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PROCEEDINGS OF THE FACULTY OF ECONOMICS IN EAST SARAJEVO

ЗБОРНИК РАДОВА ЕКОНОМСКОГ ФАКУЛТЕТА У ИСТОЧНОМ САРАЈЕВУ

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Editor's note

Dear scientists, readers and colleagues,,

I am delighted to introduce scientific journal „Proceedings of the Faculty of Economics in East Sarajevo” (Zbornik radova Ekonomskog fakulteta u Istočnom Sarajevu) one of the best journals in Republic of Srpska and Bosnia and Herzegovina in the area of economics and business. The journal was, according to the Ministry of Scientific and Technological Development, Higher Education and Information Society Republic of Srpska, won 34 out of a possible 40 points, and thus classified in the first category of scientific journals. The Journal is indexed in ERIH Plus, Bergen, Norway; Sherpa Romeo – JISC, United Kingdom; DOAJ - Directory of Open Access Journals, Hovedstaden, Denmark; ProQuest, Ann Arbor, Michigan, U.S.; Google Scholar; EBSCO Publishing, Ipswich; INDEX COPERNICUS International, Warsaw, Poland; CABELL'S Directories (Cabell's Directories of Publishing Opportunities), Texas, USA; C.E.E.O.L (Central and Eastern European Online Library), Frankfurt am Main, Germany; BASE (BASE – Bielefeld Academic Search Engine), Bielefeld University Library, Germany; JEL (Journal of Economic Literature) / EconLite, (American Economic Association's Electronic Database), Pittsburg, USA; DOI Srpska, Banja Luka; CrossRef, Oxford, United Kingdom.

This volume contains selected articles presented at the International Scientific Conference "Jahorina business forum" held at Faculty of Economics Pale on May 13th – 16th, 2024. It is very important to stress out that, besides the appropriate level of quality of scientific papers received, the Editorial Board had an additional criteria in the process of selecting papers. The focus was on papers the content of which could contribute to the theory and practice of local economic development in general.

The journal publishes the papers of the scholars from the Faculty of Economics in East Sarajevo and outside the Faculty as well. The papers refer to the broad area of economic science, and their main prerequisites are scientific contributions to economic theory and practice. The papers can be of theoretical and methodological-analytical nature, and may include areas ranging from national economic policies to business policy. Manuscripts are written in English language.

Needless to say, any papers that you wish to submit, either individually or collaboratively, are much appreciated and will make a substantial contribution to the early development and success of the journal. Best wishes and thank you in advance for your contribution to the scientific journal „Proceedings of the Faculty of Economics in East Sarajevo”.

Editor-in-Chief

Nemanja Šarenac, PhD Assoc. Prof.

CONTENTS

<i>Editor's Note</i>	5
----------------------	---

ORIGINAL SCIENTIFIC PAPERS

HANDLING HETEROSCEDASTICITY IN LINEAR MODELS: HUBER-WHITE STANDARD ERRORS VS BOOTSTRAP CONFIDENCE INTERVALS <i>Zarrukh Rakhimov</i>	11
--	----

ANALYZING THE RELATIONSHIP BETWEEN TRADE OPENNESS AND ECONOMIC GROWTH IN NORTH MACEDONIA: A SVAR APPROACH <i>Katerina Shapkova Kocavska, Elena Makrevska Disoska and Jasna Tonovska</i>	23
--	----

IMPACT OF DIGITAL TRANSFORMATION ON ECONOMIC GROWTH <i>Aleksandra Ćirić</i>	39
--	----

PRELIMINARY COMMUNICATIONS

THE PERCEPTION OF SUSTAINABILITY COMPETENCES IN LOGISTICS AND SUPPLY CHAINS <i>Mateja Čuček, Sonja Mlaker Kač, Matevž Obrecht and Lazar Pavić</i>	51
--	----

REVIEW PAPER

STREAMLINING CONSTRUCTION: MAXIMIZING EFFICIENCY THROUGH EFFECTIVE WASTE MANAGEMENT: THEORETICAL REVIEW <i>Erjola Barbullushi and Denisa Domni</i>	63
---	----

THE EFFECTS OF DISCLOSING KEY AUDIT MATTERS IN THE AUDITOR'S REPORT <i>Amira Pabrić</i>	71
--	----

BRIEFLY ABOUT THE JOURNAL	83
----------------------------------	----

INSTRUCTIONS FOR AUTHORS	85
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ORIGINAL SCIENTIFIC PAPERS

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HANDLING HETEROSCEDASTICITY IN LINEAR MODELS: HUBER-WHITE STANDARD ERRORS VS BOOTSTRAP CONFIDENCE INTERVALS

РЈЕШАВАЊЕ ХЕТЕРОСКЕДАСТИЧНОСТИ У ЛИНЕАРНИМ МОДЕЛИМА: ХУБЕР- ВАЈТОВЕ СТАНДАРДНЕ ГРЕШКЕ У ОДНОСУ НА БУДСТРАП ИНТЕРВАЛ ПОВЈЕРЕЊА

Summary: Heteroscedasticity are one of the several violations of the assumptions of OLS. If no remedy applied, residuals with non-constant variance can lead to inaccurate and biased results. Academia has suggested a wide range of remedies to tackle with heteroscedastic residuals. In this study, we suggest another approach, bootstrapping of dataset to construct our confidence intervals. In order to compare the outcome, we look at Huber-White method and look at its performance against bootstrap intervals. Results indicate that bootstrap intervals perform equally well as Huber-White based confidence intervals. This indicates that bootstrap method, similar to Huber-White approach, can be a good remedy for heteroscedasticity.

