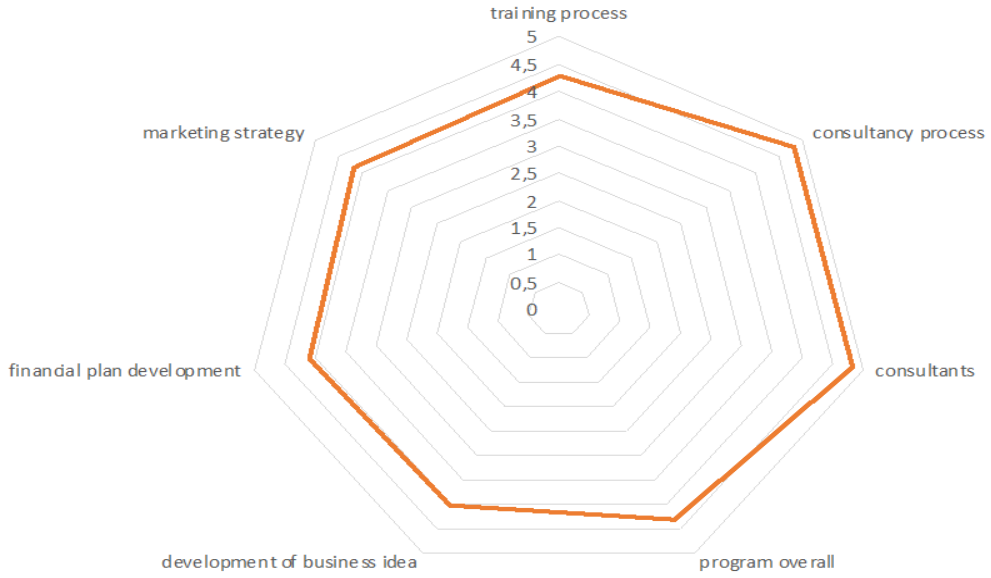
Source: Authors

The process of finding solutions was done through individual consultancy sessions with consultants in the fields identified as the weak points of aspiring entrepreneurs. Consultants served as facilitators, but, according to consultants' observations, clients did not want to be involved actively in the process - they expected fully formed solutions to their problems. All clients were aware that they had to change their career paths but were not willing to make radical changes.

Client satisfaction with training and consultancy process

The termination phase of the consultancy process revealed client satisfaction with the training and a change in the clients' level of knowledge about key subjects (marketing, finance and business idea evaluation), the consultancy process and consultants (Graph 1). On a scale from 1 (indicating the lowest level of satisfaction) to 5 (indicating the highest level of satisfaction), the participants gave the consultants the highest rating, and the business idea development workshop the lowest.

Graph 1 Client evaluation of the training and consultancy process



Source: Authors

In the narrative part of their evaluation, the clients emphasized the usefulness of the consultancy process, but also suggested alternative ways of support that might better meet their needs (C3). Clients complained that the training started too late (they were unemployed for one year before the process started), and that the training process was too fast (C1, C4). It was challenging for them to cope with so many new terms in such short timeframe. Although they were satisfied with the amount of new knowledge, they felt a little bit confused with all the tasks before them (C2). They all emphasized that they would benefit more if this consultancy support continued for a longer period. The clients were satisfied with the professionalism of the consultants. Consultants were available throughout the process and always willing to help (C5).

The evaluation process revealed the bottlenecks already identified in previous research, but it also indicated that expectations and objectives of the client play an important role. A successful consultancy process in SMEs requires a close relationship, a closely designed learning process, and promises that can be fulfilled. In the entry phase, which was done by the contracting organization, the information that four clients had already worked in their family businesses was neglected, but that information was crucial to the consultancy process.

Evaluation of the process after a five-year period through semi-structured telephone interviews showed that only one client/entrepreneur that participated in the program is still running their business, thanks to strong support of their family members. Other clients, although very grateful for the knowledge and experience, continued working for their established family businesses as employees.

Prior to the initiation of the consultancy process, no evaluation of the entrepreneurial characteristics of clients was conducted. Such data could have been very useful for the consultants while designing training activities, but also for individual consultancy sessions with the clients.

7. Conclusion

The main contribution of this paper is the examination of the consultancy process for new entrepreneurs. A detailed analysis of the consultancy process revealed not only crucial determinants but also bottlenecks that can be avoided in the future.

The research results revealed different roles of the consultants while providing advice for new entrepreneurs or SMEs. The consultants had to provide necessary information, advice, and solutions, but also facilitate the learning process of clients. Suc-

cess of the consultancy process depends on the characteristics of the consultants and entrepreneurs, problem identification, client goals, but also on the ability of the consultant to build a trustful and close relationship with the client. When the consultants overlook crucial information, there is a danger that the entire consulting process becomes too vague. The consultancy process observed in this project has been conducted under special circumstances since the clients did not have to pay for consultants' work and advice. The consultants were contracted by the former employer, with the idea that this could encourage clients to use consultants' advice in their career change. Therefore, the clients can be seen neither as victims nor as controllers of the process. Nevertheless, since the clients had the opportunity to seek specific advice or expertise, they could decide whether to implement consultants' advice or not.

Although open to take part in the consultancy process, the clients had their own agendas - joining family businesses or helping family members with knowledge and advice rather than starting their own enterprises. These agendas were revealed only later in the consultancy process. The consultants could have provided better and more suitable training and advice if the client goals had been revealed in the preentry phase.

During the process, the consultants aimed to provide all the information the clients needed within the timeframe predetermined by the contractor. This created a situation in which the clients received too much information and data in a short period of time, which prevented them from effectively internalizing it. On the other hand, the consultants did not have enough time to focus on the creation of a close and trustful relationship with the clients. Since the consultancy process was contracted before the consultants had the opportunity to meet the clients and identify problems that needed to be solved, the process itself was steered in a different direction. The consultants had to complete the whole process in four months, which was not enough for training, advice and relationship building.

Research results in this paper are limited by a small sample consisting of five new entrepreneurs, providing an overview of the consultancy process on the emerging market, with clients that had to change their career paths. Despite its limitations, the paper provides an insight into the typical consultancy process with new entrepreneurs. Most government supported consultancy programs are designed similarly to the one described in this paper, with the goal to encourage entrepreneurs to seek help from a consultant more often. Identifying bottlenecks in the process could help practitioners and policy makers create more effective approaches. Future research should focus on the characteristics of senior entrepreneurs as clients in the consultancy process.

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JEL: L23, L62, M11
Original scientific article
https://doi.org/10.51680/ev.36.2.11

Received: June 25, 2023
Accepted for publishing: September 5, 2023

REVERSE BULLWHIP EFFECT IN THE AUTOMOTIVE INDUSTRY: CASE STUDY FROM ROMANIA

Abstract

Purpose: The goal of the paper was to analyze data from a short loop supply chain (supplier – manufacturer – customer), seek the reasons for the presence of the bullwhip effect (or a reverse bullwhip effect) and quantify its intensity within a practical case study from an automotive industry company based in Western Romania.

Methodology: Data for this research were gathered over 27 weeks for the case of the most important 50 supplier-customer pairings of the manufacturing plant. The collected data were then analyzed using Holt-Winters exponential smoothing (level, trend and seasonality) and the methods of descriptive statistics: dispersion (range, variance, and standard deviation) and frequency distribution (count, percent, and frequency).

Results: Our results confirm the existence of both the bullwhip effect (BE) and the reverse bullwhip effect (RBE) within the supply chain of the production site, as there are 54% of cases where order variation between the group of analyzed suppliers and customers is surprisingly greater for the latter, with only 12% of cases being the source of the classic bullwhip effect.

Conclusion: According to our research, both effects are present, with a higher prevalence of the RBE, but the intensity of both effects can be significantly reduced by improving planning schedules, internal performance and logistics metrics, whilst also increasing the integration of suppliers and manufacturers in the upstream and downstream supply chain material and information flows.

Keywords: Demand variation, logistics performance metrics, order fluctuation, supply chain integration

1. *Introduction*

The economic and social importance of the automotive industry contributes to the fact that the industry is a driver of GDP growth and welfare, providing highly skilled jobs and acquiring other horizontal advantages of the industry (a local network of suppliers, building new and modern infrastructure, competitive salaries). At EU level, the automotive industry alone creates more than 2.5 million jobs (8.5% of EU employment in manufacturing) and is driven by the "big five" carmakers and groups (Volkswagen, BMW, Mercedes, Renault and Stellantis) (Thun & Hoenig, 2011). In Romania, where both Dacia and Ford have manufacturing

sites, the economic importance of the automotive industry is especially important: 12% of GDP and 30% of exports (in 2022), an established network of automotive suppliers (more than 500 nationally), and over 230,000 specialized jobs account for 17.5% of the manufacturing industry in Romania.

The present paper was inspired by a consultancy research contract conducted at the manufacturing plant of one of the automotive industry suppliers based in Western Romania. The research contract was carried out throughout an entire semester (27 weeks) with the goal to assess logistics and supply chain management effectiveness in view of multiple demand and supply mismatching issues, leading to high variations and fluctuations and increased shortage and overstock issues. The company is currently facing an increase in volume and will do so until 2025, until the newly started extension process is completed. Until then larger volumes, newly launched projects and increasing capacity requirements have to be managed within a facility already running at full tilt (Lücker et al., 2021). Operational performance is thus under serious pressure (Simchi-Levi et al., 2018) and the team is growing with new interns, mostly graduates or internship students (Nikolicic et al., 2019). A wide range of supplier and customer requirements and dynamic daily logistics issues (urgent customer shipments, production backlog and warehouse overstock, delivery issues) can prove quite demanding (Mircetic et al., 2022) even for an experienced logistics specialist (Simchi-Levi et al., 2015), let alone for an intern with lack of experience in such a dynamic environment or sometimes without even the most basic logistics principles, knowledge or induction (Prajogo & Olhager, 2012).

The dynamism of the sector is also enabled by rapid technological advances (Krstić et al., 2021) and quick adoption of new features, but their implementation is subject to lots of technical, legislative and operational challenges (Boada-Collado et al., 2022). One of these challenges is the bullwhip effect (BE), which has received comprehensive attention in the specialized literature (Wang & Disney, 2016), but due to certain market specifics and more recent supply and demand mismatching issues (Ponte et al., 2020), the reverse bullwhip effect (RBE) is also increasingly present. The reverse bullwhip effect (RBE) generates large variations upstream, as opposed to the classic BE, due to short-term market disruptions (price volatility, material scarcity, increasing delivery lead times) that enable opportunistic behavior from customers who order more than usual (the multiplying effect) and create high fluctuations, which distorts the regular flow of goods. Variations and supply chain issues and challenges become more apparent in global environments, where there is much more complexity (Gruchmann & Neukirchen, 2019), as is the case with the automotive industry (Pastore et al., 2019). The Forrester effect explains the reasons why fluctuations in demand increase within the upstream supply chain links in a higher proportion (as a consequence) than those generated in the downstream supply chain links (as a cause). The solution is integrated and real-time communication (Brito et al., 2020), but only in conjunction with realistic and harmonized internal performance metrics (forecast accuracy, production planning, productivity and output metrics, different stage inventory levels, perfect order deliveries) applied by each short loop supply chain (supplier – manufacturer – customer). Multi-tier supplier-manufacturer relationships and the use of EDI (either as partially or fully integrated software programs) as a means for faster (real-time), more reliable (user access and permissions) and longer-term planning (quarter, semester and/or annual forecasts) are not a guarantee against the bullwhip effect if the reliability of the data in the information exchange is not 100% accurate (Papanagnou, 2022).

The objective of the paper was to analyze, assess and interpret data from the short loop supply chain of the manufacturing company (supplier – manufacturer – customer), determine if the bullwhip effect (BE, or the reverse bullwhip effect, RBE) is present, highlight the reasons and quantify its intensity. The task of the research team was also to provide solutions and improvement proposals at the end of the conducted consultancy contract and had the role to combine a practical view with the academic mindset and produce a comprehensive report within this case study from Western Romania.

2. Materials and methods

The data used in this research paper were gathered, discussed and analyzed over a period of one semester (27 weeks) within the framework of a joint research collaboration in order to obtain a comprehensive overview of the scale of the company's internal logistics activity and its short loop supply chain. The key company members (project, group

and team leaders, as well as departmental logistics managers) were also involved in the process and contributed to the accuracy of the data used and the relevance of the results obtained. Actual orders were collected from the company's EDI system on the basis of the initial semester forecast smoothed exponentially with trend and seasonality for the case of 50 different customers and 50 most important suppliers of the manufacturing plant. This paper focuses on the short loop supply chain (supplier – manufacturer – customer) of an automotive industry manufacturing company and orders from 100 of its specific suppliers and customers (50 supplier-customer pairings) for the necessary parts to manufacture the end product at the production site not far from Timisoara, Western Romania. The company did not want to disclose either its identity/location (consent was given for general reference only) or certain parts of research carried out independently (all provided within the full report upon the completion of the research contract) in this paper, therefore some steps, links and conclusions may be subject to limitations for the reader.

Data from customer orders are compared to orders from suppliers in the 27 weeks, ranging from absolute values, variations from the overall average (absolute and relative, positive and negative, minimum and maximum) to the overall variation within the entire period for the two sets of data. In this sense, only the average orders from a selection of 10 customers and 10 suppliers are presented for the aforementioned semester, in units. The average order levels (O_{avg}) and weekly variations (O_{var}) calculated throughout 27 weeks for both customers and suppliers are measured by applying the following formulas:

$$O_{avg} = \frac{\sum_{i=1}^{w} O_w}{w},$$

where O_{avg} is the average order level and w is the number of weeks [units], and

$$O_{var} = \frac{Ow}{Oavg},$$

where O_w is the actual order level for a given week [%].

Production planning is based on data from actual customer orders in order to compile more reliable forecasts at the manufacturing company. The forecast levels for each week are based on the customer order estimate and then smoothed exponentially with level, trend and seasonality ($\alpha = 0.3$; $\beta = 0.2$; $\gamma = 0.5$). These specific values were chosen by the planning department based on previous results and their precision. A smoother average was targeted for a longer period (a 52-week forecast horizon) with a slight added weight to more recent data (α), trend does not change significantly, therefore the basic longer-term trend was preferred (β) and the chosen value for the seasonal smoothing coefficient was proven more reliable in previous observations than others (γ).

Consent was given only for the average absolute numbers (in units) and broad unit ranges; all other absolute data were subject to a non-disclosure agreement, therefore mostly relative values (percentages) are used for comparison purposes. Relative variations (both above and below average) are expressed in percentage and summed up for both groups of customers and suppliers. The total variation (in %) is then averaged out for the 27 weeks and the gap between the extremities (the difference between the maximum and the minimum variation) is also calculated to determine the amplitude of the range of values. The gap is then compared to the average variation to determine the existence of an additional metric that may add a further cause for generating (an even more intense) bullwhip effect within the short loop supply chain analyzed. The metric was used in order to partially compensate for a further limitation (non-disclosure of the actual gap, since variations are compared as absolute values and not negative-positive ranging values) and provide a more relevant estimation of the degree of variability. A bullwhip effect is present if the overall variation of orders within the group of suppliers exceeds the variation generated within the group of customers analyzed, with certain partial correlations and limitations being possible since our research data could only be revealed to a limited extent, subject to the agreed clearance obtained from the company's management. A 15% order variation level has been agreed with the company's customers where current pricing conditions apply, and the suppliers follow a broad range of terms and conditions. The company uses state-of-the-art EDI systems, is linked with most of its customers and suppliers, and applies the automotive industry standard Just-in-Time (JIT) system.

The objective of the paper was to see if the bullwhip effect was present and, if so, to quantify the extent to which it is expressed within a (very) short loop

supply chain (supplier – manufacturer – customer) case study. A selection of the tables and figures with results is provided in the section containing results, as well as comments and interpretations on the sets of data (10 customers, 10 suppliers, and a comparison between the obtained averages for each group of partners in the company's supply chain), whereas the main outcomes are outlined in the conclusion.

3. Results

The results of the present case study were obtained at a manufacturing company located in Romania, close to the city of Timisoara (in the west of the country), the most dynamic automotive industry region where many suppliers have set up or extended their production facilities. The company produces parts for all major car brands from Europe, Asia and North America, including the two car plants based in Romania (the Dacia factory in Mioveni, close to Bucharest, and the Ford factory in Craiova, in the south of the country), but its main customers (more than two-thirds of total sales) are large European carmakers from Central Europe.

Table 1 presents an overall average of all 100 customers (C_{avg}) and supplier average weekly order ranges (S_{avg}), as well as their categorized proportion [%] used for the purpose of comparison in the next part of the section, where a selection of the main 10 customers and 10 suppliers is highlighted.

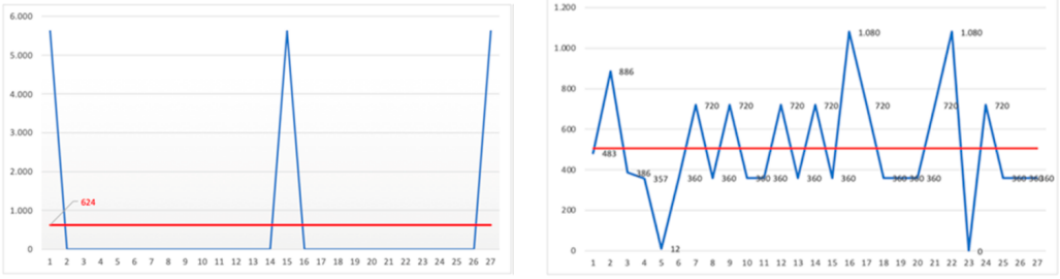
Table 1 Average range of weekly orders (parts and/or components) per customer and supplier [units]

100+	1000+	10,000+	100,000+	C_{avg}	100+	1000+	10,000+	100,000+	S_{avg}
15	26	8	1	50	2	22	19	7	50
30%	52%	16%	2%		4%	44%	38%	14%	

Source: Author

Most customers (82%) placed orders for a couple of hundred or thousand parts from the automotive industry company based near Timisoara, and more than half (i.e., 52%) between 1,000 and 9,999 units. As expected, these levels are slightly higher for the suppliers providing the necessary components according to the BOM. Most suppliers (82%) received orders of thousands of units (ranging from 1,000 to 99,999), and some of them also received orders of half a million units weekly, on average. Figures 1, 2 and 3 present supplier-customer pairing variations: the average level of orders over the semester (27 weeks) and the actual fluctuation values for each week throughout the analyzed time span.

Figure 1 Supplier 6 (left) and customer 6 (right) weekly order variations [units]

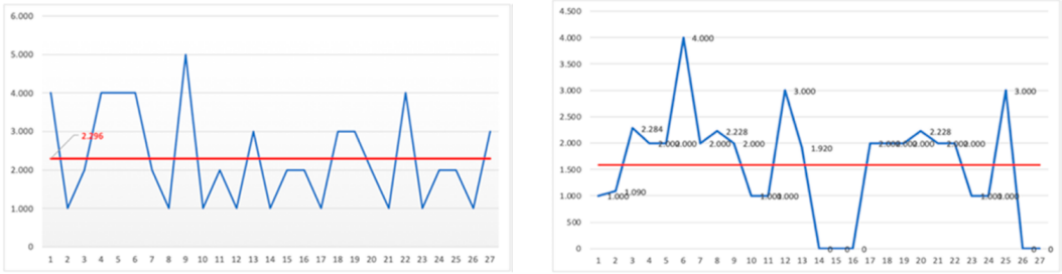


Source: Author

Figure 1 shows the weekly order variations for supplier 6 (left) and customer 6 (right). The patterns are very different in this pairing as customer 6 has a couple of peaks and troughs, the most important are the 2 peaks towards the end of the 27 weeks, whereas elsewhere it has rather stable cyclical ordering behavior. The order pattern of supplier 6 is typical of a batch system, but only 3 orders are placed in the 27 weeks, which then cover the required materials and components for the next 12 weeks, suggesting most likely a longer lead time and/or a critical component with very high ship-

ping costs. With 3 extreme peaks compared to the average, the order pattern and the overall variation of the supplier is greater than a more balanced customer pattern; therefore this situation is subject to the risk of the BE in the event of a slight increase in the customer's orders at a given moment.