Keywords: heteroscedasticity, homoscedasticity, linear model, confidence Interval, bootstrap, Huber-White, residuals, accuracy

JEL Classification: C15, C87, E22

Резиме: Хетероскедастичност представља једну од нарушених претпоставки ОЛС-а. Ако се не примјени одговарајуће рјешење, резидуали са не-константном варијансом могу довести до нетачних и пристрасних оцјена параметара. Академска заједница је предложила низ решења за решавање овог проблема. У овој студији предлагемо другачији приступ, поновљено узорковање података (бутстрап) како бисмо конструисали интервале повјерења. Посматрамо Хубер-Вајтове методу и њену примјену у поређењу са бутстрап интервалима како бисмо упоредили резултате. Резултати показују да бутстрап интервали дају једнако добре резултате као интервали повјерења засновани на Хубер-Вајтовој методи. То имплицира да бутстрап метода, слично Хубер-Вхите приступу, може бити добро рјешење за хетероскедастичност.

Кључне ријечи: хетероскедастичност, хомоскедастичност, линеарни модел, интервал поверења, бутстрап, Хубер-Вхите, резидуали, тачност

ЈЕЛ касификација: C15, C87, E22

INTRODUCTION

Linear models often derived using the Ordinary Least Squares (OLS) method, is one of the most popular methods of deriving impact of one variable on another and predicting future outcomes. OLS approach is currently used in wide range of sciences such as economics, finance, psychology, sociology to name just a few. The popularity of OLS approach comes from its simplicity, good efficiency and ease of interpretation, although it is almost an approximation to real life relationships. Yet, linear models require a set of theoretical assumptions to be satisfied in order to have accurate unbiased efficient point and intervals estimates. The core assumptions are homoscedasticity, no autocorrelation, and normality of residuals and violation of any of them might lead to inefficient or even biased confidence interval estimates. As a result of such violations, researchers and practitioners might do wrong conclusions when evaluating impact of one variable on another, affecting decisions in fields of medicine, economics and engineering. To cite an example, in studies of income and its determinants, which is very common subject of research in economics and finance, income dataset

very often violate homoscedasticity assumptions. When no remedy is applied, OLS estimations of coefficients or their confidence intervals are usually inefficient and often biased.

Situations when homoscedasticity is not satisfied is also known as heteroscedasticity. This implies that variances of the error term are not constant across observations. Presence of heteroscedasticity can distort standard errors and make confidence intervals less accurate. In practice, it means that studies that have heteroscedastic dataset can draw incorrect conclusions about variable significance or effect sizes when no remedy is applied to mitigate heteroscedasticity. One of the techniques widely used in practice is the Huber-White standard error correction. Huber-White is a mathematical transformation, which makes OLS estimations more robust to heteroscedasticity without altering the functional form of the model. Another method of handling heteroscedasticity is suggested in this study known as bootstrapping. Bootstrap confidence intervals have no distributional assumptions, which makes this approach less sensitive to non-constant variances.

This paper looks into the practical implications of heteroscedasticity on OLS estimates and investigates how both the Huber-White robust intervals and bootstrap methods can serve as ways to handle heteroscedasticity. By comparing these approaches with heteroscedastic data, we want to shed some light into how practitioners can select the best method for their specific case, balancing statistical robustness with computational efficiency.

1. LITERATURE REVIEW

Bootstrap method is a resampling method of a given dataset to build a sampling distribution of a specific statistic. Bootstrapping has become popular because it has proven to provide reliable inferences in many cases even when underlying assumptions are not satisfied. This also applied to cases of heteroscedastic residuals which is first discussed in papers of Efron (1979). Since then, theoretical foundations have been concentrated on justifying validity and efficiency of bootstrap confidence intervals with non-constant variance of errors (Davison and Hinkley 1997).

In the context of linear models, there have been primarily two types of bootstrapping used for estimating point and interval estimates, bootstrapping residuals and bootstrapping pairs (Chernick and LaBudde 2011).

Bootstrapping residuals: This method of bootstrapping was first introduced by Efron (1982). Imagine we have the following model

$$Y_i = g_i(\beta) + e_i, \quad \text{for } i=1,2,\dots,n$$

where $g_i(\beta)$ is a function with a known form. To estimate β , we minimize distance between our true dependent variable Y_i and estimated function $g_i(\beta)$. These distances are expressed in terms of residuals $\hat{e}_i = Y_i - g_i(\hat{\beta})$. The idea behind Wild bootstrap is to take the distribution of residuals each having probability of $1/n$ for $i=1,2,\dots,n$ and sample n times from this distribution to get bootstrap sample of residuals which can be denoted as $(e_1^*, e_2^*, e_3^*, \dots, e_n^*)$. Afterwards, bootstrap dependent variable can be generated using $Y_i^* = g_i(\hat{\beta}) + e_i^*$. Now, as we have our bootstrap dataset, we use simple OLS method to estimate β^* . We repeat the above procedure B times to get a distribution of β_j^* estimates for $j=1,2,\dots,B$. One can get standard deviation of β^* to build bootstrap confidence intervals.

Bootstrapping pairs: bootstrapping pairs is a rather simple but powerful approach proposed first by Freedman (1981). Under this approach, we resample independent and dependent variables from the original sample which results in a bootstrap sample. We then use usual OLS method to estimate β^* from the bootstrap sample. This procedure is repeated B times in order to get distribution of coefficients β_j^* estimates for $j=1,2,\dots,B$. This distribution in turn can give bootstrap standard deviation.

Efron and Tibshirani (1986) conclude that two approaches are equivalent when the model is correctly specified, but they can perform differently when the sample is small. Flachaire (2003) compared bootstrapping residuals and bootstrapping pairs when the model is correctly specified and when heteroscedasticity is present in the linear models. Flachaire (2003) concludes that when a proper transformation to the residual term is applied (wild bootstrap), residuals bootstrap performs better than bootstrapping pairs. Chernick and LaBudde (2011) conclude however that bootstrapping vectors are

less sensitive to violations of model assumptions and can still perform well if those assumptions are not met. This can be explained by the fact that the vector method does not depend on model structure while bootstrapping residuals do.