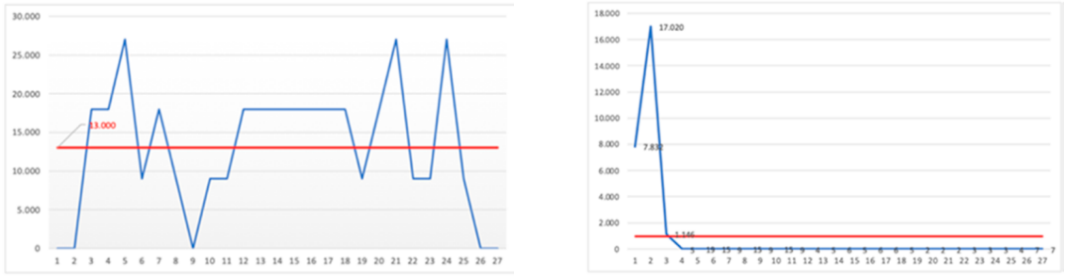
Figure 2 Supplier 7 (left) and customer 7 (right) weekly order variations [units]



Source: Author

Figure 2 shows the weekly order variations for supplier 7 and customer 7. Customer 7 has a rather cyclical order pattern, with 3 peaks in weeks 6, 12 and 26, and a slight three-week drop in orders (weeks 14-16), but generally a balanced distribution of orders. This trend is followed closely by the order pattern of supplier 7 that had higher than average orders for a few weeks (weeks 4-6, 9, and week 22), and then mostly added only smaller quantities within the remaining weeks, thus confirming a smoother distribution. Overall, both supplier and customer 7 have a rather stable order pattern with no major visible variation difference and a lower risk of exposure to the BE and/or the RBE.

Figure 3 Supplier 8 (left) and customer 8 (right) weekly order variations [units]



Source: Author

Figure 3 shows the weekly order variations for supplier (left) and customer 8 (right). Their patterns are very different: customer 8 placed a peak order at the beginning of the semester and then orders were very scarce (close to zero). Supplier 8 had a more stable distribution, with cycles (ups and downs). Some weeks recorded higher than average orders (weeks 5, 21, and 24), while others recorded troughs (weeks 9 and 26), and elsewhere the pattern was relatively stable with order volumes around average levels. With 2 extreme peaks compared to the average, the order pattern and the overall variation of the customer were greater than a more balanced supplier pattern, therefore this situation is subject to the RBE. This may be the case in situations where some materials/components are more difficult to obtain, experience delivery interruptions and are commonly used for products of several customers, therefore will have a more stable demand. It may also occur when there is a huge peak in demand for a certain type of product before it becomes part of serial production, or if the customer is subject to the acquisition of additional references as transshipment towards their own network.

Table 2 presents the analyzed data series for the customer order variations, which is then used as a means of comparison for supplier order variations (the latter is shown in Table 3 in order to identify the presence of a possible BE and its intensity in the chosen data range). The average order levels in units of 10 main customers within the time span are shown and an overall average is also calculated, as well as the number of weeks with orders above and below average. In this paper, the actual order levels of each week (O_w) are compared to the average level (O_{avg}) by division and expressed in percentage points [%]. The average order variation (variation 1) for the 27 weeks is calculated for each customer, as well as the lowest (minimum variation, V_{min}) and the highest variation (maximum variation, V_{max}) of the same period. The maximum range (variation 2, the difference between the maximum and the minimum variation) is also expressed in percentage points, whereas the variation gap adds up the average variation (variation 1) and the maximum range (variation 2). The lower the level of variation for average, range and gap, the better the chances for a more balanced and reliable production and delivery schedule for the supply chain short loop partners (supplier – manufacturer – customer).

Table 2 Overview of analyzed order parameters by semester, per customer

	Average order level [units]	Above average	Below average	Variation (min) [%]	Variation (max) [%]	Variation 1 (average) [%]	Variation 2 (max-min) [%]	Variation (gap) [%]
C1	1,425	6	21	19	315	89.22	296	385.22
C2	204	12	15	2	569	89.85	567	656.85
C3	67	9	18	13	262	97.51	249	346.51
C4	2,298	9	18	4	627	114.18	623	737.18
C5	1,902	13	14	6	107	36.00	101	137.00
C6	506	10	17	4	114	44.44	110	154.44
C7	1,584	16	11	21	153	52.88	132	184.88
C8	970	3	24	18	1656	176.37	1638	1814.37
C9	536	10	17	1	139	49.44	138	187.44
C10	1,542	13	14	6	115	41.00	109	150.00
Overall average	1,103.4	10.1	16.9	9.4	405.7	79.1	396.3	475.4

Source: Author

The 10 main customers analyzed place weekly orders, on average, ranging from a couple of hundreds to thousands of units, but they each have very different order patterns and fluctuations. The number of weeks where actual orders are below the average number of orders is greater (62%) than those above average, mainly due to specific market trends and seasonality issues. Within the semester, only customer 7 (see Figure 2) ordered over 27 weeks more times than the other customers. This customer began with average order levels, but then started increasing that quantity by up to 3 times for most of the time span, and then suddenly reduced the orders to very low levels towards the end of those 27 weeks. Compared to the average order level, having units above or below average does not necessarily mean better or worse order management: what is really important is matching demand as smoothly as possible without carrying excessive inventory levels.

The largest range of variation (from a minimum of 18% to a maximum of 1,656% compared to the average) is noticed for customer 8 (see Figure 3). In this case, an excessively large order was placed at the beginning of the analyzed period, leading to several other weeks with no orders, and towards the end of the 27 weeks more balanced volumes were requested before shifting again to 2-3 times the average rate. Customers 2, 3, and 4 also follow

an intense range of variation with similar patterns: very low orders followed by an abrupt increase (3-7 times the average), then again very low order levels for most of the period, before suddenly again demanding a very high volume (2-6 times the average) within the final weeks or even in the last week (customer 2 ordered a quantity 6.68 times greater than its average in the last week of the semester). A similar peak demand at the end of the period is also worth mentioning for customer 1. Customers 9 and 10 have a more cyclical order pattern with peaks of 2-2.5 times their average at the beginning, middle and towards the end of the 27 weeks. Customers 5 and 6 (see Figure 1) have a more balanced order pattern, as their orders are much more stable with only 2 peaks (double the average) in the middle of the time span, whereas elsewhere they rarely exceed a 25% order variation.

The average order variation (variation 1) for the 10 customers is just under 80%, with only half of the customers managing to achieve on average up to 50% of their orders (customers 5, 6, 7, 9, and 10). This is mainly due to more typical demand patterns (balanced, cyclical) in their weekly orders as a result of better forecasting strategies and techniques. In contrast, the other 5 customers have more chaotic order patterns and higher fluctuations, which is of course noticeable in their increased variations, which are double or even up to 3-4 times greater than those of the first group of customers.

The average range in variation between the same data sets for the 10 customers is almost 400%, which is 5 times greater than their combined actual average, and customer 5 had the most balanced difference between these parameters (36% variation in average orders compared to a 101% maximum variation range). Customers with lower average order variations also share the lowest maximum ranges (in most cases, 2-6 times) as a result of steadier order patterns and a narrower spread between their extreme variations. This enables the automotive industry company to be more reliable in its production and delivery schedules and significantly reduce the risk of a backlog or a shortage.

Table 3 presents the analyzed data series of supplier order variations generated by the company for the corresponding customers from Table 4. Thus, each supplier number (and associated components) corresponds to the customer number in order for the manufacturing company to make and deliver the finished products as per the BOM.

Table 3 Overview of analyzed order parameters by semester, per supplier

	Average order level [units]	Above average	Below average	Variation (min) [%]	Variation (max) [%]	Variation 1 (average) [%]	Variation 2 (max-min) [%]	Variation (gap) [%]
S1	159	16	11	1	81	16.67	80	96.67
S2	1,134	9	18	3	434	58.44	431	489.44
S3	4,594	18	9	9	78	15.18	69	84.18
S4	53,904	13	14	1	91	30.41	90	120.41
S5	2,222	6	21	100	350	155.55	250	405.55
S6	624	3	24	100	800	177.77	700	877.77
S7	2,297	10	17	13	118	45.18	105	150.18
S8	13,000	14	13	31	108	55.18	77	132.18
S9	7,823	11	16	2	156	50.18	154	204.18
S10	8,208	9	18	14	234	84.55	220	304.55
Overall average	9,396.5	10.9	16.1	27.4	245	68.91	217.6	286.51

Source: Author

The company places weekly orders for materials and components with its 10 associated suppliers, ranging on average from hundreds of units to even more than 50,000 units, with slightly different order patterns and fluctuations. The number of weeks where actual orders are below the average number of orders is greater (59%) than when these are above average in a similar proportion to the customers. Within the semester, only 30% of suppliers received orders more times above their average levels throughout the 27 weeks than the rest of suppliers. These suppliers (suppliers 1, 3, and 8) have relatively stable and balanced order patterns received from the manufacturing company, so their production and delivery schedules are also less issue-prone. Similar to the goal of customers, the main objective of comparing the order level with the average level in the case of suppliers is mainly to provide better forecasting capability, predict order patterns and increase regular on-time, in-full deliveries.

The largest range of variation (from a minimum of 100% to a maximum of 800% compared to the average) is noticed for supplier 6. In this case there is a batch ordering system in place and only 3 large orders are actually placed within the 27 weeks: at the beginning, in the middle and towards the final part of the time span, after that no other orders are placed. This is also the case for supplier 5, but the fact that there are more batch orders has reduced the maximum range, despite a very similar trend and pattern to supplier 6. Suppliers 9 and 10 have a more cyclical approach as they face orders with higher volumes at different time points and then only receive smaller order volumes from time to time as a buffer against potential customer increases. This allows for a rather more stable order dynamic and pattern, which is not the case for supplier 2, where despite a similar cycle the fill-up orders have a much higher degree of variability, looking for a more troublesome pattern, with more extreme order levels, especially towards the end of the 27 weeks.

Suppliers 7 and 8 follow a mix of cyclical and balanced order patterns and their weekly variations only rarely reach 3-5 times the average level, whereas these peaks then tend to be compensated by slightly lower orders in an overall relatively stable distribution. By far the most stable order patterns are those for suppliers 1, 3, and 4, as the weekly variations compared to the average never go beyond 100% within a demand pattern with the highest level of stability of the entire supplier range.

The average order variation (variation 1) for the 10 suppliers is under 70% (lower than the same indicator for customers), only 2 of the entire range of supplier have averages above 100% in their orders (customers 5 and 6, due to their periodic batch order pattern). On the other hand, suppliers 1 and 3 have order variations below 20%, and supplier 4 has order variations only slightly above 30%, which are very good figures. Other 3 suppliers (7, 8, and 9) have variations of around 50%, also lower than the supplier range average due to their more common cyclical order pattern. The remaining 2 suppliers have a higher range (variation 2), mainly due to the increased variability and higher fluctuation toward the end of the 27 weeks. All in all, except for the higher variability of suppliers 5 and 6, a more stable and balanced order pattern is noticeable. There are differences which can vary from 2 to 5 times depending on the chosen supplier, but the total orders of supplier groups follow a more balanced pattern.

This is also confirmed by the average range in variation between the same data sets for the 10 suppliers. Variation 2 (see Table 4) is less than 220% and 3 times greater than their combined actual average, and supplier 3 had the most balanced difference between these parameters (a 15.18% variation in average orders compared to a 69% maximum variation range), only slightly better than supplier 1 (16.67% for variation 1 and 80% for variation 2). Suppliers with lower average order variations also share lower maximum ranges (in most cases, 3-5 times) as a result of more predictable order patterns with less pronounced fluctuations. It also allows the automotive industry company to have a more reliable supplier base, enabling a better JIT system integration. This is especially important because the company maximizes its production space and warehouse utilization KPIs, therefore reliable suppliers and their deliveries are essential to production planning and order sequencing capabilities in a manufacturing facility that operates at full tilt.

Table 4 presents order variations of the 10 corresponding suppliers and customers within the short loop supply chain of the manufacturing company. The highlighted indicators include the average order level (in units), average order variation (variation 1, in %) and the maximum range (variation 2, in %).

Table 4 Supplier-customer order variation overview and comparison, by semester

	Average order level [units]	Variation 1 (average) [%]	Variation 2 (max-min) [%]		Average order level [units]	Variation 1 (average) [%]	Variation 2 (max-min) [%]
S1	159	16.67	80	C1	1,425	89.22	296
S2	1,134	58.44	431	C2	204	89.85	567
S3	4,594	15.18	69	C3	67	97.51	249
S4	53,904	30.41	90	C4	2,298	114.18	623
S5	2,222	155.55	250	C5	1,902	36.00	101
S6	624	177.77	700	C6	506	44.44	110
S7	2,297	45.18	105	C7	1,584	52.88	132
S8	13,000	55.18	77	C8	970	176.37	1638
S9	7,823	50.18	154	C9	536	49.44	138
S10	8,208	84.55	220	C10	1,542	41.00	109
Overall average	9,396.5	68.91	217.6	Overall average	1,103.4	79.1	396.3

Source: Author

The overall average variation (variation 1) of customer orders (79.1%) was almost 15% greater than the overall average variation of supplier orders (68.9%). Some of the customers had variations up to 6 times greater than their corresponding suppliers (customer 3 and customer 1 had 6.42 and 5.35 times greater variation, respectively), whereas others had around half of that proportion (customer 4 and customer 8 had 3.75 and 3.19 times greater variation, respectively). Customers 2 (53%) and customer 7 (17%) had a smaller ratio of greater variation compared to suppliers 2 and 7. On the other hand, supplier 5 (4.32) and supplier 6 (4.00) had 4 times greater variations than their corresponding customers, and supplier 10 had slightly more than twice (2.06) the variation of customer 10. Supplier 9 and customer 9 had almost a perfect matching variation (50.18% and 49.44%, respectively), while the supplier had a negligible 1.5% greater variation.

The overall average range variation (variation 2) of customer orders (396.3%) was 82% greater than the overall average range variation of supplier orders (217.6%). Some of the customers had variations almost 4 times greater than their corresponding suppliers (customer 3 and customer 1 had 3.6 and 3.7 times greater range variation, respectively), whereas others had an even higher proportion (customer 4 and customer 8 had 6.92 and 21.27 times greater range variation). Customer 2 (31%) and customer 7 (25%) had a smaller ratio of greater range variation compared to suppliers 2 and 7. On the other hand, supplier 5 (2.47) and supplier 10 (2.01) had variations twice as high as their corresponding customers, and supplier 6 had an even greater range variation (6.36) compared to its corresponding customer. Supplier 9 had 11% greater range variation compared to customer 9.

The main parameter used to compare the variations between the supplier and customer data sets is the overall average variation (variation 1 in tables 2 and 3). The value (44.86%) for the entire range of analyzed suppliers (50) was lower than that of the entire range (50) of analyzed customers (58.80%), showing a 31% greater variation in customer order volumes present in this short loop supply chain. When comparing the variations of the supplier-customer corresponding component-part pairs a difference up to 15% in variation was considered stable. A difference in variation above 15% would be considered a BE if variation was greater at the supplier end or an RBE if variation was greater at the customer end. A number of 6 supplier-customer pairs sourced a BE (12%), one pairing with only a 17% difference in variation (marked as a stable BE). Furthermore, 17 supplier-customer pairs (34%) were considered to have a stable relationship as variation between these suppliers and customers was below the set mark of 15%. Other supplier-customer pairs (i.e., 27)

sourced an RBE (54%), of which one pair only had a 17% difference in variation and was marked as a stable RBE. Thus for the whole range of 50 supplier-customer pairings 52% instances were visible RBE situations, 34% were stable and only 10% generated a visible BE. The remaining 4% were marked as stable BE/RBE, as previously shown. These results are in line with current shifts in the automotive industry where carmakers have more and more common suppliers and these tend to become more and more strategically important within the global supply chain and can thus leverage greater negotiating power. As a side note, if the 17 stable instances were also marked as either BE or RBE, 12 of these situations would have a greater customer order variation and hence would have theoretically generated an RBE. In this sense, 39 of the 50 supplier-customer pairings (78%) had greater customer variations than the variations generated within their corresponding suppliers, thus not necessarily supporting typical BE theory and giving way to a new shift of leverage in the automotive industry supply chains.

4. Conclusion

The overall results confirm the existence of both the bullwhip effect (BE) and the reverse bullwhip effect (RBE) in the short loop supply chain of the manufacturing company. A degree of demand variability was 12.64% higher for the 10 analyzed customers (32.74%) than for the corresponding group of suppliers (28.73%), but overall, it was above 30% for all customer-supplier pairings (50). This result confirms the prevalence of the RBE to a greater degree in the analyzed data since 54% of supplier-customer pairings confirmed clear RBE features in contrast to 12% with signs of the standard BE and a further 34% sourcing for a more stable correlation. The complete range of results showed that 39 out of 50 supplier-customer pairings (78%) had greater variations at the customer end rather than upstream, mostly due to the growing importance, leverage and negotiating power of leading suppliers in the automotive industry. This is also linked with the chip shortage and supply chains still recovering from major fluctuations and uncertainty caused by the pandemic, along with a range of global supply and demand mismatches.

Both the BE and the RBE are detrimental to a company's operational performance and overall efficiency, as issues of backlog and/or shortage and excess inventory and/or lack of warehousing space will take up working time and reduce the ability to run the overall logistics operations more smoothly in the already extremely competitive automotive industry. Using a modern EDI system is not enough to ensure reliable data sets, because in addition to real-time and quick information exchange, a real measure of communication is needed to understand the causes of variability. This piece of information would serve as an important input in forecasting demand and help reduce imbalances in the supply chain, reducing also the possibility of late deliveries and the use of more expensive special transport. Besides coordination, internal KPIs must be adequate, reliable and relevant on a larger scale and try to be integrated in more than one workstation or department in order to produce a multiplying effect and achieve a more global optimization, rather than local and/or isolated workstations of high performance. Very good performance levels can also be obtained by considering the needs and challenges of other department teams, and as results are interlinked, this more team-oriented view would also enable a more productive work environment and increase work efficiency in the entire logistics department.

The resulting variations can be further mitigated, especially in this type of short loop supply chain, by an enhanced level of data integration of both downstream and upstream links, making the chain stronger, more agile and resilient. Sharing reliable and relevant coordination data (real-time long-term forecasts, updated planning schedules and frozen periods), as well as qualitative data not visible to a supply chain partner, would help to better adjust internal production parameters (supplier – manufacturer – customer) and reduce both extreme fluctuation peaks and variation intensity during regular production schedules and operations. Within the full report provided to the company, a reduction in variation (of almost 50% over the next 9-18 months) below the 35% margin for its range of suppliers (from a current overall variation of 68%) was quantified, subject to certain adjustments, showing that improvements are possible if an active effort is involved to better synchronize demand and capacity in the short loop supply chain presented.

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JEL: R40, O32, F40, C23
Original scientific article
https://doi.org/10.51680/ev.36.2.12

Received: August 29, 2023
Revision received: September 11, 2023
Accepted for publishing: September 12, 2023

IMPACT OF ICT ON REGIONAL SUPPLY CHAINS IN CEECs

Abstract

Purpose: This paper aims to examine the impact of information and communication technologies and their availability in the Central and Eastern European countries that are members of the EU on regional value chains and regional supply chain management and logistics in CEECs in the context of the growing e-commerce industry.