Other approaches are stationary bootstrap (Politis and Roman 1994), and the percentile-t bootstrap (Diciccio and Efron 1992) each used under different scenarios of non-constant variance of the residuals.

On comparing Huber-White robust confidence intervals and bootstrap confidence interval, there has been numerous studies carried out and concluded that each approaches has advantages in specific scenarios. Long and Ervin (2000) claid that Huber-White standard errors are rather quick to estimate and perform well when data is sufficiently large and heteroscedastic behavior is not severe. Yet, Huber-White robust estimates can depict inconsistent results when sample is small or heteroscedasticity is arising from model complexity and varies a lot (MacKinnon and White 1985).

In contrast, Efron and Tibshirani (1994) claim that in extreme cases of heteroscedasticity or small samples, bootstrap can be more suitable. Cameron and Trivedi (2005) in their paper also conclude that bootstrap confidence intervals resulted in more accurate intervals than robust standard errors in above conditions, arguing that bootstrap is better at capturing the true sampling distribution in the presence of heteroscedasticity and other non-normal errors.

Yet, many studies (e.g. Davidson and MacKinnon, 2004) conclude that bootstapping comes at a computational cost especially when sample is large and resampling will take time and computing power. In contrast, transformational remedies such as Huber-White standard errors do not suffer from this shortcoming, as it is computationally easy to implement Huber-White approach.

2. LINEAR REGRESSION MODELS

First of all, let's look into how linear models are built and how coefficients as well as their intervals are estimated. As mentioned earlier, the linear model evaluates the impact of one or more variables (explanatory variables) to another variable (explained or dependent variable). This is done by estimating coefficients of estimates of each explanatory variable. For instance, imagine that we want to evaluate whether your year of education affects your income and by how much. If we build our simple OLS model where income is dependent "Y" variable, and year of education is "X_1" explanatory variable, then coefficient of "years of educations" (β_1) shows the size and direction (positive or negative) of the impact.

$$Y = \beta_0 + \beta_1 * X_1 + e$$

Where

Y – dependent variable,

β_0 – intercept,

β_1 – coefficient of first explanatory variable

X_1 – explanatory or independent variable

e – error or residual term

The above model is the simplest one variable example of linear regression and usually most studies take into account more explanatory variables that will improve the model (there are metrics to evaluate whether a model is improving or not, e.g. adj. R squared, AIC, MSE).

Estimation of coefficients in the above model is done with the method of least squares commonly known as OLS (ordinary least squares). Least squares estimate of β_1 is given by:

$$\hat{\beta}_1 = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^n (X_i - \bar{X})^2}$$

where

n – number of observations

X_i – value of the independent variable for the i-th observation

Y_i – value of the dependent variable for the i-th observation

$\bar{X}$ – mean of the independent variable X

$\bar{Y}$ – mean of the independent variable Y

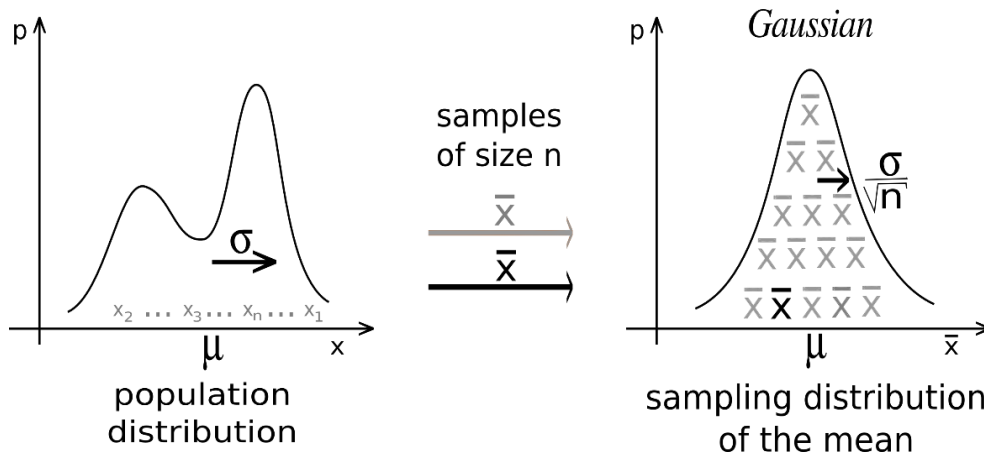
3. TRADITIONAL CONFIDENCE INTERVALS

Researchers are often interested not only in point estimates of coefficient, but also interval estimations. This is because point estimates of coefficients are always an approximation to true population value. In contrast, interval estimations, commonly known as confidence intervals, have a set of advantages. Firstly, it gives a range of values where true population value can be located. Secondly, confidence intervals will indicate whether the true population parameter might be equal to 0. In other words, whether the effect of that specific explanatory/independent variable to dependent variable is insignificant. Currently, all statistical softwares provide both point and interval estimates by default. Below, we will look at the theoretical side of building confidence intervals of coefficients of linear models.

Central Limit Theorem

Central Limit theorem (CLM) is the core concept of statistics that is employed also in building confidence intervals. The theory says that irrespective of the true population dataset, if one derives many sample averages from many samples generated from the same population, then the distribution of sample averages is approximately normal (also referred as Gaussian, see graph below) (Lind et al, 1967). The midpoint of resulting distribution of sample averages will be equal to the true population mean (see Figure 1). This is a very strong finding that can also be applied in confidence interval construction.