Methodology: We used a balanced data panel of 11 countries over 9 years (2011-2019) to examine the impact of ICT indicators on regional supply chains. The analysis included the ordinal Spearman rank correlation coefficient and the panel GMM method, which accounts for endogeneity. We implemented the Arellano-Bond estimator within the GMM framework, considering the ordinal nature of the dependent variable. This approach allowed for an effective analysis of the complex relationships in the data, considering the panel structure and the individual country observations.

Results: The findings indicate that the hypothesis claiming that the integration of digital technologies in supply chains in CEEs leads to statistically significant improvements in efficiency, controllability, and cost-effectiveness, cannot be rejected. Enhanced communication, collaboration, and overall logistics performance have led to increased customer satisfaction. Additionally, the study shows a positive correlation between ICT infrastructure and logistics performance, emphasizing the crucial role of digital innovations in shaping supply chain dynamics.

Conclusion: The study supports the hypothesis that integrating digital technologies into supply chain management in Central and Eastern Europe is associated with enhanced efficiency, resilience, and economic integration through value-added export. These insights offer pathways to foster economic integration in the region.

Keywords: ICT, e-commerce, digital technologies, supply chains, RVCs

1. *Introduction*

The e-commerce sector has experienced remarkable growth, and the COVID-19 pandemic has accelerated this trend. This rapid expansion has brought new supply chain management (SCM) challenges. Dealing with fluctuating demand, shorter delivery times and higher customer demands requires innovative solutions. To overcome these hurdles, supply chain professionals are increasingly turning to digital tools such as Big Data analytics, the Internet of Things (IoT) and artificial intelligence (AI).

This paper explores the profound impact of digital advancements on SCM and e-commerce logistics in Central and Eastern European countries (CEECs). These countries include EU member states such as Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Digital technologies bring numerous benefits, including increased supply chain visibility, improved predictive accuracy and an enhanced customer experience. They enable businesses to tailor their offers, promotions and customer service to individual preferences. IoT tools, such as RFID tags and GPS trackers, provide real-time inventory updates and streamline order fulfilment workflow.

In this context, our hypothesis is that the integration of digital technologies into CEEs supply chain management will lead to increased economic integration through the integration of value-added elements.

Nevertheless, the process of integrating digital technologies into e-commerce supply chains is not without its challenges. These include the need for robust IT infrastructure and expertise, and the looming spectre of data breaches. Channel innovations characterised by omnichannel methods optimise inventory management by seamlessly linking online, retail and app-based channels. While these strategies reduce reliance on warehousing, they require significant investment in IT, logistics and organisational adjustments.

Digital technologies are also transforming e-commerce transfers and inventory monitoring. The synergy of Big Data and IoT increases transport efficiency and transparency, especially in omnichannel strategies. This synergy simultaneously improves inventory management and order fulfilment processes. Emerging models such as direct-to-consumer (DTC) and drop-shipping are gaining traction and promise to reduce costs and improve inventory. However, they require careful management to ensure a satisfactory customer experience.

In summary, digital technologies have immense potential for improving the resilience, efficiency and environmental sustainability of e-commerce supply chains. Our hypothesis assumes their impact on economic integration through value chain integration into CEEs. Yet, their integration comes with numerous challenges, such as the need for specialised skills and the looming spectre of data security breaches. The purpose of this paper is to provide a comprehensive examination of these dynamics.

2. Literature review

2.1 Global and regional value chains

A value chain is a series of steps that companies take to turn an idea into a consumed product, including post-use aspects. The concept of the global value chain (GVC) emerged in the early 2000s and shows how production processes are distributed across countries and interconnected in industries. GVC analysis provides insights into the dynamics of trade, production and economic linkages. It focuses on efficient inputs, foreign linkages and evolving specialisation. It also sheds light on networks, global buyers and economic governance.

De Backer and Miroudot (2014) examine how global trade is organised through GVCs, focusing on country integration. They introduce indicators for an accurate representation and analyse value chains in different industries.

Mance et al. (2023) examine Croatian regional value chains (RVCs) using value added data. They find linkages between Croatian exports and partners' value added, indicating a strategic organisation of regional value chains. The study emphasises the resilience, efficiency and EU integration of RVCs.

It builds on the work of Mance et al. (2021), which highlights the role of RVCs in trade and development. Using UNCTAD Eora data, they derive the RVC indicator - domestic value-added in exports. The study covers Croatia and neighbouring countries and shows how developed countries affect less developed countries in RVCs.

2.2 The role of ICT in supply chain management

In recent years, there has been significant growth in the integration of digital technologies into SCM. These technologies include electronic devices, tools and resources that generate, process, store, transmit and receive data, information and knowledge. Their application has the potential to improve supply chain efficiency by increasing transparency, reducing costs, fostering collaboration, and enhancing customer satisfaction.

Supply chain visibility is a key aspect of efficient SCM. Digital innovations such as radio frequency identification (RFID), bar coding, and global positioning systems (GPS) enable companies to track the path of goods from supplier to customer. These technologies provide real-time data on the whereabouts of goods and enable flexible responses to supply chain disruptions and improved inventory management.

Industry giants such as Best Buy, Wal-Mart, Tesco, Target and Metro AG have effectively harnessed these technologies. Numerous studies (Wamba et al., 2008, Twist, 2005) on a three-tier retail supply chain address scenarios where RFID and the EPC network are merged. Preliminary results of an "open-loop" deployment are promising as these technologies synergise with business process management (BPM) and optimise the synchronisation of information and product flows. This harmony improves data integration between supply chain stakeholders and highlights the potential of these technologies to enable seamless end-to-end information flows within supply chains.

In addition, digital technologies are able to reduce supply chain costs by automating processes, minimising manual labour and improving efficiency. For example, the use of automated guided vehicles and drones can reduce labour costs and increase warehouse productivity (Basaldúa and Di Palma, 2023). The use of machine learning algorithms and artificial intelligence can optimise supply chain operations, reduce costs and increase efficiency.

Another benefit of digital technologies is that they improve collaboration between supply chain partners. They enable real-time communication and information sharing. Cloud computing and social media facilitate interaction between suppliers, manufacturers, retailers and customers. Digital technologies can also support collaborative planning, forecasting and replenishment (CPFR), enabling data sharing and collaborative supply chain planning, especially in healthcare supply chains (Friday et al., 2021).

In addition, digital technologies improve the customer experience by enabling real-time tracking, personalised recommendations and better customer service.

2.3 Logistics performance

The Logistics Performance Index (LPI) shows the ability to track and trace consignments (from 1=low to 5=high). It is an ordinal Likert scale variable indicating the degree of tracking ability as expressed by the parties involved in the logistics and transportation process. The LPI is produced by the World Bank, and it is an important tool for quantifying logistics efficiency and trade facilitation effectiveness. The LPI is based on industry experts' assessments of various aspects such as customs procedures, infrastructure, the quality of logistics services and labour skills, and calculates a score between 1 and 5 to determine the level of logistics capability. Higher scores correspond to higher efficiency and a competitive advantage. This makes the LPI an important tool for policymakers, researchers and businesses to recognise trade landscapes, identify areas in need of improvement and allocate resources for logistics infrastructure development – in line with the World Bank's goal to promote efficiency and facilitation of global trade. This nuanced assessment of logistics capacity underpins the informed promotion of trade-related decisions and policy formulation.

Alnıpak et al. (2023) examine the LPI determinants in the context of the European region. Emphasising the central role of logistics in global trade, the study examines data from 32 European countries from 2010 to 2018. Using static panel data models, the authors find that GDP per capita, the percentage of commercial services imports and the linear shipping connectivity index have a significant impact on LPI scores at the country level, outperforming other factors. In particular, the study uncovers a previously under-researched negative correlation between the LPI and the share of imports of commercial transport services. By applying a comprehensive panel data approach, the study improves the understanding of factors influencing logistics performance in the European region.

Martí et al. (2014) conducted an empirical analysis of developing countries and used the gravity model to assess the role of logistics in export in the regions such as Africa, South America and Eastern Europe. The results indicate positive correlations between the LPI coefficients and its components, reflecting a commitment to improving logistics. The need for competitive freight services is evident, especially as developing countries seek integration into global trade networks.

Wong and Tang (2018) find that nations with lower corruption and a stable political climate have a higher LPI, and that improvements in resource provision, such as infrastructure, technology, labour, and education, also have a significant and positive impact on LP. As a result, making institutional reforms and boosting resources are effective options for accelerating LP.

2.4 ICT-enhanced supplier selection in green supply chains

The need for sustainable supplier selection highlights the importance of a multi-criteria decision-making model (MCDM) in green supply chains. Amin-Tahmasbia and Alfi (2018) address this complexity by using ICT to manage uncertainty and optimise supplier capacity in line with customer demand. Their model refines supplier ranking through interconnected criteria and uses fuzzy linguistic relationships for more precision. By integrating the utility index, their MCDM approach systematically selects suppliers and awards contracts, improving the sustainability and success of the green supply chain. Fuzzy logic accounts for uncertainties in capacity and demand and provides an accurate overview of the supply chain. Evaluation of criteria such as cost, quality, delivery, technology and environmental factors is enabled. Merging incomplete fuzzy linguistic relationships refines comparisons and rankings. Optimisation of cost and purchase value functions balances financial and environmental considerations. This innovative blend of sustainability and operational efficiency enables informed decision-making in line with green supply chain goals.

2.5 Big Data analytics in supply chain management

The rise of data in the supply chain is both a challenge and an opportunity for managers. Big Data analytics involves processing huge data sets to gain insights and make informed decisions that provide real-time visibility and a rapid response to issues. Studies highlight the SCM potential of Big Data. For example, it optimises transportation, shortens lead times and improves customer service. Similarly, Gupta and Kohli (2006) find that real-time insights improve responsiveness. However, there are some challenges in implementing Big Data analytics in SCM. Due to disparate data sources, there is a lack of a standard framework for integration, making meaningful insights difficult. In addition, the required investment in technology and expertise can be prohibitive for some companies.

2.6 Internet of Things in supply chain management

The Internet of Things (IoT) refers to the networking of physical devices, vehicles and objects with embedded sensors, software and network connectivity. IoT technology has the potential to revolutionise supply chain functions by enabling real-time tracking of products and assets, providing instant insight into supply chain operations and facilitating proactive decision-making.

Numerous studies highlight the potential benefits of IoT technology for sustainable SCM. For example, Saqib and Zhang (2021) found that IoT technology can improve supply chain visibility, reduce lead times and increase supply chain flexibility without compromising sustainability. Mathaba et al. (2017) also found that IoT technology can improve inventory management by providing real-time inventory data and enabling automatic replenishment. They explored the fusion of RFID and Web 2.0 technologies to improve inventory management. Their research shows the synergy between object communication of RFID in IoT and data transmission in Web 2.0.

2.7. Blockchain in regional supply chain management

Blockchain, a distributed ledger technology, improves supply chain transparency and product authenticity. It limits fraud and improves traceability to solve transparency issues, especially related to product provenance (Cole et al., 2019). Furthermore, automation, e.g. in order tracking and payment processing, optimises SCM efficiency (Moosavi et al., 2021).

This technology is reshaping SCM with transparency, security and efficiency. Its decentralised, immutable ledger provides tamper-proof records in the supply chain. It empowers stakeholders to verify authenticity, quality and compliance, while minimising fraud and errors through streamlined processes. Smart contract integration increases efficiency. As companies use blockchain for collaborative supply chain optimisation, its transformative potential becomes increasingly clear.

As part of the global and regional value chain assessment, the UNCTAD-Eora GVC database covers 189 countries and provides a time series from 1990 to 2018 with indicators for foreign value added (FVA), domestic value added (DVA) and indirect value add-

ed (DVX). The GVC, which is based on value added (VA), quantifies production inputs net of input costs and captures the value of labour, capital and production elements. Incorporation of blockchain increases the precision of value creation through transparent, traceable data throughout the supply chain, increasing accuracy and reducing errors. Traceability mechanisms and smart contracts improve value allocation and speed up transactions. Blockchain's versatility improves data reliability and collaboration.

Amid fragmented global value chains (GVCs), blockchain provides accessible records that manage the complexity of sustainability. Nikolakis et al. (2018) present an evidence, verifiability and enforceability framework (EVE) that uses blockchain for sustainability. Tan et al. (2023) illustrate how SCI mediates the visibility of blockchain and SCP. In the context of global trade, the emphasis on GVCs, driven by technology, cost dynamics and policy changes, increases efficiency and competitiveness. Given the policy implications of GVCs, empirical evidence remains essential. This study provides GVC indicators, dissects industries and examines supply chain functions. A comprehensive understanding of the role of GVCs is central to discussions of trade, competitiveness, growth and development.

3. Data and methods

We used a balanced data panel of 11 countries (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) during 9 years spanning the period from 2011 to 2019, with the goal to grasp the dynamic effects of changes in the growth of ICT indicators on the changes in the growth of regional supply chains in terms of value added. It is not our intention to imply causation, just statistical association. The dataset was carefully structured to facilitate the identification of unique country observations.

Since one of our dependent variables is ordinal, we should focus on statistical methods that are appropriate for analysing ordinal outcomes. In this context, ordinal Spearman's rank correlation coefficient measures the strength and direction of the monotonic relationship between two variables, even if the relationship is not linear.

The regression equation was carefully formulated to include the ordinal outcome variable, continuous predictors, indices and additional covariates. To mitigate endogeneity problems arising from the potential bidirectional relationship between certain predictors and the ordinal outcome, the generalised panel method of moments (panel GMM) was applied. This approach allows the inclusion of appropriate instruments, such as lagged variables and exogenous predictors, to correct for possible bias due to endogeneity. The panel GMM framework was implemented using the Arellano-Bond estimator, which is tailored to the panel structure. The subsequent interpretation of the coefficients considered the ordinal nature of the dependent variable and accounted for the endogeneity addressed. The use of the GMM offers distinct advantages in modelling scenarios, where the dependent variable is a Likert scale and the independent variables include an index and a continuous variable. The efficiency of the GMM lies in its ability to accommodate different types of data. Following the seminal contributions of Arellano-Bond (1991) and Wooldridge (2001), the ability of the GMM to incorporate moment conditions based on underlying theoretical relationships allows for effective mitigation of non-linearities inherent in Likert-scale data, while accounting for potential endogeneity issues. The fusion of an index and a continuous variable within the GMM framework enhances its analytical capabilities and facilitates the detection of complicated relationships and plausible interactions. Moreover, the GMM is more resistant to model misspecification due to its emphasis on moment conditions rather than strict distributional assumptions. Thus, the generalised method of moments proves to be indispensable for estimating complicated relationships between Likert-scale variables and different independent variables. In an Arellano-Bond GMM procedure, lagged differences of endogenous variables are used as tools to mitigate endogeneity problems in dynamic panels. This involves a two-step procedure. First, a generalised least squares model is estimated using the first differences and then the lagged values are integrated as instruments.

4. Results

Table 1 shows the results of a comprehensive Spearman rank-order cross-correlation analysis between the logistics performance index (LPI), information and technology infrastructure (ICTINFR), information and technology access ICTACC, and gross domestic product per capita corrected for purchase parity (GDPPCPPP).

Table 1 Spearman rank-order cross-correlation analysis

		LPI	ICTINFR	ICTACC	GDPPCPPP
LPI	Correlation	1.000000			
	Probability	–			
ICTINFR	Correlation	0.164040	1.000000		
	Probability	0.1047	–		
ICTACC	Correlation	0.203438	0.789287	1.000000	
	Probability	0.0434	0.0000	–	
GDPPCPPP	Correlation	0.378926	0.679438	0.719825	1.000000
	Probability	0.0001	0.0000	0.0000	–

Calculation: Eviews 13. Sample: 2011 2019. Periods included: 9. Cross-sections included: 11. Included observations: 99.
Source: World Bank

The correlation values, which range from -1 to 1, provide information about the degree and direction of linear relationships. The correlation coefficient of 0.79 between ICTINFR and ICTACC shows a high level of multicollinearity between the two variables. Thus, we needed to eliminate one of them for further analysis. We kept ICTINFR.

The Levin-Lin-Chu (LLC) test shown in Table 2 is a robust panel unit root test. In particular, it takes into account both cross-sectional and time-series dimensions by adjusting for potential cross-sectional dependence through a correction to the group mean, and along with its ability to adjust for bias and efficiency, it makes the test suitable for panels with heterogeneous characteristics. The null hypothesis of the Levin-Lin-Chu (LLC) test is that the series under consideration have a unit root.

Table 2 Common unit root test table – Levin-Lin-Chu (LLC) test

At Level		LPI	ICTINFR	GDPPCPPP
With Constant	t-Statistic	0.5673	3.1414	8.2742
	Prob.	0.9936	0.9992	1.0000
With Constant and Trend	t-Statistic	0.8774	0.6161	-2.8135
	Prob.	0.9997	0.0001	0.0025
At First Difference		d(LPI)	d(ICTINFR)	d(GDPPCPPP)
With Constant	t-Statistic	0.2884	0.0421	-2.1055
	Prob.	1.0000	0.0005	0.0176
With Constant and Trend	t-Statistic	0.1121	0.0031	-10.9165
	Prob.	0.9999	0.0031	0.0000

Calculation: Eviews 13. Sample: 2011 2019. Periods included: 9. Cross-sections included: 11. Included observations: 99.
Source: World Bank

Across variables (LPI, ICTINFR, and GDPPCPPP), the test statistics indicate the presence of unit roots, implying non-stationarity, except for ICTINFR when considering both constant and trend. After taking the first differences, ICTINFR and GDPPCPPP, our main independent variables become stationary. Thus, we decided to use dynamic panel analysis in the form of the Arellano-Bond GMM procedure.

Table 3 Panel GMM of the LPI as a dependent and ICT infrastructure as an independent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPI(-1)	0.272840	0.033570	8.127575	0.0000
ICTINFR	0.003684	0.001654	2.227616	0.0500
Mean dependent var	0.041429	S.D. dependent var		0.206070
S.E. of regression	0.217686	Sum squared resid		3.554052
J-statistic	8.788123	Instrument rank		11
Prob(J-statistic)	0.457058			

Calculation: Eviews 13. Transformation: First Differences. Sample (adjusted): 2013 2019. Periods included: 7. Cross-sections included: 11. Total panel (balanced) observations: 77. Instrument specification: @DYN (LPI, -2).

Source: World Bank

We performed a GMM panel regression analysis using the first differences approach. With a panel structure spanning seven periods and including eleven cross-sectional units, we examined the relationship between the logistics performance index (LPI) and the information infrastructure index (ICTINFR). Our results show that the lagged value of the dependent variable, LPI (-1), has a significant and positive impact on the current logistics performance index. Specifically, a one unit increase in the lagged value of the logistics performance index is associated with an average 0.272840 unit increase in the current value, highlighting its persistent influence. At the same time, we found that the Information Infrastructure Index (ICTINFR) is positively and statistically significantly associated with logistics performance. A one unit increase in the information infrastructure index is associated with an average increase of 0.003684 units in the current logistics performance index. While this relationship is statistically significant with a p-value of 0.05, it suggests a nuanced interaction between information infrastructure and logistics performance. The specification of the model with cross-sectional fixed effects combined with a comprehensive assessment of summary statistics and J-statistics underscores the importance of information infrastructure in shaping modern logistics and its impact on optimised global trading systems. Table 4 shows the results of the Arellano-Bond post-hoc test.

Table 4 Arellano-Bond serial correlation test

Test order	m-Statistic	rho	SE (rho)	Prob.
AR (1)	1.297311	0.182239	0.140475	0.1945
AR (2)	-1.772997	-0.569836	0.321397	0.0762

Sample: 2011 2019. Included observations: 77.

Source: World Bank

The null hypothesis of the Arellano-Bond serial correlation test is that there is no serial correlation in the residuals of the dynamic panel data regression model. In other words, the null hypothesis states that the error terms of the model are uncorrelated over time, homoscedastic and have no serial dependence or autocorrelation. The associated p-values of 0.19 for AR (1) and 0.08 for AR (2) indicate that there is no strong evidence to reject the null hypothesis of no first-order serial correlation. By adding the GDP p.c. corrected for PPP to the model, we see increases in the strain on the logistics performance in Table 4.

Table 5 Panel GMM of the LPI and ICT infrastructure indices and GDPPCPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPI(-1)	0.162320	0.036674	4.426072	0.0013
ICTINFR	0.013276	0.002142	6.198077	0.0001
GDPPCPPP	$-2.93 \cdot 10^{-5}$	$5.21 \cdot 10^{-6}$	-5.616948	0.0002
Mean dependent var	0.041429	S.D. dependent var		0.206070
S.E. of regression	0.225338	Sum squared resid		3.757518
J-statistic	8.859688	Instrument rank		11
Prob(J-statistic)	0.354271			

Calculation: Eviews 13. Transformation: First Differences. Sample (adjusted): 2013 2019. Periods included: 7. Cross-sections included: 11. Total panel (balanced) observations: 77. Instrument specification: @DYN (LPI, -2).

Source: World Bank

The results of the Arellano-Bond test for serial correlation with the associated probabilities (Prob.) of 0.4298 and 0.1299 for AR (1) and AR (2) indicate that there is no significant autocorrelation at the first and second lag.

The inclusion of the GDPPCPPP variable in the model shows that a higher GDP per capita corrected for purchasing power parity increases the burden of logistics performance. This phenomenon could be explained by the fact that with each increase in GDP per capita, international trade activities also increase at the same time. This relationship is due to the correlation between economic prosperity, trade dynamics and logistics demands. A more prosperous economy tends to engage more in global trade, leading to increased demand for logistics networks to ensure the efficient movement of goods. The positive correlation between the GDPPCPPP and the logistics burden suggests that economic growth leads to more trade, which exacerbates logistics challenges and highlights the complicated interplay between economic factors and logistics.

Table 6 Panel GMM of the Croatian VA export and ICT infrastructure index

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CROATIA(-1)	1.039696	9.66E-05	10767.68	0.0000
ICTINFR	$1.97 \cdot 10^{9}$	3869068.	508.7500	0.0000
Mean dependent var	$7.77 \cdot 10^{9}$	S.D. dependent var		$9.26 \cdot 10^{10}$
S.E. of regression	$1.32 \cdot 10^{11}$	Sum squared resid		$3.24 \cdot 10^{10}$
J-statistic	18.51260	Instrument rank		17
Prob(J-statistic)	0.236676			

Calculation: Eviews 13. Transformation: First Differences. Sample (adjusted): 2013 2019. Instrument specification: @DYN (ICTINFR, -2).

Source: World Bank

The probabilities (Prob.) of 0.3124 for AR (1) and 0.3542 for AR (2) indicate that there is no significant autocorrelation at the first and the second lag. We conclude that in the case of Croatia, an increase in ICT infrastructure is statistically positively associated with an increase in the Croatian value-added export. In what follows, we provide the results of the panel GMM test for other CEECs (Table 7).

Table 7 Panel GMM of the VA export and ICT infrastructure index

Dependent var.	Independent var.	Coefficient	Std. Error	Prob.	AR(1)	AR(2)
BULGARIA	BULGARIA (-1)	-0.41206	$3.57 \cdot 10^{5}$	0.0000	0.3270	0.3444
	ICTINFR	$7.16 \cdot 10^{8}$	3882133	0.0000		
CZECH REP.	CZECH REP. (-1)	0.205094	0.000275	0.0000	0.2958	0.2720
	ICTINFR	$7.95 \cdot 10^{10}$	$2.03 \cdot 10^{10}$	0.0000		
ESTONIA	ESTONIA (-1)	0.393418	$6.51 \cdot 10^{5}$	0.0000	0.7466	0.3141
	ICTINFR	$-2.77 \cdot 10^{8}$	3997688	0.0000		
HUNGARY	HUNGARY (-1)	0.434731	$3.47 \cdot 10^{5}$	0.0000	0.1811	0.4500
	ICTINFR	$6.32 \cdot 10^{10}$	56262278	0.0000		
LATVIA	LATVIA (-1)	0.322652	0.000275	0.0000	0.2563	0.3087
	ICTINFR	$-1.35 \cdot 10^{9}$	6576098	0.0000		
LITHUANIA	LITHUANIA (-1)	0.399418	0.000123	0.0000	0.5234	0.3010
	ICTINFR	$-3.37 \cdot 10^{9}$	28751594	0.0000		
POLAND	POLAND (-1)	0.493702	8.47E-05	0.0000	0.2552	0.3456
	ICTINFR	$6.17 \cdot 10^{10}$	$1.04 \cdot 10^{8}$	0.0000		
ROMANIA	ROMANIA (-1)	0.405411	0.000142	0.0000	0.2553	0.1348
	ICTINFR	$1.21 \cdot 10^{10}$	62159672	0.0000		
SLOVAKIA	SLOVAKIA (-1)	0.407618	0.000100	0.0000	0.3173	0.3799
	ICTINFR	$2.98 \cdot 10^{10}$	63379591	0.0000		
SLOVENIA	SLOVENIA (-1)	0.403251	0.000154	0.0000	0.2911	0.2786
	ICTINFR	$2.14 \cdot 10^{10}$	48096784	0.0000		

Calculation: Eviews 13. Transformation: First Differences. Sample (adjusted): 2013 2019. Instrument specification: @ DYN (ICTINFR, -2).

Source: World Bank

The results presented in Table 7 shed light on the relationship between value-added (VA) export and the ICT infrastructure index in a number of countries. It is worth noting that there are differences not only in the magnitudes but also in the signs of the ICT infrastructure coefficients (ICTINFR) between these countries. While most countries have positive coefficients for ICTINFR, indicating a positive correlation between ICT infrastructure and VA export, other countries have negative coefficients, indicating an opposite relationship, as is the case with the Baltic States. This is something worth investigating further.

5. Discussion

In this study, we examine the dynamic interplay between information and communication technology indicators and regional supply chain growth in Central and Eastern European countries over the period from 2011 to 2019. Our Spearman cross-correlation analysis reveals complex relationships between logistics performance, information and communication infrastructure and access and gross domestic product per capita adjusted for purchasing power parity. The stationarity tests revealed unit roots in the data, prompting us to perform a dynamic panel analysis. The subsequent General Method of Moments panel regression reveals a positive persistent impact of lagged logistics performance and a nuanced association between information infrastructure and current logistics performance. Moreover, the introduction of gross domestic product per capita valued in constant purchasing parity highlights the correlation between economic growth and logistics challenges. Extending our investigation to specific Central and Eastern European countries,

we find different relationships between value-added export and information and communication infrastructure. In summary, our study highlights the transformative potential of digital technologies for supply chain management and e-commerce logistics. It highlights the benefits and challenges while using advanced statistical techniques to decipher the intricate relationships between key variables in this evolving landscape.

The impact of digital advances on supply chain management is unmistakable. These digital innovations promise to revolutionise supply chain management, leading to greater efficiency, resilience and sustainability. Yet integrating these digital marvels is not without its challenges. Supply chain professionals must be prepared to allocate resources to new technologies and revise their operational frameworks to take advantage of digital technologies. In addition, the implementation of these technologies raises legitimate privacy and data security concerns that require careful consideration.

Digital technologies offer improved supply chain transparency. Real-time insights into the movement of goods can improve delivery speed, accuracy and customer satisfaction. These technologies also increase supply chain flexibility. AI and Big Data quickly detect shifts in demand and help with adjustments. Challenges include data security, privacy, ownership and accessibility, which require careful management for a seamless digital transition.

Another challenge is the investment required. Many digital technologies require significant investment in hardware procurement, software implementation and extensive training. At the same time, supply chain professionals may need to reconfigure their processes to realise the full potential of digital technologies, a transition that requires additional investment in terms of time and resources. This complex interplay of challenges and opportunities underscores the transformative yet complex landscape that digital technologies offer to supply chain management.

Finally, this paper looks at the transformative impact of digital technologies on SCM and e-commerce logistics, with a focus on Central and Eastern European countries. With the rapid growth of the e-commerce industry, accelerated by the COVID-19 pandemic, supply chain professionals face both opportunities and challenges in their quest for efficient, agile and customer-centric operations. The integration of digital technologies, including Big Data, IoT and AI, is emerging as a key strategy to improve visibility, forecasting accuracy and customer experience in the evolving landscape. The study identifies notable factors such as GDP per capita, imports of trade services and the linear shipping connectivity index as influential factors in assessing the logistics performance index at the country level. The adoption of omnichannel strategies and innovative distribution channels, along with technological advances, is proving to be a promising approach to supply chain optimisation. Despite the promising benefits, the adoption of digital technologies comes with privacy, security, investment cost and workforce qualification considerations.

The empirical results presented in the study, supported by advanced statistical methods such as Spearman rank order covariance, cross-correlation analysis and the generalised method of moments, provide a comprehensive insight into the nuanced relationships between key variables and fail to reject the research hypothesis that information and communication technology is positively associated with economic integration at the regional level in terms of rising dynamic values of value-added present in multilateral commerce.

6. Conclusion

In conclusion, our research hypothesis that the integration of digital technologies into Central and Eastern European (CEE) supply chain management is a catalyst for greater efficiency and resilience, together with its potential impact on economic integration through imported value-added export, finds empirical support in our comprehensive analysis. The evidence presented in this study shows that digital innovations, particularly in information infrastructure, play a central role in shaping logistics performance. Our results show a positive relationship between logistics performance and ICT infrastructure, suggesting that the adoption of digital technologies contributes to more efficient supply chains. Moreover, the complex dynamics uncovered between value-added export and ICT infrastructure in specific countries CEE underscores the nuanced nature of this relationship.

Overall, our study contributes to a deeper understanding of the transformative impact of digital technologies on CEE supply chains and highlights their potential to drive economic integration in the region.

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JEL: G33, G34
Preliminary communication
https://doi.org/10.51680/ev.36.2.13

Received: June 10, 2022
Revision received: March 21, 2023
Accepted for publishing: April 4, 2023

ARE INSOLVENCY PROCEEDINGS OPENED TOO LATE? THE CASE OF GERMANY, CROATIA AND SLOVAKIA

Abstract

Purpose: The aim was to analyze insolvency proceedings in Germany, Croatia and Slovakia and answer the research question whether insolvency proceedings are opened too late in the observed countries and how this issue can be explained.

Methodology: Comparative analysis of insolvency systems in Germany, Croatia, and Slovakia was conducted. Furthermore, the financial profile (liquidity) of firms in pre-insolvency and insolvency proceedings in Germany, Slovakia and Croatia was analyzed and respective results were compared with data on government effectiveness and the rule of law in the observed countries. The one-way ANOVA was performed to test the differences in liquidity among companies that initiated pre-insolvency and insolvency proceedings.

Results: The results indicate that German companies respond to signs of crises earlier in comparison to Croatian and Slovakian companies and these differences cannot be explained only by criminal law measures which are not equally effective across jurisdictions, but they depend to a large extent on government effectiveness and the rule of law in a country.

Conclusion: The results show that despite the similarities in the civil law frameworks, insolvency proceedings in Croatia and Slovakia are still initiated on average much later than in Germany. Moreover, according to the results, criminal law sanctions against the late initiation of insolvency proceedings can have preventive effects. However, while they can increase the number of timely insolvency proceedings, their effectiveness is still limited by the efficiency of the judicial system measured by the strength of institutions and their consistent application.

Keywords: Insolvency, insolvency proceedings, criminal law, delayed insolvency

1. Introduction

The main objectives of modern (Goode, 2011, 10 f.) insolvency proceedings, especially in EU countries, are rescue, debt settlement, reorganization or liquidation of a debtor[1]. Academics point out that "corporate failure remains a critical financial concern, with implications for both firms and financial institutions" (Veganzones & Severin, 2021, p. 204). Borchert et al. emphasize that in times of economic crises, "companies are exposed to increased financial distress" (Borchert et al., 2023, p. 348), while Pervan et al. (2018) state that firm failure is a topic of special interest in times of recession and global financial crisis. In the modern environment, where companies are facing consequences of the COVID 19 pandemic, an unstable political and economic situation as well as the global economic crisis, the issue of firm failure and insolvency proceedings is again a topic of interest among practitioners and researchers. Insolvency proceedings are necessary to protect the interests of creditors and to shield the market from companies entering into additional contracts for transactions, which they cannot fulfill (Hess, 2013, 39 f.). Therefore, insolvency proceedings play an important role as a stabilizing and control mechanism (Keay, 2000, 510 f.). However, in order to have this stabilizing effect, insolvency proceedings must be initiated in a timely manner. This poses a serious problem in practice, as the directors, who are usually in the best position to identify the existence of grounds for the company's insolvency, have a vested interest in delaying insolvency proceedings and the resulting shift of power to the company's creditors. Therefore, the legislature must create mechanisms to ensure compliance by directors. These mechanisms can range from civil liability rules to criminal sanctions.

In our research, we analyzed three countries that have similar regulations regarding the initiation of insolvency proceedings and generally similar systems of civil law, i.e., Germany, Croatia and Slovakia. Despite similarities in the legal framework, it is still considered that, especially in emerging economies such as Croatia and Slovakia, "legal enforcement and creditor protection are substandard" (Tomas Žiković, 2018, p. 23). Couwenberg (2001) states that in addition to bankruptcy law, other rules and regulations affect the initiation of liquidation proceedings as well as the ways of their operationalization. Hence our assumption is that despite the similarities in the civil law frameworks, insolvency proceedings in Croatia and Slovakia are still initiated on average much later than in Germany and this could be explained by differences in the efficiency of the judicial system.

Empirical data published by Doing Business[2] show that insolvency proceedings lead to very different outcomes as measured by receivables recovery rates. While Germany achieves a moderate/good recovery rate value of 79.8%, the other two countries have low recovery rates (Croatia 35.3%, and Slovakia 46.1%). We argue that an important factor for such low receivables recovery rates in Croatia and Slovakia is related to the late opening of insolvency proceedings, while the conditions for initiating the procedure were met earlier. Other authors also warn against opening bankruptcy or pre-bankruptcy proceedings too late (for example Laitinen, 2011; Tomas Žiković, 2018; Pervan et al., 2018). Therefore, the research question within this paper is whether insolvency proceedings are opened too late in the selected countries and how this issue can be explained. In order to answer the research question we performed a liquidity analysis of firms in pre-insolvency and insolvency proceedings in selected countries. After that, a comparative overview of insolvency proceedings regulation was provided and criminal sanctions for delaying the initiation of insolvency proceedings were determined. We assume that these sanctions are not equally effective across the observed countries, but they depend to a large extent on the efficiency of the judicial system. Claessens & Klapper point out that "in addition to legal rights, there is a need for an efficient judicial system to enforce these rights or at least to serve as credible enforcement threat and to speedily conduct the process of liquidation or restructuring when so desired" (Claessens & Klapper, 2006, p. 9). Following their approach, we use the rule of law and government effectiveness indicators for measuring the efficiency of judicial systems in the observed countries. The research results have shown that insolvency proceedings in Croatia and Slovakia are on average initiated too late and that companies continue to operate despite the fact that they fulfill mandatory insolvency reasons. Furthermore, the results indicate that criminal law sanctions against the late initiation of insolvency by it-

1 Regulation (EU) 2015/848 of the European Parliament and of the Council of 20 May 2015 on insolvency proceedings, L 141/19, Art. 1(1).

2 https://www.doingbusiness.org/en/rankings

self cannot explain detected differences in liquidity. These differences can be explained by dissimilarities in indicators related to government effectiveness and the rule of law, which represent the efficiency of judicial systems in the observed countries.

The paper is organized as follows. After the introductory section, Section 2 of the paper presents features of insolvency proceedings regulation analyzed in the observed countries. Section 3 presents a comprehensive economic analysis of key aspects of bankruptcy and pre-bankruptcy procedures in Germany, Croatia and Slovakia. In this section, key findings and discussion are presented. The final section brings concluding remarks on the topic.

2. A comparative overview of insolvency proceedings regulation in Germany, Slovakia and Croatia

One of the key objectives of an effective insolvency system is value preservation and that "insolvency procedures should be designed and implemented to preserve and maximize the total value ultimately available to creditors" (EBRD, 2021, p. 4). Moreover, Ravi states that "one of the goals of the insolvency regime is to preserve value, delays in proceedings that lead to further erosion of value are particularly important to guard against" (Ravi, 2015, p. 22). Aalberts et al. (2019) say that "strategic bankruptcy" is aimed at preserving firm value. While the objective of preserving a firm's asset value impacts the design of almost all insolvency systems around the world, the mechanisms to achieve a high level of asset value protection vary significantly. As this paper aims to answer a very specific question by using a comparative approach, we chose to minimize the differences in legal systems by analyzing EU countries, which share the *acquis communautaire* and fundamental human rights principles, but have succeeded, to varying extents, in establishing strong institutions.

Certain common factors governing the initiation of insolvency proceedings have been established within many EU member states. In this regard, indicators that may trigger insolvency proceedings include: (1) pending illiquidity, (2) illiquidity, and (3) over-indebtedness, with the latter two being usually mandatory insolvency reasons for the debtor (Drescher, 2014, p. 49). While the criteria for initiating insolvency proceedings may be similar in general, there are wide variations with regard to the mechanisms meant to ensure timely compliance with those rules. Namely, countries have implemented various rules to ensure timely initiations of insolvency proceedings including civil law rules that grant claims against managers, fines and criminal law sanctions. While these rules aim to improve compliance with mandatory insolvency law, they often have very harsh consequences for managers and other accountable individuals.

2.1 German insolvency regulation

In Germany, insolvency proceedings are regulated by the Insolvency Statute (*Insolvenzordnung* – InsO)[3]. Grounds for insolvency under German law can be divided into mandatory and voluntary reasons. The two mandatory reasons are illiquidity, which occurs when the debtor is unable to service its due debt obligations, and over-indebtedness, which exists when the assets of a corporation do not cover its liabilities. Illiquidity is limited by the factor that it cannot be assumed based on temporary liquidity gaps that might occur for example between large customer payments or during a refinancing procedure. Furthermore, the value of assets within over-indebtedness is dependent on a projection of chances for a business to continue. Only if it can reasonably be assumed that the business will continue (Morgen & Rathje, 2018, 1955 f.; Tresselt & Schlott, 2017, 193 f.), the value of assets can be based on such continuation and not their liquidation value. As a ground for voluntary filing, the debtor can initiate the procedure in the case of pending illiquidity, which occurs when it becomes predominantly probable that the debtor will become illiquid.

While both the debtor and the creditor are authorized to file for insolvency under mandatory insolvency reasons, only the debtor can initiate the procedure in the case of pending illiquidity. However, it is always the obligation of the debtor's directors to initiate insolvency proceedings if mandatory insolvency reasons exist. A violation of this obligation constitutes a criminal offense, which, in the case of negligence, carries a prison sentence of up to one year or a fine. Furthermore, complex case law exists on civil law obligations of directors and directors' insurance providers who violate their obligations under para. 15a InsO.