Figure 1: Central Limit Theorem



Source: generated by the author

In practice, we often cannot take many samples from the same population and very often left to work with only one sample. Nevertheless, one can still make some estimation regarding the population value (e.g. mean, coefficient) using the central limit theorem even when the distribution of the population dataset is not known.

Confidence interval based on CLT

Consider we have only one sample from the population data. Firstly, we can estimate the sample coefficient using the method of ordinary least squares (discussed in previous chapter). Afterwards, we can estimate standard error of the estimated coefficient using the following formula also arising from the method of least squares.

$$se(\hat{\beta}_1) = \frac{s}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2}}$$

where

s – standard deviation of the residuals (residual standard error)

n – number of observations

X_i – value of the independent variable for the i-th observation

$\bar{X}$ – mean of the independent variable X

As distribution of $\hat{\beta}_1$ coefficient is approximately normal distribution based on central limit theorem, we employ properties of standard normal distribution (z-distribution) and build 90%, 95% or 99% confidence intervals.

$$\hat{\beta}_1 \pm z_{\frac{\alpha}{2}} * se(\hat{\beta}_1)$$

where

$\hat{\beta}_1$ - is sample coefficient estimate

$z_{\frac{\alpha}{2}}$ – is a value from the standard normal distribution the give an area of $\frac{\alpha}{2}$

$se(\hat{\beta}_1)$ - sample variance of the coefficient

The above interval estimation is interpreted in the following way. 97% interval indicates that if we construct 100 confidence intervals from 100 random samples generated from the true population, then 97 of those confidence intervals will contain true population coefficient β_1 . Also, employing this confidence interval you can verify whether population coefficient is insignificant. If estimated confidence interval contains zero, then one can suspect that the true population parameter can be equal to zero (Gujarati, 2004)

However, one can see that estimation of the standard error of the same coefficient depends on the normality of the residual term. In the presence of heteroscedasticity, standard deviation of the error term can be inflated which will result in inaccuracies in confidence interval constructions using the CLT approach (Gujarati, 2004).

Heteroscedasticity can arise from various sources, such as:

1. Omitted variables
2. Measurement error
3. Non-linearity of the relationship of dependent and independent variable
4. Outliers
5. Residual variance that deviates with time
6. Endogeneity
7. Model misspecification

If no remedy is applied to heteroscedasticity in residuals, it will make the standard error of the residuals biased and can lead to wrong conclusions in hypothesis testing. Academia suggested a set of way on how heteroscedasticity, such transforming variables, weighted least squares, including important variables and many others (Greene 2021)

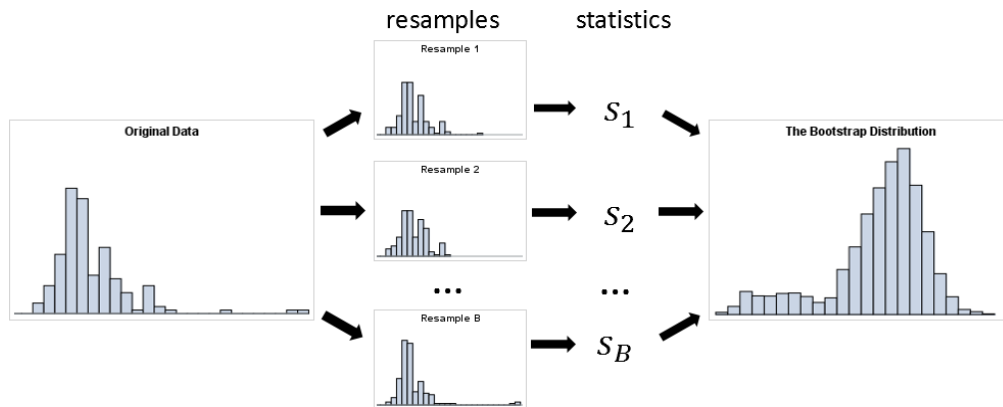
Below, we suggest another way, bootstrap, of handling heteroscedasticity in residuals for construction of our confidence intervals for coefficients.

4. BOOTSTRAP CONFIDENCE INTERVAL ESTIMATION

In the first place, it is necessary to explain the concept of bootstrapping. Bootstrap is a relatively easy resampling technique that can offer alternative ways of building confidence intervals. Bootstrap implies selecting one sample and generating many other different samples from this single original sample and estimating your parameter of interest in each newly created sample. Under the bootstrap approach, the original sample is considered as a population and we generate many other samples (known as bootstrap samples) out of it. When a large number of bootstrap samples are created, we estimate sample parameters (e.g. coefficient) from every bootstrap sample. Consequently, we will have a distribution of bootstrap sample estimates.

This distribution of bootstrap sample estimates can be used to construct our confidence intervals. For example, if we want to construct a 95 percent interval, we take 2.5th and 97.5th percentiles from bootstrap distribution. Figure 2 explains visually the method of bootstrapping.

Figure 2: Bootstrap distribution generated from original sample



Source: generated by the author

Bootstrap in case of heteroscedasticity

Consider a sample that indicates presence of heteroscedasticity as a result of measurement of error in some data points. Earlier, we discussed that heteroscedasticity can lead to a bias if we employ traditional OLS based methods of building confidence intervals. This is because standard errors of residuals will be affected by heteroscedastic residuals. This in turn influences standard errors of estimated coefficients which is used for building traditional confidence intervals. There are a set of advantages to this approach over traditional methods. Firstly, if sample size is smaller than 30 if we remove outliers from the original dataset, bootstrap interval estimation can still be derived. In contrast, traditional methods required sample size to be larger than 30 for estimates to be reliable enough. Secondly, by removing samples that contain potential outliers, our distribution of estimates should not be influenced by extreme outliers. Lastly, bootstrap distributions of estimates do not have any assumptions of true distribution of population dataset.

In contrast, bootstrap confidence intervals do not rely on standard deviation of residuals. It generally has no assumptions on the distribution of the coefficient which serves as its biggest advantage over the traditional approach.

5. HUBER-WHITE ROBUST STANDARD ERRORS

The Huber-White approach has turned into one of the commonly used methods to derive robust standard errors in regression models where residual do not have constant variance. As mentioned earlier, one of the assumptions of traditional OLS model is that the error term have a constant variance, also known as homoscedasticity, across all levels of the independent variables. When homoscedasticity is not satisfied, confidence intervals and hypothesis tests might be inaccurate or even biased. Huber (1967) and White (1980) suggested so called Huber-White method, which has proven to be a good remedy to cases of heteroscedasticity and give robust standard errors to build confidence intervals.

Theoretical Foundation of the Huber-White Method

In linear models, the mathematical estimation of $\tilde{\beta}_1$ coefficients assumes that error terms e have constant variance across observations. Mathematically speaking:

$$\text{Var}(e) = \sigma^2$$

Yet, if homoscedasticity is not satisfied, the derived variance of $\tilde{\beta}_1$ may be inaccurate and biased. The Huber-White approach resolved this problem by deriving the variance-covariance matrix to adjust for unequal error variances.

Formula of the variance of $\hat{\beta}_1$ in OLS models is:

$$Var(\hat{\beta}_1) = (X'X)^{-1}X'\Sigma X(X'X)^{-1}$$

where Σ is the variance-covariance matrix of the residuals, often assumed as $\sigma^2 I$ (a constant times an identity matrix). When residuals are heteroscedastic, Σ changes across different X values. The Huber-White approach instead calculates $\hat{\Sigma}$ as:

$$\hat{\Sigma}_{HC} = diag(\hat{e}_i^2)$$

where $\hat{e}_i^2$ is the squared error terms for each observation. As the result, Huber-White methods estimates variance of the coefficient using the following formula:

$$Var_{HB}(\hat{\beta}_1) = (X'X)^{-1}X' \left(\sum_{i=1}^n x_i x_i' \hat{e}_i^2 \right) X(X'X)^{-1}$$

Here, x_i is the vector of independent variables for each observation, weighted by their residual variances.

This method has proven to be appropriate in handling OLS models with heteroscedasticity and resulting variances are unbiased and more accurate, especially in cross sectional or panel datasets.

6. SIMULATION

In order to evaluate performance of bootstrap confidence intervals when heteroscedasticity is present, it is necessary to carry out a simulation of a linear model. Simulation is necessary for two reasons. First, we need to know the true population coefficient β_1 and in practice we rarely know the true population parameter. Secondly, we need to evaluate performance of estimated confidence intervals in presence of heteroscedasticity. Although real data can have heteroscedasticity of residuals, we do not know the true form of residuals distribution. For these two reasons we need to model our linear model with heteroscedastic residuals. We select the simplest form of linear model with one explanatory variable that is correlated with the error term.

$$Y = \beta_0 + \beta_1 * X1 + \epsilon$$

where

$$X1 \sim N(5, 4)$$

$$\epsilon \sim N(0, X1/2)$$

where intercept (β_0) and β_1 are defined by us. Independent variables (X_i) come from normal distribution with mean of 5 and standard deviation of 4. Error term (ϵ) is simulated following the approach suggested by Flachaire (2003) yet the form of heteroscedasticity is slightly different. Under this scenario, error term is correlated with explanatory variable and its variance grow as the value of $X1$ grows.

We check the performance of bootstrap confidence intervals in different sample sizes. Thus, we have a first sample size of 30 and then we increase it by 10 observations up to 200 observations. All of the simulations are carried out in R software.

We take the following steps for simulation of linear model with heteroscedasticity with different sample sizes

Step 1: set intercept $\beta_0 = 4$ and coefficient $\beta_1 = 5$

Step 2: Set sample size to $n=30$

Step 3: generate $X1 \sim N(5, 4)$ starting with sample size n

Step 4: generate Y with $Y = \beta_0 + \beta_1 * X1 + \epsilon$, where $\epsilon \sim N(0, \frac{X1}{2})$

Step 5: estimate confidence intervals using traditional method without remedy, Huber-White robust intervals and bootstrap methods in repeated simulations (1000 times). Here we construction 95 percent confidence intervals

Step 6: evaluate how many times (out of 1000), true parameters were within estimated OLS intervals with and without remedy and bootstrap confidence intervals

Step 7: repeat step 2 to step 8 by adding 10 observations to sample size ($n=n+10$). Finish when sample size reaches 200 observations

Traditional and bootstrap confidence intervals estimations are discussed in above sections. For traditional intervals, we use the following formula which is estimated in any statistical package when we construct our linear model.

$$\hat{\beta}_1 \pm t_{\frac{\alpha}{2}} * se(\hat{\beta}_1)$$

Bootstrap confidence intervals are built taking values in certain percentiles of parameter distributions that were generated as a result of bootstrapping.