3 Insolvenzordnung of 5.10.1994 (BGBl. I S. 2866), last amendment 22.12.2020 (BGBl. I S. 3328).

2.2 Croatian insolvency regulation

Croatian law was strongly influenced by German sources. Therefore, it is no surprise that the Croatian Insolvency Act[4] was largely based on German insolvency law (Borić & Petrović, 2000, p. 58; Garašić, 2008, para. 3; Bilić, 2013, p. 16). As a result, Croatian insolvency law contains the same mandatory and voluntary insolvency reasons. Furthermore, criminal law sanctions also carry a prison sentence of up to one year or a fine. Other sanctions like directors' civil liability also exist, even though directors insurance is less frequent in practice. However, while German insolvency law has been for a long time the main influence on national legislation, in recent years there have been some major changes in Croatian insolvency law, inspired by other legal systems, especially that of the United States. The US system differentiates between bankruptcy and restructuring procedures and provides for different sets of rules for those respective categories (Cheeseman, 2013, 471 f.; Twomey & Jennings, 2008, p. 704). However, reforms that were made did not remove the existing criminal law sanctions from the system.

2.3 Slovakian insolvency regulation

In Slovakia, insolvency proceedings are regulated by Act No. 7/2005 Coll. on Bankruptcy and Restructuring and on Amendments and Supplements to Certain Acts ("BRA"). The Slovakian system also contains the insolvency reasons described above. A debtor is considered insolvent if it is cash-flow insolvent or if it suffers from over-indebtedness (BRA Act No. 7/2005 § 3(1)). A legal person is considered insolvent on the grounds of cash-flow insolvency if it is unable to fulfill obligations towards at least two creditors for over 30 days after the end of the maturity period (BRA Act No. 7/2005 § 3(2)). In a similar vein, over-indebtedness also requires the debtor to have at least two creditors, but for this requirement, the total value of the debt has to exceed its total asset value determined under the rules of the BRA. It is important to notice that valuations of assets and liabilities can generally be based on the premise of the continuation of business activities unless the continuation of business activity cannot be reasonably assumed. The debtor is required to follow its financial situation and prevent insolvency. If despite all efforts to prevent insolvency the debtor becomes insolvent, this triggers the obligation to submit an application for the announcement of insolvency within 30 days from the day on which the debtor learned that the criteria defined above are fulfilled, or from the moment the debtor would have learned it if they had taken reasonable professional care. If the person liable to file for bankruptcy on behalf of the debtor breaches the obligation to file for bankruptcy in good time, this is ground for a penalty that cannot be avoided through third-party agreements. The person shall furthermore be liable to the creditors for damage unless they prove that they acted with professional diligence.

Slovakian insolvency law has furthermore gone through multiple changes aimed at improving compliance. Especially important changes included the introduction of the so-called register of disqualified persons under § 13a of the Commercial Code in 2016. Furthermore, the key change for our analysis is another important piece of legislation, which calls for greater responsibility of statutory bodies. Act No. 264/2017 Coll. of 12 October 2017 (among other things) extended the factual nature of the criminal offense of obstruction of bankruptcy or settlement proceedings to the obligation to file a petition for the declaration of bankruptcy in time (Poláková et al., 2018, p. 127). If this rule is violated, directors face sanctions ranging from 6 months to 5 years in prison, or 3 years to 10 years if additional requirements are met. Slovakian insolvency law thus has more severe sanctions in place than the respective laws in both Croatia and Germany.

3. Empirical analysis, results and discussion

To understand the underlying relations between the various indicators and possible causes of the delayed opening of insolvency proceedings, it is essential to know the main economic mechanisms influencing the decisions of the parties involved. The following text provides an overview of previous research dealing with business failure as well as the results of conducted analysis of the financial profile of failed companies.

3.1 Previous research in business literature

Previous accounting and finance research in this area can be classified into two groups, i.e., pre-bankruptcy prediction research and post-bankruptcy prediction research (Laitinen, 2011, p. 171). It is possible to point out a whole series of studies in this area, and in what follows, selected studies relevant to the

4 Stečajni zakon, Narodne novine, 71/15, 104/17.

context of this paper are presented in more detail. In 2001, Couwenberg (2001) conducted a comparative study aimed at identifying how different systems are designed to improve the chances of survival of the debtor company. The author compared the survival rates in five different countries (the US, the UK, France, Germany and Sweden), and concluded that survival rates for selected Western European countries are comparably low and offer more questions than answers. Therefore, the author points out a suspicion that, in addition to bankruptcy law, other rules and regulations (for example, in the field of commercial and labor law) affect the initiation of liquidation proceedings as well as the ways of their operationalization. Much research dealing with the prediction of bankruptcy outcomes has been conducted on a sample of US companies, where the effectiveness of Chapter 11 has been analyzed. The research conducted by Barniv et al. can be emphasized as representative of this stream of research (Barniv et al., 2003). According to the results of their research, analysis of financial variables alone in predicting bankruptcy outcomes is not sufficient and the predictive power of the model is increased by including non-financial variables.

In the Republic of Croatia, Sajter (2010) surveyed a sample of insolvency practitioners. According to the research results, the initiation of insolvency proceedings is not certain or expected even in the conditions of long-term insolvency (over 1 year). The author points out that research in the field of insolvency in the Republic of Croatia is quite rare, especially if it takes into account the economic aspects of bankruptcy. Survey results indicate that the majority (89.6%) of insolvent companies in Croatia have been insolvent for more than 60 days, and 69.8% of them have been insolvent for over a year (Sajter, 2010, p. 141). Because insolvency is one of the mandatory criteria for initiating insolvency proceedings and delaying the initiation of this process is a criminal offense, it would be expected that a large number of proceedings would be initiated in Croatia on time, which is not the case in practice. Specifically, the results show that in the period from 2003 to 2008, the number of initiated proceedings decreased. The research results indicate disharmony between the theory or legal framework and the practice of Croatian companies because despite an apparent increase in the number of insolvent companies, they remain active on the market and do not open insolvency proceedings. Laitinen (2011) conducted a survey aimed at analyzing the survival of Finnish corporations that entered the process of reorganization or bankruptcy under the relevant regulation. Survey results indicate that a higher percentage of companies that applied for reorganization ultimately went bankrupt, while a large number of those that started insolvency proceedings survived. Moreover, according to the results, non-financial variables add more information value to the model in estimating survival than when only financial variables are used.

A study of the success of small business reorganization in Belgium was conducted by Leyman in 2012. He pointed out that there are significant differences in regulating the area of corporate reorganization, and in this context, it is useful to carry out comparative research to determine which countries have the highest survival rates, and to improve regulations in countries where the rate of survival is quite low (Leyman, 2012, p. 534). Pervan et al. (2018) and Tomas Žiković (2018) also emphasized the issue of late opening of bankruptcy proceedings in Croatia. In addition, Pervan et al. state that in Croatia, "the bankruptcy procedure starts at a very late stage of crisis, when a firm's liabilities are higher than assets" (Pervan et al., 2018, p. 269). In their research, the authors developed an alternative model for firm failure prediction – the financial distress model. According to the research results, the developed model outperformed traditional models in terms of better accuracy and prediction of firm failure status. Tomas Živković also warns about the late initiation of insolvency proceedings in Croatia. The author points out that "by comparing the number of companies that declared bankruptcy in Croatia in 2011 (4,878) and the number of insolvent companies in the same period (35,876 blocked companies), it can be concluded that only 13.6% of insolvent companies initiate insolvency proceedings, while the others continue to operate and spread insolvency throughout the system" (Tomas Živković, 2018, p. 6). Veganzones & Severin analyzed corporate failure prediction models using an in-depth review of 106 published scientific articles in this area. The authors point out that the analysis revealed certain agreements but also certain differences in terms of constructing a model for predicting bankruptcy. However, they conclude that financial variables are still primarily used in prediction models, while other variables are used as complements (Veganzones & Severin, 2021).

3.2 Analysis of the financial profile of failed companies

While the insolvency reasons that oblige directors or shareholders to initiate insolvency proceedings were described in the legal analysis within Section 2, it is also important to understand their underlying financial indicators, as well as the impact of those factors on the survival chances of the debtor. In this paper, empirical analysis consists of three steps. In the first step, liquidity in all pre-bankruptcy and bankruptcy proceedings in Croatia, Germany and Slovakia is compared to establish the level to which insolvency proceedings are initiated too late in systems that largely relied on criminal law sanctions in comparison to those which only recently introduced them. In the second step, we compare the results obtained for liquidity and timely initiation of insolvency proceedings with indicators that represent judicial efficiency in the observed countries. Finally, trends in liquidity over time in Slovakia were analyzed to determine how a change in the insolvency regulation (from 2017) influenced a change in the number of initiated procedures.

3.2.1 Comparative analysis of liquidity in pre-insolvency and insolvency proceedings

To be able to compare data from three countries, it was necessary to establish uniform terminology, as different countries use various terms to describe different procedures, which was also manifested by the incompatible use of those terms in the Amadeus database[5]. Thus, in order to include insolvency proceedings for the observed countries we focused on statuses in the Amadeus database:

- for Croatia, companies with statuses "In liquidation", "Bankruptcy" and "Rescue plan" were analyzed;
- for Germany, two categories were included: "Insolvency proceedings" and "Default of payments"; and
- for Slovakia, companies with statuses "In liquidation", "Bankruptcy" and "Insolvency proceedings" were analyzed.

After establishing uniform terminology, all companies with no data available for status opening and those where procedures were opened before 2013 were excluded from further analysis. This analysis covers the period from 2010 to 2019, and data on liquidity for the analyzed companies were obtained from the Amadeus database. In the first step, we focused on the opening date of insolvency status, and then sorted all data accordingly. In the next step, we analyzed data on liquidity in the year of the insolvency procedure opening, and one, two and three years before the insolvency procedure opening. It should be noted that it was necessary to exclude some companies from the sample due to a lack of data on liquidity. The research results are presented hereafter.

According to the research results presented in Table 1, obvious liquidity problems were detected in all analyzed countries. For example, in Croatia, three years before the procedure opening the liquidity ratio was less than 1 in 53.26% of cases, and this share of illiquid companies rose to 61.31% in the year of the procedure opening. Such results are in line with the findings of Sajter (2010, p. 133), who states that it is not necessarily expected to start the procedure even in the case of long-term insolvency (over 1 year). The issue of a late opening of bankruptcy proceedings in Croatia is also emphasized by Pervan et al. (2018) and Tomas Žiković (2018).

Slovakian companies are also facing significant illiquidity issues as 45.90% of them have a current ratio of less than one three years before the procedure opening. In the year of the procedure opening, even 60.85% of companies have liquidity issues. This confirms the assumption that companies ignore the warning signs of crisis and start the reorganization processes too late, which compromises the outcome of the reorganization process. As for the German sample, the results indicate that about 36.92% of companies have liquidity problems three years before the procedure opening and this ratio rises to 47.47% in the year of the procedure opening. This indicates that German companies respond to signs of crises earlier in comparison to Croatian and Slovakian companies.

5 https://amadeus.bvdinfo.com/version-20211122/Home.serv?product=amadeusneo

Table 1 Comparative analysis of liquidity in initiated pre-insolvency and insolvency proceedings

	Croatia		Slovakia		Germany	
	Number	**%**	**Number**	**%**	**Number**	**%**
Procedures year T	1.039		567		99	
Procedures year T-1	2.603		1.481		229	
Procedures year T-2	2.946		1.439		984	
Procedures year T-3	2.717		1.377		1.219	
Current ratio < 1 year T	637	61.31%	345	60.85%	47	47.47%
Current ratio < 1 year T-1	1.574	60.47%	758	51.18%	113	49.34%
Current ratio < 1 year T-2	1.612	54.72%	683	47.46%	380	38.62%
Current ratio < 1 year T-3	1.447	53.26%	632	45.90%	450	36.92%

Source: Authors' calculations

To test the differences in liquidity among companies that initiated pre-insolvency and insolvency proceedings in the analyzed years (year T, year T-1, year T-2 and year T-3), the authors performed the one-way ANOVA because the analysis of differences in liquidity between three different samples (countries) was conducted. The results indicated that all the observed differences were significant at the 5% significance level (p-value = 0.0001).

Overall, it can be concluded that the research assumptions have been confirmed and that, on average, insolvency proceedings in Croatia and Slovakia are initiated too late, and that companies continue to operate on the market even though mandatory insolvency reasons exist. Namely, the results of the research indicate that the main trigger for insolvency proceedings – insolvency - is present in companies even three years before the initiation of the proceedings, which suggests that the companies accumulate losses for years and ignore the obvious signs of financial instability.

3.2.2 Comparative analysis of liquidity data in relation to government effectiveness and the rule of law

Data on liquidity presented in Table 1 indicate that Slovakian companies perform slightly better than Croatian companies. However, the results are still far behind those concerning companies in Germany. For example, in the year of initiating a bankruptcy or pre-bankruptcy procedure, 47.47% of German companies have liquidity issues, while this ratio rises up to 60.85% for the Slovakian sample. The results of the performed liquidity analysis of opened bankruptcy or pre-bankruptcy procedures show that insolvency proceedings in Croatia and Slovakia are, on average, initiated too late and that differences among the observed countries exist although all the observed countries have a similar legal framework in the context of criminal sanctions for delaying the initiation of insolvency proceedings. For example, Croatia and Germany have the same predicted sanction in terms of a prison sentence of up to one year or a fine. In Slovakia, insolvency laws were changed during the period covered in our analysis, but the results are still not in line with the stricter criminal sanctions for late initiations of insolvency proceedings that have been introduced in recent years. As the design of the national law alone cannot explain the detected disparities in liquidity, the next logical step is to look into indicators that show the actual application and enforcement of the law in the countries concerned.

Such an approach is in line with Couwenberg (2001) and Tomas Žiković (2018), who pointed out that the operationalization of bankruptcy laws and the actual application and enforcement of the law may cause differences in the initiation of insolvency proceedings. Thus, not only the insolvency framework but also the effective judicial system affects the timely initiation of insolvency procedures. For this reason, we focused on worldwide governance indicators related to government effectiveness and the rule of law as proxies for the efficiency of the judicial system. Government effectiveness shows the perceptions of the quality of public and civil services, as well as the perceived degree of its independence from political pressures. The rule of law

indicator points to the "perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence" (World Bank, 2022).

As presented in tables 2 and 3, among the analyzed countries, both analyzed indicators achieve the highest scores in Germany. The value of these indicators is significantly lower in Slovakia, while Croatia achieves the lowest value in both groups. For example, the average value for the government effectiveness score in Germany for the period 2013-2019 is 93.70, while this score drops to 75.05 for Slovakia. For the same period, the average value of the government effectiveness score in Croatia is 70.66.

Table 2 Government effectiveness in the period 2013-2019

Country/Year	2013	2014	2015	2016	2017	2018	2019	Average
Croatia	71.09	73.08	72.12	69.71	72.12	69.23	67.31	70.66
Slovakia	73.93	75.00	75.00	76.92	75.00	75.48	74.04	75.05
Germany	92.42	94.71	93.75	94.23	94.23	93.27	93.27	93.70

Source: The World Bank, Worldwide governance indicators, retrieved from: https://databank.worldbank.org/reports.aspx?source=worldwide-governance-indicators#

Table 3 Rule of law in the period 2013-2019

Country/Year	2013	2014	2015	2016	2017	2018	2019	Average
Croatia	58.22	63.46	61.06	63.46	62.50	62.98	63.46	62.16
Slovakia	64.32	69.23	68.27	72.60	69.71	69.71	70.19	69.15
Germany	92.02	93.75	93.27	91.83	91.35	91.35	92.31	92.27

Source: The World Bank, Worldwide governance indicators, retrieved from: https://databank.worldbank.org/reports.aspx?source=worldwide-governance-indicators#

The results presented above show that there are differences in indicators related to government effectiveness and the rule of law among the observed countries. These differences could explain the detected disparities in the share of illiquid companies in the samples. The results lead to the conclusion that it is not just the intensity of the sanction but also the likelihood of being convicted that strongly influences the decision-making process of individuals in the context of starting liquidation proceedings in the observed countries. Therefore, we can conclude that the results confirm that the way the laws are executed plays an important role in the prevention of late insolvencies.

3.2.3 Cross-time analysis of liquidity in pre-bankruptcy and bankruptcy procedures for the Slovakian sample

In this part of the study, we present the results of a cross-time analysis of liquidity for a sample of Slovakian companies that initiated procedures in the period between 2013 and 2019. A more detailed analysis of the Slovakian sample was performed because Slovakia introduced criminal law penalties for late initiations of insolvency proceedings in 2017, so it was interesting to analyze how this influenced the number of initiated procedures in this country. We assume that the introduction of criminal law penalties in Slovakia should increase the number of timely insolvency procedures, but only up to a level proportionate to the efficiency of the judicial system in this country. The results are presented in the following table.

Table 4 Liquidity analysis for the Slovakian sample

Year 2019	Number	%
Procedures year T	160	
Current ratio < 1 year T	60	37.50%
Year 2018	Number	
Procedures year T	188	
Current ratio < 1 year T	134	71.28%
Year 2017	Number	
Procedures year T	70	
Current ratio < 1 year T	43	61.43%
Year 2016	Number	
Procedures year T	13	
Current ratio < 1 year T	6	46.15%
Year 2015	Number	%
Procedures year T	95	
Current ratio < 1 year T	71	74.74%
Year 2014	Number	%
Procedures year T	28	
Current ratio < 1 year T	21	75.00%
Year 2013	Number	%
Procedures year T	16	
Current ratio < 1 year T	10	76.92%
TOTAL	Number	%
Procedures year T	567	
Current ratio < 1 year T	345	60.85%

Source: Authors' calculations

From the data given above, it can be noted that the number of initiated procedures increased significantly in 2017, which corresponds to the introduction of criminal law sanctions. This implies that criminal law sanctions have a positive effect on the prevention of late insolvencies in the Slovakian sample. It has long been proven that the severity and likelihood of criminal law penalties applied to individuals have a strong influence on their behavior (Becker, 1968). The results show that in 2017, the year when criminal law sanctions for the late initiation of insolvency proceedings were introduced in Slovakia, the number of initiated procedures increased to 70. The effect was more noticeable with a one-year lag, i.e., in 2018, when as many as 188 procedures were initiated, which is a significant increase in comparison to previous years (70 and 13 procedures in 2017 and 2016, respectively). This implies that criminal law sanctions have a positive effect on the initiation of bankruptcy and pre-bankruptcy procedures. The average share of illiquid companies in the sample in the years after introducing criminal law sanctions (2018-2019) was 54.39%. In comparison with the average share of 68.06% in years before these measures (2013-2016), it can also be concluded that the introduction of these criminal law sanctions had a positive effect on the timely initiation of insolvency proceedings. Thus, the results clearly show that criminal law sanctions positively influence the initiation of timely insolvency proceedings. But, as shown above, only up to a ceiling determined by the strength of institu-

tions and the rule of law in a country. Even the fact that the Slovakian system introduced more severe sanctions could not help to reach the level of efficiency achieved in modern western countries like Germany. Criminal law sanctions therefore clearly have a place in insolvency law. However, for them to have optimal effects, other elements concerning the application of law and the judicial environment must be improved.

4. Conclusion

In this paper, the authors performed a comprehensive analysis of insolvency proceedings in Germany, Croatia and Slovakia. The main goal of the research was to examine the assumption that insolvency proceedings are opened too late in the observed countries and to explain this issue. The research results have been confirmed and insolvency proceedings in Croatia and Slovakia are, on average, initiated too late. According to the results, companies continue to perform their business activities even though mandatory insolvency reasons exist. The results of the conducted analysis show that the main trigger for insolvency proceedings - insolvency, is present in companies even three years before the initiation of the proceedings, which indicates that companies accumulate losses for years and take no notice of obvious signs of financial crisis instability. Furthermore, the results of the conducted analysis indicate that criminal law sanctions against the late initiation of insolvency proceedings can have preventive effects. These sanctions, however, can increase the number of timely insolvency proceedings only to a certain level as their effectiveness is limited by the strength of institutions and their consistent application.