7. RESULTS

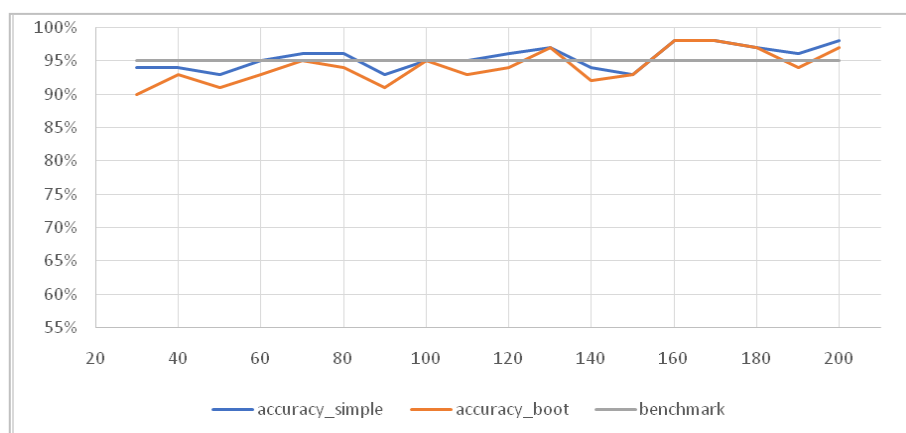
We will look into two results of the simulation in this part. First is with homoscedastic residuals and second is with the presence of heteroscedasticity. In present of heteroscedasticity, we compare traditional confidence intervals without remedy and bootstrap intervals. Afterwards, we build confidence intervals using Huber-White standard errors and check how they perform against bootstrap. In all these comparison, we also look at how estimated intervals change as we change our sample size.

Correctly specified model

First of all, we want to see how traditional CLT based and bootstrap confidence intervals perform when no violations of OLS assumptions are present. We expect that both approaches will do relatively good work in building interval estimates. In other words, for 95 percent confidence intervals, we expect true parameters to fall within estimated intervals at least 95 per cent of cases.

The first graph below shows often true coefficients fall within estimated confidence intervals built using traditional and bootstrap methods. One can see that both methods are doing relatively well, that is constructed intervals are containing true coefficient at least The chart clearly shows that both traditional and bootstrap confidence intervals contain true parameter in 90-100 percent of the cases which is expected outcomes (see Figure 3).

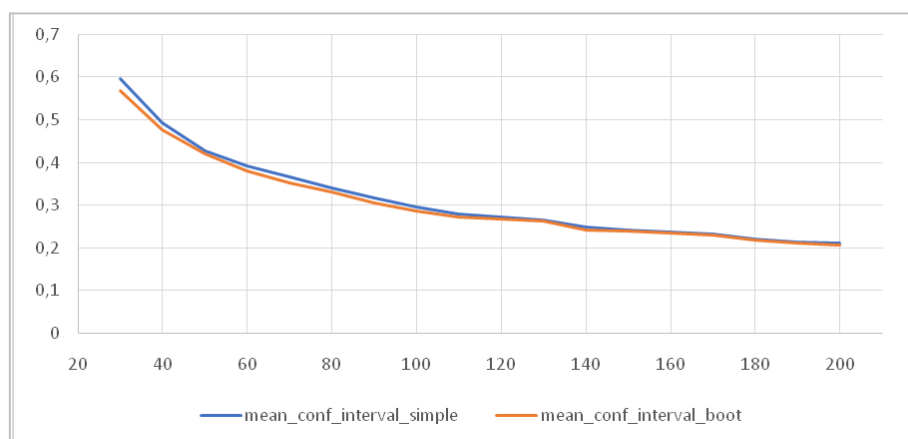
Figure 3: Accuracy of confidence intervals when model is correctly specified: traditional confidence intervals vs bootstrap confidence intervals



Source: generated by the author

Bootstrap confidence intervals contain true coefficients more often compared to traditional OLS intervals. This is explained in the second graph which shows that bootstrap intervals are larger in width compared to OLS intervals across all sample sizes (see Figures 4).

Figure 4: Size or width of confidence intervals when model is correctly specified: traditional confidence intervals vs bootstrap confidence intervals

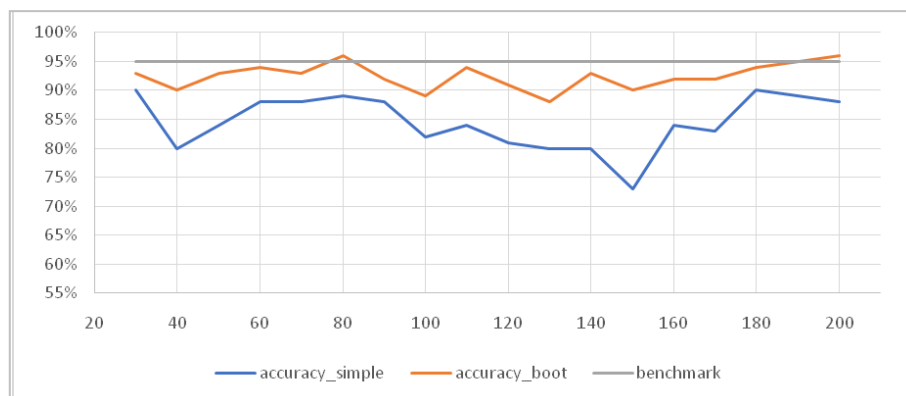


Source: generated by the author

Misspecified model: case of heteroscedastic residuals

As explained in previous chapter, we introduce heteroscedasticity by making our variance of residuals equal to $X_1^2/2$. This will make variance of error term be dependent of values of X_1 and thus make the error term heteroscedastic. In other words, the larger the explanatory variable, the larger the variance of the error term becomes. Here, we again plot the two graphs to check accuracy and width of traditional OLS confidence intervals compared to bootstrap ones.