This, in conclusion, means that criminal law sanctions are an effective short-term tool, but that criminal law sanctions in the long term cannot substitute for an improvement to the rule of law and the strength of institutions in a specific country. As the strength of institutions is especially relevant to the coherent application of the law, and thus the likelihood for perpetrators to be convicted, the results could also indicate that jurisdictions such as Croatia and Slovakia do not apply criminal law sanctions equally to all perpetrators. Future research should therefore especially focus on the economic impact of the level of the arbitrariness of the application of criminal law penalties in insolvency law. Furthermore, difficulties in establishing uniform terminology should be pointed out as research limitations because different countries use different terms to describe different procedures. Finally, the sample was reduced due to a lack of data on status opening or data on the liquidity ratio in the year of analysis.

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JEL: D12, P25
Preliminary communication
https://doi.org/10.51680/ev.36.2.14

Received: April 3, 2023
Accepted for publishing: June 13, 2023

DETERMINANTS OF FREQUENCY OF WINE CONSUMPTION IN CROATIA

Abstract

Purpose: In the last 10 years, wine consumption in Croatia has increased and consumer habits and expectations have changed. Understanding consumer behavior in relation to wine consumption is important for wine-producing countries where wine is an important component of economy. The aim of this study is to identify the factors that influence the frequency of wine consumption in Croatia, where wine production is an important agricultural activity in terms of the number of people employed in the sector and an important factor in the development of tourism.

Methodology: Empirical research was conducted by means of a questionnaire filled out by 169 wine consumers who visited a wine fair in the Croatian Adriatic region. Based on the collected data, we developed and estimated a multinomial logit model.

Results: The results indicate that wine is consumed more frequently by men, married people, people in long-term relationships, and older people. In addition, people with high levels of education tend to drink wine less frequently. The paper explains the reasons for somewhat puzzling results and suggests future avenues of research.

Conclusion: Behavioral differences were confirmed in this study between subsample groups in accordance with four demographic characteristics, i.e., gender, age, marital status, and education criteria. Our analysis showed that males are more likely to consume wine than women, older than younger and less educated than more educated participants. Our results help wine marketers to segment and target wine consumers.

Keywords: Wine industry, Croatia, wine consumption frequency, sociodemographic characteristics

1. Introduction

Wine is a product valued in many, if not most, modern cultures around the world. Besides a few basic types of grapes, there are hundreds of species and subspecies or varieties grown all over the world. It can hardly be denied that the choice of wine is a matter of preference and choice, and it is not surprising that preferences for all sorts of things, including the taste of wine, are often an interesting point of discussion among people. However, to put it in an economic context, a better understanding of consumer behavior in regard to wine consumption is needed. Under the influence of globalization, increasing wine competition from the New World countries, and a series of economic crises in

the EU and beyond, the wine industry has changed dramatically over the past decade. The industry is facing a tremendous increase in competition, while consumer habits of consumption and purchasing decisions are changing due to changing attitudes toward health (Smith & Miltry, 2007; Hledik & Harsanyi, 2019; Deroover et al., 2021), purchasing power, lifestyle, and social utility (Orth et al., 2005), among other factors. Castellini and Samoggia (2018) studied millennials' wine consumption and purchasing habits, and their research findings suggest that Italian millennials are wine neophilic. Their findings are important for wine producers when targeting new consumers.

The above-mentioned increase in competition and market pressure, and thus the need to promote rural and agricultural development, has been recognized by the European Union (EU). However, producers must be trained not only to increase production, but also to better understand consumer habits and preferences. An adequate response by wine producers to changes in consumer preferences related to supply adjustments provides producers with a competitive advantage. According to Smith and Miltry's (2007) study, "consumer behaviors in developed countries of the European Union appear to be converging in many ways due to increasing interconnectedness and cultural cross-fertilization". They also concluded that consumer preferences are less driven by regional tradition and more by a growing acceptance of a cultural change. Destination image and experience became critical factors affecting consumers and wine tourism. For destinations traditionally involved in wine production, wine tourism began to play an important role in the national economy (Scorrano et al.; Rosato, 2018).

Croatia is a country with a long wine production tradition. Today, the sector consists mainly of small family-owned wineries, while there are almost no companies, with the exception of a few privatized ones. Although competition in the Croatian wine market is quite strong, there is a remarkable difference in the possibilities of developing distribution channels between producers from the Adriatic region and producers from the continental region. In the Adriatic region, tourism is an important flywheel for economic development and also one of the most important distribution channels for wine producers in this area.

Croatian agricultural acreage and commercial wine production have remained fairly stable over the past two decades, while homemade production of wine has declined, resulting in a decrease in the overall production. Although exports are slightly increasing, low production volumes of individual wine producers, small and fragmented vineyards, and tourism as a distribution channel are reasons for wine producers' lack of interest in exporting and their inability to compete with large producers on the foreign market. Pulls, clusters and other strategic alliances are the way to improve the position of Croatian wine producers on the foreign market. Imports are growing much faster than exports as demand in the domestic market increases and the self-sufficiency rate decreases from a maximum of 120 percent in 2007 to less than 80 percent in 2017. Due to the development of tourism and changing consumer preferences, interest in wine in Croatia is increasing.

Considering the role of the Croatian wine sector in the Croatian economy and in the development of tourism and due to the increase in the share of quality/premium wines in the total wine production, the **aim of this paper** is to identify the demographic profiles of Croatian wine consumers regarding frequency of wine drinking. The variables whose influence on consumer preferences is examined in this paper are gender, age, education level, the number of household members, marital status, and household income. The main research question of the paper is whether there exist significant differences in the determinants of consumer preferences when consumers have already revealed their initial preferences for wine consumption (by attending wine fairs) in comparison with the bulk of empirical literature that models consumer preferences on a completely random sample.

Our research represents an extension of previous research on consumer habits, both in general and in the wine industry. The results of our research can be of use to all those involved in the supply chain, especially to wine producers in identifying markets for developing the company's production and marketing strategy (expanding a product range, changing the appearance of the label, targeting a specific market and consumer type, etc.). The paper is structured as follows. After a brief literature review (second section), model development (third section) used in this paper is presented. The estimation results and discussion are presented in the fourth and fifth section, respectively, while the last section provides a conclusion.

Thus, our main research **hypothesis** is that there are significant differences in the frequency of wine consumption among wine consumers and that these differences are influenced by age, gender, marital status, income, and education level of consumers.

2. Literature review

Wine is a specific, valuable product with unique characteristics in terms of consumption. It can also be seen as a complex product considering the many factors that influence wine consumer behavior. Some recent Croatian research indicates that wine is primarily perceived as a pleasure from the consumer's point of view (Alpeza et al., 2023), while others go further and state that wine could be seen as an experience good (Kaštelan Mrak & Kaštelan, 2023). A study (Bouillet, 2014) conducted on a sample of 2,000 Croatian students found that 63.4% of them consume wine at least once a month, while Leko Šimić and Turjak (2018) found that wine is the most common choice of alcohol for students in domestic consumption.

Recognizing the importance of understanding the profile of wine consumers and directing the focus of producers to consumer behavior has become a necessity to keep up with rapid global changes. There are relevant prior research papers that address the wine industry from the perspective of consumer theory and preference theory (for example, Thach et al., 2022, and Borchgrevink & Sherwin, 2017). Lockshin and Corsi (2012) pointed out that in the period between 2004 and 2012, about 100 journal articles addressed wine consumer behavior. The Web of Science database contains 570 articles on this topic in its Core Collection from 2012 to 2023. Of these, 142 articles fall into the categories of Business, Economics, and Agricultural Economics Policy (Web of Science, 2023).

Recognizing and understanding the profile of wine consumers is essential for wine producers in order to adjust and improve their offer to the needs of the market. According to Molina et al. (2015), although most of the scientific literature deals with research on the influence of subjective variables on wine market segmentation, objective variables (like socio-demographic) could be more suitable. The socio-demographic factors identified as significant in relation to wine consumption are age, income, the level of education, marital status and gender.

Age was determined as a significant predictor in several recent research studies (Rebelo et al., 2021; Dubois et al., 2021). Stockley et al. (2017) analyzed wine consumption by different age groups in Australia. They found that the 65+ age group was more likely to drink wine ≥ 5 days per week, while respondents aged 25-34 were more likely to consume five or more standard drinks per occasion than all other age groups. Thus, older consumers tend to drink more frequently, while consumers aged 25-34 are more likely to drink larger amounts. This same age group (i.e., 25-34) is recognized as the group with the highest percentage (29%) of wine drinkers in Poland, followed by the 35-44 age group (28%) (Statista, 2022). Recent research on wine consuming preferences conducted in Croatia (Alpeza et al., 2023) showed that consumption frequency commonly increases with age.

When Gustavsen and Rickertsen (2018) were analyzing age as an independent variable, they established in their sample that there was a 0.4 percentage point rise in wine consumption frequency with a rise of respondent age by one year. Rebelo et al. (2021) conducted a study on frequency of wine consumption in Spain and Portugal during the COVID-19 pandemic and found that in Portugal there was a significant impact of age, i.e., older people tend to drink more frequently, but they find no such effect in Spain. In a research study conducted by Dubois et al. (2021), age has a different effect depending on the country - in France, the categories of respondents aged 18 to 29 and older than 51 increase the likelihood of additional consumption, while in Italy, this is the 30-40 segment. In contrast to research mentioned previously, in this one conducted in Spain the segment aged under 18 increases the likelihood of additional consumption with no significant effect in Portugal.

The influence of income, as one of the traditional demand factors, on alcohol and/or wine consumption has been studied by various authors (Dubois et al., 2021; Garcia-Cortijo et al., 2019; Gustavsen & Rickertsen, 2018). Gustavsen and Rickertsen (2018) also noted slight income differences, where an increase in income by 1% makes wine drinking more probable by 0.2 percentage points. A study conducted by Garcia-Cortijo et al. (2019), who examined the influence of income on wine consumption in China, among other factors, concluded that an increase in income level leads to an increase in wine consumption. Their findings are consistent

with those of other authors who have conducted the same research on China, but they should be considered in the light of the specifics of the market studied. China is not a traditional wine country and it appeared on the wine map of the world only 15 years ago. Dubois et al. (2021) found out that income level has no significant influence on consumption in the whole sample. However, a subsample of respondents in France showed that the lowest income was associated with an increase in wine consumption. Considering the specifics of Croatia - a long winemaking tradition, a large share of wine production for home consumption, wine as a readily available product, it is assumed that the level of income has a greater influence on the quality of wine consumed by consumers than on the quantity, which is why this variable was included in the model we tested.

The impact of education as an independent variable proved to be substantial in research done by Gustavsen and Rickertsen (2018), where a Bachelor's degree increases the probability of wine consumption by 8.6%. Bruwer and Buller (2012) found that the percentage of women with low levels of education who consume wine is higher than that of men, while the opposite is true for those with medium levels of education. However, research conducted by Rodríguez-Donate et al. (2019) showed that as the level of education increases, the percentage of men who frequently consume wine decreases and the percentage of men who rarely consume wine increases. In their study, this behavior was not observed among women, although women with a non-university degree tended to be low-frequency consumers compared to men. Villanueva et al. (2017) found in their study that the lower the level of education, the higher the wine consumption. A higher education level can be associated with higher consumption among those consumers who supplement wine quantity with wine quality. Wine consumption in these cases has a biased component for a more informed and qualified demand.

Marital status is among significant factors influencing alcohol-consuming behavior. That was shown in results of an influential study published by Dinescu et al. in 2016. Their study was conducted on a large sample of same-sex twin pairs (Dinescu et al., 2016) and it confirmed a general finding that married people tend to consume less alcohol. The study showed statistically significant differences between married couples and their single, divorced, and even cohabiting twins. Although to varying degrees, the differences are significant for both male and female respondents. In addition, and of greater importance to our study, married couples consume alcohol less frequently than their single counterparts. This study attempted to isolate wine as an alcoholic beverage, and we understand that wine, especially quality wine, may lead to different results, but general results show that married couples consume less alcohol, which we believe is important. According to other research, marital status also matters for alcohol consumption in several ways. As noted above, marriage is an important variable in wine brand choice in some studies, but perhaps more interesting is the finding of a study among older couples that showed that alcohol consumption by both partners reduced negative marital quality (Birditt et al., 2018), and that the same finding was not confirmed when both partners did not consume alcohol. Thus, joint moderate alcohol consumption may indicate shared interests. That being married has a positive impact on wine drinking frequency was also observed in Gustavsen and Rickertsen (2018), who found a 1.9% difference for married.

The influence of gender on consumer behavior is of great importance to wine producers in developing their business strategy and has been the topic of scientific papers (Dubois et al., 2021; Rodríguez-Donate et al., 2019 and 2017; Gustavsen & Rickertsen 2018; Nazan Gunay & Baker, 2011). The difference between male and female perspectives on the decision-making process and attitudes toward wine consumption is a result of culture (Palan, 2001) and also biological differences. According to Nazan Gunay & Baker (2011), gender is an important target segmentation criterion. A slight impact of gender on wine consumption frequency was observed in Gustavsen and Rickertsen (2018), where being a woman increased the probability of drinking wine by 0.9 percentage points. In a research study published by Dubois et al. (2021), gender has a significant influence on wine consumption (demonstrated in a subsample in Italy), where men consumed wine less frequently during the COVID-19 lockout. In their latter work, Gustavsen and Rickertsen (2019) examined associations between personality traits and expected frequencies of wine and beer consumption, concluding that being open or driven by extrovertism or higher social capital leads to more frequent consumption. Thach (2012) studied the

differences in wine consumption between men and women and concluded that men drink more wine and on more occasions than women. Rodríguez-Donate et al. (2017) examined the influence of gender on the frequency of wine consumption, among other sociodemographic determinants. They found that adult males were more likely to consume wine. In general, their research shows significant gender differences in the decision to consume wine. Rodríguez-Donate et al. (2019) found in their recent work that the predominant wine drinking behavior in both genders is that with low frequency of consumption, where the percentage with high frequency of consumption is much higher among men than women. In addition, the percentage of women who do not consume wine is higher than that of men.

3. Data and methodology

This research was conducted through a questionnaire (survey). Data gathering took place in Croatia, during the season of wine fairs in June 2021. Wine fairs in Croatia are organized either in a way that a visitor rents a glass and pays to taste wine presented by winemakers, or a visitor pays an entrance fee and can then taste various wines. As this might prove costly, only consumers who are wine lovers and who consume wine more than the average of the general population were included in this research. For the same reason, the questionnaire was not conducted online and via social media. Filling out the questionnaire took about 10 minutes, and 169 wine consumers were included in this research. All respondents were over 18 years old, which is the minimum age limit for consuming alcoholic beverages in Croatia. Almost 95% of respondents lived in the same county in Croatia (Primorje-Gorski Kotar County), as the questionnaire was taken at wine fairs organized in that county, which is why this variable was not included in the model.

The questionnaire consisted of 24 questions divided into several categories. The first category consisted of 6 demographic questions: age of respondents, gender, the level of education, the number of household members, marital status and monthly household income. The second category consisted of 8 questions about consumer preferences: how often respondents consume wine (on a daily/weekly/monthly basis, several times a year), on what occasions (alone, with friends, with family), how much money they spend on wine, what price range they prefer when they buy wine, and what type (white/black/rose, dry/semi sweet/sweet, table/quality/premium, domestic/imported) of wine they consume more often. The third part of the questionnaire consisted of 12 questions about wine preferences. The answers were offered in the form of a Likert scale, ranging between 1 that stands for – completely disagree, to 5 that stands for – completely agree.

Table 1 shows sociodemographic characteristics of the respondents.

Table 1 Sociodemographic characteristics

Sociodemographic characteristics	%
Gender	
Men	48.5
Women	51.5
Age	
18-29	30.2
30-39	27.2
40-49	25.4
50-59	11.2
60-69	5.3
no reply	0.7
Education level	
Secondary education	22.5
Bachelor's degree/Master's degree	52.1
Postgraduate level	24.8
no reply	0.7
Marital status	
marriage/long relationship	65.7
single/divorced/widowed	32.5
no reply	1.8
Income (monthly per household)	
up to 1,300 euro	30.2
1,301 - 2,650 euro	49.7
2,651 - 3,999 euro	7.1
above 4,000 euro	10
no reply	3

Source: Authors' calculations

The respondents are between 19 and 69 years old. Males and females make up 48.5% and 51.5% of the sample, respectively. In the sample, 22.5% of respondents completed high school, 52.1% hold a Bachelor's degree, and 24.8% completed postgraduate studies (MBA or PhD level). Married people made up 65.7% of respondents, while 32.5% were single, divorced or widowed. Monthly household income of almost half of the respondents (49.7%) ranges between 1,301 and 2,650 euro.

Table 2 shows descriptive statistics of the sample.

Table 2 Sample descriptive statistics

	mean	sd	min	max
Cons. freq.	1.025	0.640	0	2
Male	0.481	0.501	0	1
Married	0.660	0.475	0	1
Income	2.432	1.576	0	6
Education	1.037	0.686	0	2
Age	37.83	11.73	20	69
N	162			

Source: Authors' calculations

Table 3 Wine consumption frequency in the sample

Cons. freq.	Freq.	%
daily	31	18.34
weekly	101	59.76
monthly or yearly	37	21.90
Total	169	100

Source: Authors' calculations

Based on the aforementioned literature, especially on the paper written by Rodríguez-Donate et al. (2017), where they investigated the sociodemographic determinants of wine consumption in Tenerife using multinomial logistic regression, we developed and estimated the following multinomial logit model:

$$\ln \frac{P(y_i=m)}{P(y_i=0)} = \alpha_m + \sum_{k=1}^{5} \beta_{mk} X_{ik} \ , \qquad [1]$$

where Y is a categorical variable consumption frequency with three categories (daily, weekly, monthly or a couple of times a year), with daily being the reference category. X_{ik} is a vector of regressors (k is the index for regressors), that is, a vector that includes variables male, married, income, education and age. Income and education are categorical variables with seven and three categories, respectively, while male and married are dummy variables. Estimated coefficients are interpreted as odds of being in a particular category (e.g., weekly wine consumers) versus the base category of a dependent categorical variable (e.g., daily wine consumers). This means that we had two sets of estimated coefficients, one set representing odds of being in the category of a weekly wine consumer vs. a daily wine consumer, and one set representing odds of being in the category of a monthly or a yearly wine consumer vs. a daily wine consumer. These odds ratios are also called relative rise ratios and are presented in the Results section of the paper (Table 4). As a diagnostic check, we conducted the Brant test for parallel lines, which was not significant, suggesting that we can use our estimations.

4. Results and discussion

The log likelihood ratio test statistics showed that our five-predictor model provided a better fit than the model under the null hypothesis, under which we have the model with only the constant included.

According to our results (Table 4), being married or in a relationship decreases the odds of being in category I (weekly wine consumers) by (0.25-1)%, i.e., -75.1%, and by 84.2% of being in category II (monthly and/or yearly wine consumers) versus category 0 (base category - daily wine consumers). The age effect had the same direction, but the size is much lower. An increase in age by one year decreases the odds of being in category I and in category II by 7.2% and by 6.4%, respectively. Gender is borderline significant (at a 5% significance level) and only for the coefficient of the first category. It is in line with other research in this field, that is, men tend to drink wine more frequently than women. Education is significant at a 10% significance level and it indicates that more educated people tend to drink more occasionally (greater odds of being in categories I and II with respect to category 0).

Table 4 Results of the multinomial logit model

	Category I	Category II
Ind. vars	weekly	monthly & yearly
Male	0.377**	0.405
	(0.184)	(0.232)
Marital status	0.249**	0.158**
	(0.173)	(0.118)
Income	0.923	0.670**
	(0.135)	(0.132)
Education I	2.785*	3.952*
	(1.637)	(2.950)
Education II	1.161	3.578
	(0.735)	(2.850)
Age	0.928***	0.936***
	(0.0204)	(0.0239)
LR chi2(22)	44.76	p-val = 0.000011
Pseudo-R2	0.1443	
N	162	

Exponentiated coefficients, standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

Source: Authors' calculations

From the size of the coefficient across the categories of our DV (dependent variable), we concluded that overall, married people (or people in relationships) drink more frequently than unmarried or divorced people. The coefficient for age showed that older people drink more frequently. The most comparable study with our research is that of Rodríguez-Donate et al. (2017), with the most important differences being the sampling process (we conducted our survey at wine fairs, which by definition creates a sampling bias) and a different country/region. We may add that the fact that the sample in their research was taken on an island (Tenerife) might also bring a new element that makes one-to-one comparisons with our results harder. Notwithstanding these differences, our findings are mostly in line with their research, which is important given our research question, and has practical implications for wine producers and wine marketers.

In general, our results show that married people consume wine more frequently than single, divorced, or widowed persons. Age also plays a role, as older people in the sample tend to consume wine more frequently. As in most studies, men tend to drink more often than women, although this difference is not as significant in our sample. The final variable for which we found a significant value is education level, as educated consumers tend to drink wine more occasionally.

In our study, marital status led to more frequent wine consumption. As can be seen from the literature review, the results of previous studies are not consistent with respect to this variable. One study (Dinescu et al., 2016) indicates that married people consume less alcohol than others, while another (Birditt et al., 2018) indicates that married couples are more likely to be satisfied with their relationship when drinking together. There are several points to note about this. First, while there is alcohol in wine, alcohol and wine are not the same thing. As wine is increasingly perceived as an expensive/quality commodity, it may (or may not) be the case that unmarried individuals who consume more alcohol do not drink more wine than their married counterparts. Second, higher frequency does not automatically mean greater quantity. Third, our survey was conducted at a wine fair, most of our participants came in groups, many of them were couples, and it is reasonable to assume that visitors to a wine fair like wine and are likely to prefer it to other alcoholic alternatives. In this regard, our conclusion that married people are more likely to drink wine than others is not necessarily inconsistent with previous research suggesting that they consume less alcohol, but may be consistent with research suggesting that couples who drink together are happier, and also with previous research suggesting that people like drinking in groups. There are a number of possible explanations for this, and besides sampling biases that have already been explained, it can be mentioned that Croatia has a long tradition of wine consumption and that, like in other Mediterranean countries, wine is an integral part of most social events.

Our finding that men tend to drink more frequently than women is consistent with most other research studies. It is notable that this factor is statistically less significant in our study. Again, this could be related to the sample size and a bias (wine fairs do not attract people who do not like wine). Higher levels of education are generally associated with higher income and different social status, so differences in wine consumption frequency among educated people are not surprising. Moreover, we believe that people with higher education levels are not only less likely to consume wine, but also more likely to

consume more expensive wines. However, in our study sample, we found no statistically significant difference in this regard.

5. Conclusion

Understanding consumer behavior in relation to wine consumption is always important for wine-producing countries, as wine is an important component of agriculture and thus of the economy. This is even more important today as European wine producers face strong competition from the New World countries offering cheaper products. Therefore, in the traditional EU wine-producing countries, including Croatia, the main trend in wine production is towards higher quality and better product differentiation (Katunar et al., 2020a). The aim of this research was to gain a better understanding of Croatian wine consumers. For the purpose of our research, 169 wine consumers completed the questionnaire at a wine fair in Croatia. We developed and estimated a multinomial logit model.

Our analysis confirmed some of our previously expected results in regard to wine consumption frequency. Behavioral differences were confirmed between subsample groups according to four demographic characteristics: gender, age, marital status, and education criteria. Our analysis showed that males are likely to be more frequent wine consumers than women, older than younger and less educated than more educated participants. Inter-estingly, data from our sample showed that mar-ried people were also likely to be more frequent wine consumers than participants who are single, divorced or widowed. Our results help wine mar-keters to segment and target wine consumers. For example, one target group indicated in our research are older married people. Overall, our results con-tribute to the existing literature on market segmentation in specific industries, as wine producers can use them to better differentiate individuals and groups that are more likely to become their customers. This is especially true for small wine producers who often rely on direct sales by inviting consumers to wine tastings at their wine basements/stores (Katunar et al., 2020b). However, some of our other expectations were not confirmed. We believe this is due to the main limitations of our study – a relatively small sample and a bias in the sample. The bias is caused by the fact that we conducted a survey exclusively at wine fairs, which are usually frequented by wine lovers. Notwithstanding the bias in our sample, our results show that the significance of the main determinants of wine consumption is in line with previous research in this research field.

Nevertheless, for our future research, we plan to conduct a survey with a larger and more diverse sample. In our future research, we will use this survey and conduct it on a larger scale. Our aim is to confirm some of these findings in a larger sample and add variables such as brand loyalty, consumer preferences, etc. Moreover, in future research, the survey will include respondents from different geographical regions of Croatia. This should allow, among other things, the analysis of possible regional differences and the substantiation of the results and conclusions. In addition to the sample-related issues that we will address, we plan to expand our questionnaire to relate wine consumption to consumption of other alcoholic beverages and to better understand the relationship between wine consumption frequency and quantity.

Acknowledgement

This paper has been partially supported by the University of Rijeka through project 22-49 and by the University of Rijeka through project ZIP-UNIRI-2023-4.

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JEL: R11
Preliminary communication
https://doi.org/10.51680/ev.36.2.15

Received: August 7, 2023
Revision received: September 4, 2023
Accepted for publishing: September 5, 2023

EMISSION-FREE LOGISTICS IN REMOTE RURAL AREAS

Abstract

Purpose: The EU Green Deal aims at making the continent climate-neutral by 2050. This heavily impacts the logistics sector, which currently predominantly relies on carbon-emitting ground, sea and air transports. While there are economic incentives to implement innovative emission-free alternatives in urban regions, rural areas can barely even hope for economical transportation services and thus are often supplied by traditional, emission-intense, means of transport. In particular, Remote Rural Areas (RRAs) provide a challenge to this goal: A combination of factors hinders the application of modern sustainable transport solutions in this context. The purpose of this paper is to define and analyse emission-free transportation in RRAs, providing an overview of current approaches to the issue and aiming to synthesize an opportunity to improve current concepts.

Methodology: It provides an overview of existing literature on supplying remote rural regions, with a special focus on emission-free transportation. It relies on quantitative methods, exemplary comparison and analysis of current good practices.

Results: The research results in the proposal for an implementation process for associated transportation concepts in RRAs, based on a detailed discussion of literature and practice. This combined logistical concept supports decision makers in their task of supplying their regions sustainably.

Conclusion: The paper concludes that freedom from emission is claimed more often than it is realised. Nevertheless, often independent RRA systems provide favourable conditions for achieving the Green Deal objective, assuming that funding and interest in the issue are given.

Keywords: Rural, remote, logistics, green deal, emission-free

1. Introduction

1.1 Problem definition

The long-running tendency for urbanization in Europe and beyond has political, economic and structural consequences for supply chains and the infrastructures they operate on. With the centralisation of people in agglomerations, demands and final destinations of many supply chains are also being centralized. This, in turn, transforms many serial supply chains into less divergent supply chains. Last mile logistics is consequently becoming increasingly short-distance intra-city transport rather than long-distance delivery transport (see Bretzke, 2013). These divergent supply chains are increasingly becoming economically and ecologically

sustainable, as transport to the agglomeration can be bundled and short-distance last-mile deliveries can be operated by emission-free transport modes, such as cargo bikes or electric delivery cars. Seto et al. (2010) even argue that we cannot afford not to urbanize to become increasingly sustainable as a global society. While these transformations are ongoing, a future featuring largely emission-free transports starts to look increasingly feasible for urban populations.

In contrast, rural areas do not profit as much from the described transformation of supply chains, since both demands and supplies of businesses and industries in rural areas are more dispersed. Given the smaller volume of transport to and from rural areas, logistic services and the infrastructure they operate on are often underused, overpriced and thus deteriorate over time. As Porru et al. (2020) argue for public transport, this in turn accelerates the urbanization and widens the urban-rural gap even further. In many remote rural areas, deteriorating infrastructure forces inhabitants to migrate, as life in isolation is becoming increasingly risky (see Marino & Lazrus, 2015). Finally, improving the transport offer in rural areas is one facet of making rural areas more accessible, which, according to Brovarone and Cotella (2020), is a prerequisite for an ongoing sustainable development of rural areas.

The urban-rural divide seems to be even wider when it comes to sustainable transport (and mobility). As Wappelhorst et al. (2014) argue, the potential for electric car sharing e.g. is "too low to guarantee the economic viability" in non-urban regions. Last-mile deliveries, which are carried out in both urban and rural areas, are three times as expensive in rural areas, as Gevaers et al. (2014) determined, which leads to a trend that delivery companies are increasingly reducing their delivery frequencies to rural areas or raising their prices. As Kokorsch and Küpper (2019) conclude, possible ways out of the growing urban-rural divide seem to be either (semi-)autonomous transport technologies or social innovations. This study will examine efforts to maintain rural areas in an - economically and ecologically - sustainable way.

It will further focus on remote rural areas, a subcategory of rural areas, which are far from urban agglomerations. Remote rural areas are typically inhabited by few people and often possess insufficient or outdated transport infrastructure due to the challenging terrain or climate conditions. This geographical area of research is further defined in the following chapter, accompanied by framework definitions of unique challenges of transportation in this setting and two levels of freedom from emission. Subsequently, good practices of remote rural areas, which strive to become emission-free, are presented and classified. A derived strategic supply chain concept for promoting emission-free transportation in remote rural areas is the focus of this study. It is followed by a comprehensive conclusion, critically discussing current efforts and recommending further research.

1.2 Methodology

To realise the outline above in a scientific way, a qualitative methodology establishes a structured framework of relevant sources.

An extensive review of available literature on the topics of emissions in transportation and remote rural areas allows for multidimensional and fact-based definitions of the required nomenclature. Coexisting definitions are analysed, discussed and combined. On this basis, significant good practices could be identified through an increasingly targeted literature review process. As this section represents a dynamic status quo, current digital sources were used to ensure the topicality of the introduced states. The synthesis of these two method applications, first in theory, then in practice, is conducted by the identification of a strategic supply chain concept for the observed areas, presentable in a meaningful process flow chart.

As a result, the paper summarises the current state of emission-free transport in remote rural areas and proposes an approach to increasing its share.

2. Definitions

2.1 Remote rural areas

Remote rural areas are geographical regions that are both rural in nature and remote. They are thus far from neighbouring regions, cities or settlements. Both terminologies, rural and remote, are used to define a wide range of concepts and therefore require a definition to clarify how they will be understood in the following text.

Rural is usually defined in opposition to urban, a definition that is often disputed, e.g. by the Thünen Institute in Germany, as it suggests that all non-urban regions can be considered similar, which barely

is the case (see Küpper, 2016). For the remainder of this study, however, an understanding of rural as non-urban is sufficient, as the study will focus on a narrower concept of remote rural areas.

Remote areas are areas that are far away from any other area. What distance this characterisation requires is often left unclear. For the sake of defining a distinct threshold, this study considers only areas that are hard to access as remote. Hard to access, in turn, shall imply that there is no individual means of transport or at least hourly operating scheduled public transport that could bring people and goods to and out of the area and to another area within less than an hour during daytime. This threshold is consistent with the OECD's definition of PRR (Predominantly Rural - remote) areas, as recorded by Dijkstra and Ruiz (2010), which requires a driving time of over an hour to a population centre over 50,000 inhabitants for more than 50% of inhabitants.

Remote rural areas (RRAs), subsequently, are regions that are both rural in nature, and thus non-urban, and remote, therefore hard to access.

The European Union understands the development of such regions as the main political aim to reach cohesion, it furthers the equality of life in remote rural areas to other parts of the continent. As part of these cohesion policies, the Commission identified so-called "regions with specific geographical features" that can rightly be called the remote rural areas of Europe. According to ADE (2012), these can be grouped into:

1. Remote rural islands, in particular in Scotland, Croatia, Greece, and the Baltic and the Arctic Sea.
2. Remote mountainous areas, as those found in the Alps, the Balkans, the Pyrenees, and, depending on the geographical definition of Europe, the Caucasus and the Ural Mountains.
3. Sparsely populated areas, which are predominantly found in the Arctic regions of Europe and in some parts of Spain, Romania and Bulgaria.

This grouping indicates that RRAs are neither limited to a region nor to a country of the European Union. Even though this paper is focused on the EU and its RRAs as outlined above, all regions of the world include hard to reach communities of this nature. Supplying them with goods poses multiple logistics challenges.

2.2 *Unique characteristics of logistics and mobility in RRAs*

Remote rural areas constitute a challenge to logistical means. As a result of their remoteness and thus isolated position, the areas defined above require reliable logistic connections to other areas to sustain themselves. Resilient supply chains for supplies, such as food or medicine, are a necessity for the local population. Likewise, local businesses depend on reliable supply chains leading from the rural remote areas to sell their goods (Brown et al., 2008).

While many non-remote rural areas are connected by conventional modes of transport, maintaining any earthbound infrastructure is very cost-intense given the often small population targeted (Morgenroth, 2014). This favours the use of modes of transport which do not rely on continuous infrastructures, like aeroplanes, helicopters or, where applicable, ships (see Mukkala & Tervo, 2013). Provision of logistics services is therefore more demand driven, bundled and expensive in remote areas. Transport-related access to the area can be obstructed by geography (e.g. insular or mountainous) or climate factors (especially in the Arctic region). Specialised supply chains, for example cold chains for medical resources or fresh food, involve legal requirements which further complicate the provision.

At the same time, as mentioned above, the EU (EU, 2021) recognises the necessity of appropriate provision of transportation for people and goods as "a critical aspect of social and economic development and cohesion", while emphasising that this is to be "implemented in close alignment with the energy and ecological transitions". This implies that sustainable transportation is to be provided to all Europeans, regardless of their place of residence - including those who inhabit the RRAs defined above, to further the emphasis on an equal collective of states and their regions. Likewise, many national laws demand that all citizens of their respective countries benefit from the same level of state services, such as the healthcare system, which is only feasible if a resilient logistics solution is in place (see Wilson et al., 2009).

It becomes evident that the provision of logistics and mobility to RRAs is a more vital topic than is often presumed, both in the political sphere and as a challenge to related businesses. This mirrors the current state of sustainability in all aspects of life, i.e. the looming climate catastrophe. To sum up, preventing emissions in logistics, be it urban, rural or remote, has to be the top priority from a scientific point of view. The intersection of emission-free logistics and RRAs can therefore be considered an issue of importance to corporate and public organisations alike. In order to reliably promote this intersection, a reliable definition of what constitutes freedom from emission becomes necessary.

Logistics, the movement of goods, and mobility, the movement of people, are typically two different fields of research, which are sometimes linked, but only rarely intertwined. For the remainder of this paper, the feasibility and the status quo of emission-free logistics and mobility in remote rural areas are often, but not always, considered simultaneously. As all forms of transportation, whether of goods or people, rely heavily on the same earthbound infrastructure, the challenges of a transformation towards emission-free forms of logistics and mobility are often structurally very similar. Once an emission-free bus or train is developed to operate in a specific remote rural area, it is regularly also capable of transporting goods - or vice versa. The authors acknowledge that a more granular differentiation might be important or even crucial in some contexts.

2.3 Emission-free

All European and most non-European states are committed to reducing or stopping emissions of carbon dioxide, the main driver of man-made climate change. This goal was formulated in the adoption of the 2015 Paris Climate Agreement (see UNFCCC, 2016), which vows to limit global warming by drastically reducing emissions by the year 2030. However, a range of different concepts exist to reach that target. One such concept, and the easiest one to measure, is emission-free, which means that no greenhouse gas emissions are emitted at all. In particular, this concept does not include areas that still emit carbon dioxide but compensate for these emissions, e.g. by so-called 'tree banking' (see World Economic Forum, 2022).

When speaking about remote rural areas, a further differentiation in *internally emission-free areas*, i.e. areas in which no emissions are emitted by transportation, but which are reached by carbon dioxide emitting means of transport, and *externally emission-free areas*, which are additionally exclusively served by emission-free means of transport, is required. In the latter case, a more comprehensive approach to freedom from emission is given, including the upstream (resp. downstream) leg of the supply chain.

In both cases, an exclusively internally and more comprehensively externally emission-free RRA, an already challenging logistical environment, is limited further in its options. The examples of good practice collected below reflect both concepts, before these findings from theory and practice result in a synthesised strategy to achieve emission-free RRAs.

3. Good practices

3.1 Internally emission-free remote rural areas

3.1.1 Remote rural islands: Porto Santo, Portugal

Porto Santo is a small Portuguese island in the Atlantic, measuring approx. 40 square kilometres. It is part of the Madeira archipelago, but its nearest neighbour island to the southwest is over 40 km away, isolating the island, not only but also in its production of energy. Even though the island is currently still relying on a TPP (thermal power plant) for most of its energy needs, ambitious plans are drawn up to increase the share of sustainable energy sources as high as possible. The potential to be internally emission-free is being researched and realised by a public private partnership including an automotive company. This includes the plan to switch to electrical vehicles for all the needs of Porto Santo's 5,500 inhabitants. As an RRA of manageable size, the limited range of these vehicles does not threaten the integrity of island-based supply chains. According to Torabi et al. (2017), the storage of energy to handle peaks in demand is a current challenge to these plans. Facilities acting as batteries or the involvement of vehicles to this end (bidirectional EVs) are possibilities proposed by Strobel et al. (2021) and Torabi et al. (2021).

The plan towards emission-free Porto Santo is further jeopardised by the biggest local economic factor and source of peak demand for energy, namely tourism. The vast majority of the 100,000 tourists a year arrive by plane, the most frequent but least

sustainable mobility option to reach the island. All plans to achieve zero emissions therefore exclude the airport and its use, the emission-heavy part of tourist mobility. Inhabitants are conflicted by the knowledge that their goal of eradicating emissions attracts an increasing number of tourists, hence aeroplanes, hence emissions. All intentions of Porto Santo to become emission-free thus currently merely focus on internal measures.

3.1.2 Remote mountainous regions: Zermatt, Switzerland

Zermatt is an RRA in southern Switzerland, located in the mountains of the Alps. Like Porto Santo, it supports a population of between five and six thousand, generously supplemented by winter sports tourists. The village itself is combustion engine free and - according to its own statements (see Zermatt Tourismus, 2023) - it reduces emissions wherever possible, only really causing emissions with snowcats used for slope preparations. Local energy production is based to a large extent on hydroelectric power (73% in 2021) (see Elektrizitätswerk Zermatt AG, 2022), ensuring a clean source for electricity demand in Zermatt. Electric vehicles, which serve the logistics and mobility needs of the city, are manufactured and designed specifically for this region and are exclusively owned by public actors and businesses, reducing the share of personal vehicles to zero. As this was democratically decided and the small inhabited village core is accessible on foot, the residents of this RRA are quoted as being satisfied without owning a personal vehicle.

However, Zermatt still encourages tourism and provides large parking lots for combustion engine cars outside of Zermatt to get there. This makes the area, just like the island of Porto Santo, only an internally and only mostly emission-free RRA.

3.1.3 Sparsely populated areas: Svalbard, Norway

The Norwegian archipelago of Svalbard is a secluded Arctic region. Its area includes the former coal mining town of Longyearbyen. Housing approx. half of the inhabitants of Porto Santo or Zermatt, but nearly all of Svalbard's population, its logistical needs are of manageable nature. Nevertheless, throughout its history and current focus on research regarding climate change, this RRA aims to be internally emission-free. This goal is emphasised by the multiple effects of global warming, which, according to Paddison (2021), are challenging the town constantly. As a result, the closure of its current energy source, an old and expensive coal plant, is planned for 2023. It is to be replaced by multiple sources of renewable energy, reducing carbon emissions of the city by 80% by 2030. For now, the mayor encourages shared mobility solutions for immediate improvements in mobility emissions. A modelling study by Ringkjøb et al. (2020) examined the feasibility of this shift towards renewables with positive results, emphasising the need for power storage and back-up capacity. The purchase of a 'giant battery' in 2022 (see Jonassen, 2022) brings this proposed concept into motion.