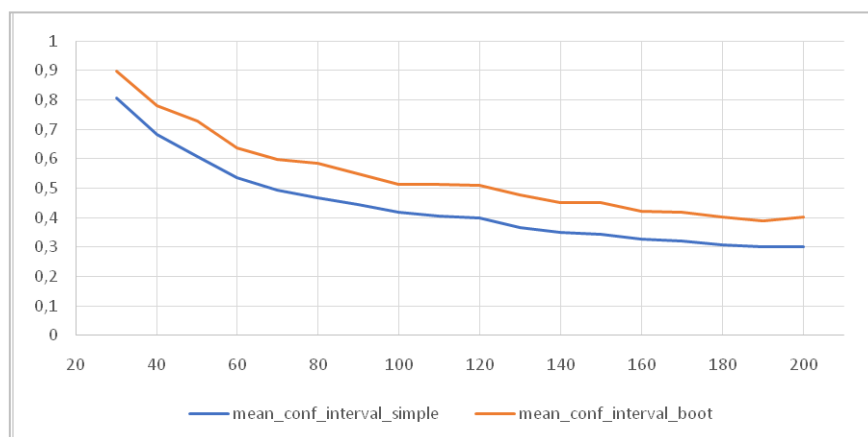
Figure 5: Accuracy of confidence intervals when residuals of the model are heteroscedastic and not remedy is applied: traditional confidence interval without remedy vs bootstrap confidence interval



Source: generated by the author

One can clearly see from the Figure 5 in Appendix that neither of the approaches are reaching expected 95 per cent coverage of confidence intervals. Yet, accuracy of bootstrap confidence intervals are much higher than that of traditional intervals. To put in other words, approximately 90 per cent or more bootstrap confidence intervals contain true population coefficient across different sample sizes. In contrast, traditional confidence intervals' accuracy are below 80 per cent which clearly indicates that confidence intervals are highly influenced by non-constant variance of residuals which distorts standard deviation of estimated coefficient. Higher coverage of bootstrap intervals are explained by the fact that the width of bootstrap intervals are wider compared to traditional ones (see Figure 6).

Figure 6: Size or width of confidence intervals in presence of heteroscedasticity: traditional confidence interval without remedy vs bootstrap confidence interval

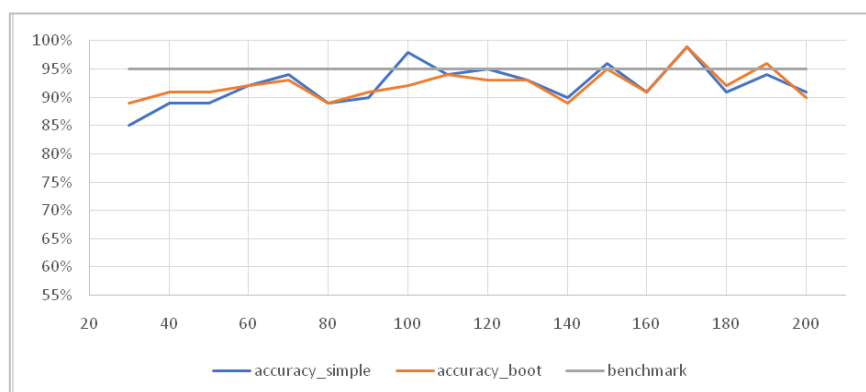


Source: generated by the author

As pointed out in the literature review part, Chernick and LaBudde (2011) claim that bootstrap intervals constructed using bootstrapping pairs are less sensitive to violations of model assumptions, which is also justified in the current simulation.

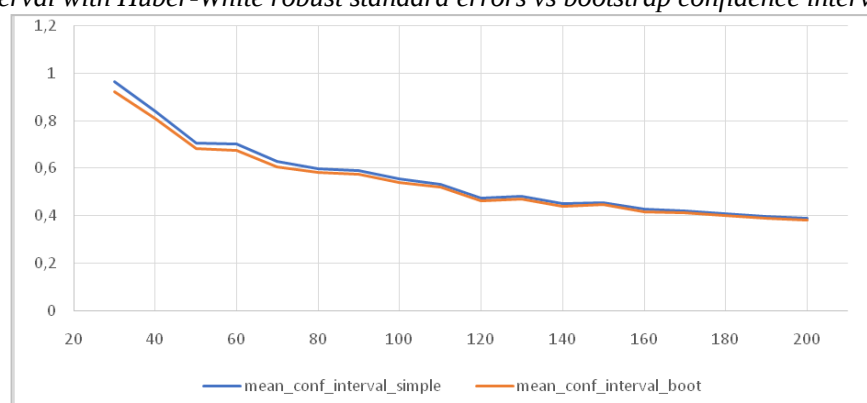
Now we will have a look at how bootstrap confidence intervals contrast with traditional intervals when we apply Huber-White method. In our specific form of variance of the error term ($X1/2$), Huber-White robust intervals perform almost the same as bootstrap confidence intervals in term of accuracy (see Figure 7). Size of confidence intervals of both methods are also almost the same, although bootstrap intervals are slightly narrower compared to Huber-White intervals.

Figure 7: Accuracy of confidence intervals when residuals of the model are heteroscedastic and remedy is applied: traditional confidence interval with Huber-White robust standard errors vs bootstrap confidence interval



Source: generated by the author

Figure 8: Size or width of confidence intervals in presence of heteroscedasticity: traditional confidence interval with Huber-White robust standard errors vs bootstrap confidence interval



Source: generated by the author

To sum up all the above-mentioned simulation results, traditional confidence intervals can result in misleading inferences when residuals have non-constant variance and no remedy is applied. In such cases, researcher apply different transformation, such as Huber-White method, in order to make our coefficient estimates robust to heteroscedasticity. Here, we suggested and tested bootstrap confidence intervals as another approach of handling heteroscedasticity arguing that bootstrapping does not have any distributional assumptions. Simulations discussed above indicate that bootstrap confidence intervals can work very well to build our intervals estimations and make inferences. Bootstrapping has accuracy at expected 95 per cent and performed as good as Huber-White robust intervals, while bootstrap interval had narrower intervals.