As a result, Svalbard is close to becoming entirely emission-free, despite the harsh conditions of the Arctic. However, Longyearbyen sees a stark increase in flight traffic and moorings for cruise ships, becoming a hub for arctic tourism. As these modes of transport are not feasible in an emission-free way yet, Svalbard has to be considered on its way to becoming merely internally emission-free.

3.2 Externally emission-free remote rural areas

3.2.1 Remote rural islands: Samsø, Denmark

A small Danish island of Samsø is home to around 4,000 people who live in 22 villages spread over 112 km². Its geographic position favours renewable energy through wind turbines, which satisfy most of the island's energy needs, in a combination with solar panels and biomass plants.

Replacing coal-based electrical power from the mainland, this transition towards emission-free energy sources was conducted in just ten years. According to Sperling (2017), the shift was possible through the integration of and participation by the local community. Among other factors, Sperling attributes the success of this huge endeavour to a 'sense of locality and responsibility' and a 'community spirit', but also to various supportive actions by the government. He nevertheless describes the processes as intensive. Lewis (2017) identifies the resulting co-ownership of infrastructure by the community itself as a vital success factor for the transformation.

Surpassing this community-based effort in Samsø, the island aims to be completely emission-free by 2030, eliminating the last carbon-emitting sectors of heating and road transport by introducing wind power- and biomass-based alternatives (see UNFCCC, 2023). To achieve decarbonisation of the trans-

port of good and people to and from Samsø, the municipality had to start their own shipping company in 2013 to order new LNG powered ferries. The new shipping company immediately conducted a feasibility study to produce all the required LNG locally on Samsø (Mikkelsen, 2015). Today, the Samsø municipality-owned ferry is entirely fuelled by locally produced natural gas (Tybirk, 2018). In 2024, an electric ferry shall replace this LNG-powered ferry as a next step towards freedom from any emissions (see Danfoss A/S, 2023).

Emissions are about to be eliminated from Samsø - internally, in heating and mobility, just like externally, in transportation to and from the island.

3.2.2 Remote mountainous regions: Stoos, Switzerland

A small mountain village Stoos in Switzerland is on its way to become the first emission-free village in the Alps. It has only 150 inhabitants, but also additional 2,200 beds for tourists, as it is a winter sports resort. Like Zermatt, it has always been car-free, but started to invest heavily in reducing emissions that result from reaching the RRA. In 2017, it replaced its old cable car with an earthbound electric funicular (see Stoosbahnen AG, 2023). Later, it linked the funicular to the public transport network of Switzerland with an electric bus. Finally, the village started a project with an all-purpose vehicle company to design and built a vehicle that can transport goods to and from the village (see Hiller, 2022). This effort will potentially make Stoos' logistics and mobility internally and externally emission-free in the future.

3.2.3 Sparsely populated areas: Bulnes, Spain

Bulnes is a tiny hamlet in northern Spain. It is home to just approximately 40 people and until 2001 it could have been reached only by a two-hour hike from a neighbouring village. Since 2001, an electric funicular links the village to a neighbouring settlement and the national Spanish road network (see Basterra, 2011). As the funicular itself does not emit any carbon dioxide, it could thus technically be considered externally emission-free. Internally, Bulnes, similarly to Stoos, has teamed up with an all-purpose vehicle producer (Alke, 2023) to design an emission-free vehicle that can be transported via the funicular and do deliveries and transport within the village, making all transport internally emission-free.

4. Strategic RRA supply chain concept

The collection of good practices of RRAs, which seek freedom from emissions, and the included methods complementing these attempts show progress which remote areas are making and the tools they can use for this purpose. A discussion of existing efforts and achievements in internal and external emission freedom revealed a usually comprehensive wish to eliminate harmful energy consumption - the focus is seldom exclusively on the logistics sector and its 'footprint'. The authors found that there is a lack of coordinated application of methods in this sector until the end of the complete concept for logistics. In this section, therefore, they attempt to synthesise a strategic concept which considers knowledge of the findings so far.

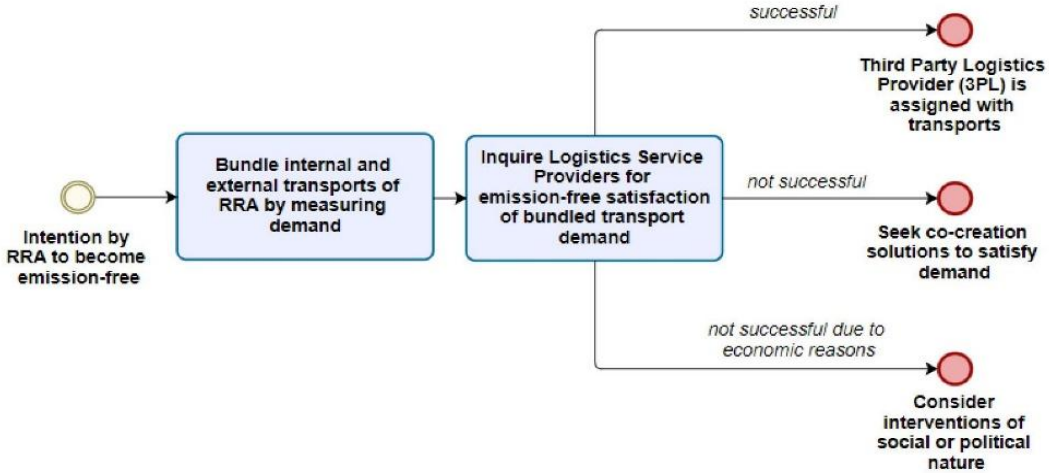
It is usually trivial to define the geographical boundaries of RRAs due to their remoteness, which is one reason why it is often easier for RRAs to attempt to limit internal freedom from emission at all. The necessary transport of goods and people can thus easily be grouped into transport *within* the RRA, as well as *to and from the RRA* – or, in other words, internal and external transports. The first step towards any transport solution for RRAs, including emission-free ones, would be the ownership of transport demand data. This is not simple because public institutions typically do not measure the demand for logistics services fulfilled by third-party companies. Yet, it is required as a foundation to formulate a comprehensive strategy towards freedom from emission.

In the second step, the RRA could and should actively seek for possible service providers that can meet these bundled transport needs, while requesting these services to be provided without emitting any harmful emissions. The RRA has an advantage because it can define a clear demand for a service, e.g. "deliver X tons of goods daily from the island to the mainland and Y tons from the mainland to the island, without emitting any carbon dioxide". If no service provider is able or willing to provide such a service to the RRA and its citizens, the RRA should invest in finding a solution from within. This is exemplified by Samsø, which had to develop an ambitious community-based plan of public investments and co-ownership, or Bulnes and Stoos, which both had to design and construct vehicles fit for the purpose of operating in their respective RRA.

Should the procurement of a service provider fail solely and exclusively for economic reasons, meaning an unprofitable business case, the RRA community can also invest in social innovations from within. That such innovations from within have the potential to (re-)vitalise or sustain an entire RRA can be observed, e.g., in the Chatham Islands, which manages its entire internal and external transport infrastructure successfully since its parent state, New Zealand, failed to provide such services (Rennie, 2022). Crowd logistics, active involvement of community members and their resources in respective supply chains, could be one of the solutions to overcome the financial gap. Another solution could be a public subsidy of the required service to maintain the connectedness of the RRA, while reducing its emissions. These unconventional solutions to providing transport in, to and from RRAs require extensive involvement of the democratic entities of the region – mirroring the earlier clustering of demand as a community effort.

As a result, in all potential outcomes of this strategy, one of three clear paths can be pursued. Figure 1 provides an overview of this simple concept.

Figure 1 Model of strategic RRA supply chain concept



Source: Authors' own representation, by Bizagi Modeler

Looking at the discussed and many other good practices observed, taking these steps seems to be the best chance for RRAs to become emission-free, as they allow RRAs to autonomously reduce their emissions gradually to become emission-free. In particular, the proposed model grants the RRA the autonomy to act without having to trust, demand or ask for improvement of the infrastructures bridging the gap between the RRA and the larger markets outside of it. This is crucial, as infrastructures leading to and from RRAs are typically not owned by the RRA community and thus any infrastructural improvement has to be made by higher-level, often national, bodies. As Fox & Porca (2001) argue, national bodies will often conclude that infrastructural investment in RRAs is very unlikely to drastically improve remote economies and thus avoid major investment in such infrastructure.

5. Conclusion

This overview of emission-free logistics options in RRAs provided various insights. In an established framework of clear definitions, existing efforts could be observed and evaluated. The resulting strategic supply chain concept in this context provides a synthesised and simplistic framework for RRAs, which aim to reach freedom from emission. This chapter includes final conclusions of this approach, followed by a summarising feasibility discussion of emission-free RRAs and an identified area for further research on this topic.

The strategic RRA supply chain concept of the previous chapter was structured to reflect the current state of research on the topic. As shown, many RRAs aim for emission-free transportation, with varying results. By generally following the described steps, a collective and purposeful course of action can be followed. By involving the public in a democratic way and with participation-based solutions (as demonstrated in numerous examples of good practice such as Zermatt and Samsø), population resources, innovative potential and, most importantly, cooperation in collective action are ensured in a way which could never be provided sustainably by a top-down approach. At the same time, the possibility of the concept of involving large logistics providers makes economic solutions possible: Externalisation of transport requirements through MaaS (Mobility as a Service) solutions provides access to economies of scale and can make the latest vehicles or platforms attainable in this way. A focus on renewable energy sources and electrification as opposed to internal combustion engines is a common factor in these logistical aspects. RRAs rely on this technology to reach their goal; efficient use of renewable resources, energy storage capabilities and corresponding innovations in logistics vehicles is ongoing and accelerating. In those RRAs, which nevertheless cannot be serviced economically without environmental emissions, the remaining options are of social (e.g. crowd logistics) and political (e.g. subsidies) nature. Especially in the European Union, growing cohesion in these two fields could prove the applicability of the concept.

As reasonably constrained areas, RRAs already offer great opportunities for the development and testing of emission-free options, whether by service providers or collective community efforts. Overall, they proved to be good laboratories for the application of emission-free transport and mobility methods, which can later be adopted on a larger scale. Distances within settlements are typically shorter than in urban centres and travel to and from remote rural areas is rare, as the accessibility of the area often makes it impossible for its citizens to commute. In some cases, as is the case with a number of Scottish islands, the transition towards sustainability is driven by state and public actors, such as the regions and islands concerned and the Scottish Government. In other cases, as is the case with the Greek island of Astypalea or the aforementioned Porto Santo in Madeira, public-private partnerships drive the transition.

On the other hand, the adaption of emission-free modes of transport and mobility in RRAs is limited by multiple factors. Most notably, differences in the comprehensiveness of sustainability efforts are clearly visible, demonstrating a deeply rooted issue at hand: emission-free logistics concepts for RRAs are more often than not incomplete, shifting emissions to upstream processes in the supply chain, like bordering parking lots and planes. While this avoids the negative local effects of emissions, such as particulate matter emission in populated areas, the goal of preventing greenhouse gases in general is not sufficiently addressed. In this context, current technology does not yet provide emission-free long-distance or high-speed means of transport that can serve RRAs. The potential exception of high-speed trains is infrastructure-bound and requires extensive investment, even in less challenging environments. Additionally, stakeholders can also jeopardise the efforts. Public-private partnerships carry risks for the community, especially if it relies on the output, as in mobility and transportation. Greenwashing, building a sustainable appearance without actual progress, can be considered one of them. Its deceiving language is encountered repeatedly in this research since upon close inspection, none of the practices examined can claim to actually have no emissions as defined, internally or externally, at least when factors other than transportation are taken into account. Bulnes could serve as the exemption from this rule, as its extremely small size and population made the discussed solutions possible. Stoos emits no carbon dioxide from internal and external transport, while Samsø, Porto Santo, Zermatt and Svalbard are not yet internally or externally emission-free in terms of transport. Explaining this, many of the RRAs mentioned above are tourism-focused economies, which rely on their public image and can invest in expensive sustainable solutions to increase their appeal to environmentally conscious travellers. Of course, not all RRAs are tourism-focused and well-off enough to consider this trade-off. Alternatively, community-based approaches, as embodied in the strategic concept, can only succeed with an involved public, which invests time and resources in long-term shifts towards sustainability. Misinformation about climate change or lack of interest

in the topic can, for example, prevent constructive approaches by labelling them as unnecessary.

Finally, there are limitations to the analyses conducted, posed by the nature of available source material and authorship. As mentioned, the interest in being perceived as a sustainable RRA can spin any public-facing publication towards a distorted and therefore less scientific conclusion. On the other hand, internal and more reliable policy-related sources, such as scientific pre-studies, are seldom written for public use. Therefore, they are often composed in the local language and not retrievable by conventional research methods within the scope of this work. In relation to authorship, both authors of this study are scholars in the domain of business sciences. A linear point of view of the natural sciences is lacking in this discussion of topics, which are certainly related to this additional field. To handle this limitation, the authors have limited the presentation of natural sciences and related technologies to consensus in the respective field.

As evident from this long list of uncertainties and limitations, further research is needed in this important field. For the most part, sustainability continues to be a priority after economic KPIs. The authors see this as an opportunity to adapt current economic analyses. According to (Laird & Mackie 2014), current cost-benefit analyses do not include all the benefits of servicing remote rural areas. Future approaches to this topic should thus consider both all (indirect) economic aspects and the impact on emissions as beneficial. A comprehensive approach to the transport needs of remote rural areas can therefore produce adequate solutions for stakeholders in and outside of the regions in a sustainable way, economically and environmentally.

As the effects of climate change are immediate events, adequate action becomes increasingly urgent. RRAs could be at the forefront of setting an example, regardless of the small global impact of a single success in reducing emissions. Approximations like the Pareto principle show the great impact of small first steps - as long as there is a will to change.

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Conference review

Jerko Glavaš, Marija Ileš, Ivana Unukić:
Interdisciplinary Management Research Conference – IMR 2023

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INTERDISCIPLINARY MANAGEMENT RESEARCH CONFERENCE – IMR 2023

IMR 2023: The 19th International Conference on Interdisciplinary Management Research aims to bring together academics, researchers, and practitioners to exchange and share their research findings and (business) experiences in all aspects of management and related fields. IMR serves as an interdisciplinary platform for academics, practitioners, and educators to present and discuss the latest trends and issues, as well as practical challenges encountered and solutions adopted in the field of management, but it also extends its scope to encompass various domains including Business, Financial Economics, Industrial Organization, Law and Economics, etc. The IMR conference is tailor-made for postgraduate students, providing them with a platform to showcase and exchange ideas about their research. It enables them to receive valuable feedback from their peers, academics, and practitioners. The conference fosters a welcoming and informal atmosphere, offering PhD students the opportunity to network with academics and practitioners, and develop their professional relationships.

1st day of the conference

The Conference on Interdisciplinary Management Research started with the opening ceremony on Thursday, 28 September 2023, at 1.00 pm. Ivana Jobst from the Faculty of Economics and Business in Osijek moderated the programme. The speakers were **Jerko Glavaš,** PhD, Faculty of Economics and Business**,** Josip Juraj Strossmayer University of Osijek, Chairman of the Conference Programme**, Boris Crnković**, PhD, Full Professor, Dean, Faculty of Economics and Business in Osijek, Josip Juraj Strossmayer University of Osijek, and **Ivana Katavić Milardović,** Head of the Administrative Department for Economic Affairs of Osijek-Baranja County. In addition, a European Union project Dialogue4Tourism - Institutional Dialogue on Sustainable Tourism and Governance in the Euro-Med area was presented by **Kristina Brščić**, PhD, Institute for Agriculture and Tourism, Poreč. After that, **Igor Berecki**, MD, gave a keynote lecture in Croatian entitled Može li nas u upravljanju organizacijama zamijeniti AI? Kako spremiti svoj mozak u računalo... i zašto? Two parallel sessions were held

from 2.30 to 4.00 pm in different halls at the Faculty of Economics and Business in Osijek, where participants gave their presentations live. Meet the city and discover its secrets – a walk through Osijek was organised for all interested conference visitors from 4.15 to 6.00 pm. On the conference inaugural day, all participants had the delightful opportunity to enjoy a dinner at Crna svinja.

2nd day of the conference

The second day of the Conference (i.e., 29 September 2023) started at 9.30 am with the keynote lecture "EFMD Network, Activities & Quality Services portfolio" delivered by Ivana Marinković, EFMD Global Network, Director for Central and Eastern Europe. After the keynote lecture, Adam Đanić presented the Centre of Competences for Advanced Engineering Nova Gradiška. Three parallel sessions were held and 29 papers were presented on the second day of the conference, which ended with a doctoral workshop where postgraduate doctoral students had the chance to receive answers to all their questions related to writing their doctoral thesis.

The latest issue of the Conference Proceedings, i.e., "Interdisciplinary Management Research XIX" (ISSN 1847-0408), encompasses 70 papers written by 148 authors from 7 countries. The sections of the conference proceedings and the articles are divided into three topics: General Management (40 papers), Marketing Management (17 papers), and Finance Management (13 papers). The Conference Proceedings were published by Josip Juraj Strossmayer University of Osijek, Faculty of Economics and Business in Osijek, Croatia, Postgraduate Doctoral Study Programme in Management, Pforzheim University, Business School, Germany, with Boris Crnković, PhD (Dean, Josip Juraj Strossmayer University of Osijek, Faculty of Economics and Business in Osijek, Croatia), and Thomas Cleff, PhD (Dean, Hochschule Pforzheim University, Germany) for the publishers, and Aleksandar Erceg, PhD (Faculty of Economics and Business in Osijek, Croatia) as the editor. The IMR conference proceedings can be found in the following databases: Clarivate Analytics, Web of Science, and EBSCO. This makes the IMR conference even more significant and thrilling for numerous academics, entrepreneurs, business professionals, researchers, and visitors. The publication of the conference proceedings is partially funded by the Ministry of Science and Education of the Republic of Croatia.

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Ekonomski Vjesnik / Econviews – Review of Contemporary Entrepreneurship, Business, and Economic Issues is intended for researchers and practitioners, and devoted to the publication of papers that contribute to the theoretical, methodological and empirical insights in the complex field of economics. Articles can be based on quantitative as well as qualitative analyses; they can be a synthesis of previous research and discuss open issues in specific areas of social and economic practice. The journal welcomes papers focused on different levels of analysis (from individual cases to small or large samples) and contexts (SMEs and large companies, industrial sectors, local, regional and national economies, international economics, branches of economy, healthcare and education, labour and demographics, natural resources and other socio-economic frameworks).

The journal is focused on research in economics, business economics and entrepreneurship, however, as these are closely intertwined with other disciplines – information and technical sciences, law, sociology, psychology and other fields – multidisciplinary submissions are also welcome.

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The journal publishes reviewed papers (scholarly articles), research reports, scholarly debates and reviews. Individual issues can be dedicated to more specific topics. Submissions will undergo a double blind review. Within the peer review process, papers published in the journal are categorized in one of the following categories: original scientific papers, preliminary communications, review papers and professional papers. Papers must be in English.

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Papers must be formatted so as to allow printing on paper size 210 X 297 mm. Times New Roman or Arial font, size 12 (unless otherwise stated herein) should be used, and line spacing should be 1.5.

The margins (left, right, top and bottom) should be 25mm wide. The text should be aligned with both the right and left margins (justified). The paper should have between 4500 and 7500 words. Above the title, in the upper right corner, the authors state JEL classification of the article.

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