8. LIMITATIONS OF THE STUDY

Although our paper sheds some light in new ways of handling heteroscedasticity in OLS models using bootstrap confidence intervals, there are some limitations in this method. Firstly, aligned with many papers in bootstrapping, this method is computer intensive and resampling of large dataset can be costly. In our simulation study, we also required some computing power and time to get results of the bootstrap confidence intervals while Huber-White methods was delivering faster and less computer intensive outcomes. Thus, readers are recommended to apply Huber-White method in cases when it helps produce more accurate and reliable estimates or when sample data is relatively large. Secondly, in this simulation study, we considered only one type of heteroscedasticity when variance of the error term is equal to $\frac{X_1^2}{2}$. Researchers are highly encouraged to consider other forms of heteroscedasticity and compare bootstrap confidence intervals with widely known remedies such as Huber-White robust method. Lastly, we selected Huber-White method for comparison and it has resulted in similar outcomes as bootstrap method. Areas for further research could be to compare bootstrap intervals with other methods of handling heteroscedastic residuals in linear models.

CONCLUSION

In this paper, we carried out a simulation study of building bootstrap confidence intervals in linear models when variance of residuals is not constant. We first looked at existing literature on this topic and then looked at the theoretical side of linear models with heteroscedasticity. We explained that traditional confidence intervals might be biased when heteroscedasticity is present in data and therefore suggested using bootstrapping pairs for building confidence intervals, which do not have any assumptions of residual distribution. Afterwards, we compared performance bootstrap intervals with one the widely used techniques to handle heteroscedasticity, Huber-White method.

When model is correctly specified and residuals are homoscedastic, both traditional confidence intervals and bootstrap intervals have intervals with good accuracy and almost the same size which is aligned with the theory. Given that bootstrap is computer intensive, traditional confidence intervals are more preferable when all assumptions of OLS are met. Yet, when heteroscedasticity is introduced and not remedy is applied, bootstrap confidence intervals are showing superb performance with accuracy around 95 per cent which traditional intervals are highly inaccurate. Lastly, we compared bootstrap confidence intervals with one of the widely known techniques to get heteroscedasticity robust intervals known as Huber-White approach. Results indicate that the both approaches are promising and very similar in accuracy and size or width of the intervals. This bring us to conclude that bootstrap approach performs equally well as widely known Huber-White methods and researchers can use both approaches interchangeably.

Yet, it is important to be note the limitations of this study. First, one should be aware that bootstrap could be computer intensive, especially when dataset is large. Secondly, we investigated only one type of heteroscedasticity while many other forms of non-constant variance of residuals are present in practice. Lastly, we picked Huber-White approach for comparison and did not consider other remedies that researchers are encouraged to look in future studies.

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ANALYZING THE RELATIONSHIP BETWEEN TRADE OPENNESS AND ECONOMIC
GROWTH IN NORTH MACEDONIA: A SVAR APPROACH

АНАЛИЗА ОДНОСА ОТВОРЕНОСТИ ТРГОВИНЕ И ЕКОНОМСКОГ РАСТА У
СЈЕВЕРНОЈ МАКЕДОНИЈИ: SVAR МЕТОДОЛОГИЈА

Summary: *The relationship between trade openness and economic growth is complex. We employ a structural vector auto-regression (SVAR) model using quarterly data for the period from 2005 to 2022 to estimate the impact of trade openness on the economic growth in North Macedonia. The study's findings indicate a negative and significant relationship between trade openness and economic development in the short and long run. The complexity of this relationship highlights an adverse impact on countries specialising in low-quality production or those with low levels of human capital accumulation, such as North Macedonia. The dynamic effects of shocks to trade openness on interest rates, consumer price index, interest rates, labour force, and exchange rate are investigated using impulse response functions. The paper suggests that North Macedonia's trade strategy requires reorientation towards trade diversification, attracting export-oriented FDI, and fostering regional trade integration to achieve sustainable economic growth and development.*

Keywords: Trade Openness, Economic Growth, SVAR, forecast error variance decomposition, impulse response function.

JEL classification: C22, C53, F41, F43

Резиме: *Корелација између отворености трговине и економског раста је замршена. Користећи модел структурне векторске ауторегресије (СВАР) са кварталним подацима који обухватају период од 2000. до 2023. године, анализирамо утицај отворености трговине на економски раст у Северној Македонији. Наша студија открива значајну и негативну везу између отворености трговине и економског раста, како краткорочно тако и дугорочно. Ова сложеност наглашава штетан утицај на нације специјализоване за производњу ниског квалитета или које поседују ограничену акумулацију људског капитала, као што је Северна Македонија. Истражујемо динамичке последице шокова на отвореност трговине на различите економске показатеље – укључујући каматне стопе, индекс потрошачких цена, радну снагу и девизне курсеве – користећи функције импулсног одговора. Налази овог истраживања залажу се за преоријентацију трговинске стратегије Северне Македоније ка диверсификацији, привлачењу извозно оријентисаних страних директних инвестиција (СДИ) и промовисању регионалне трговинске интеграције ради подстицања одрживог економског раста и развоја.*

Кључне речи: отвореност трговине, економски раст, SVAR, декомпозиција варијансе грешке прогнозе, функција импулсног одзива.

ЈЕЛ класификација: C22, C53, F41, F43

Paper presented at the 13th International Scientific Conference “Jahorina Business Forum 2024:
Circular Economy - The Model of New Business”

INTRODUCTION

This paper tries to empirically examine the relationship between trade openness and economic growth in North Macedonia. Empirical evidence suggests that this relationship is ambiguous. Different studies confirm that trade openness can have either a positive, a negative, or a neutral impact on economic growth, depending on the specific country's circumstances. Furthermore, there is a divergence in the scientific techniques employed to investigate this relationship. The approaches adopted involve the development of different statistical models, such as ordinary linear regression models with panel data, vector autoregressive models and vector error correction models. To investigate the impact of trade openness on the Macedonian economy, this research employs structural

vector auto-regression (SVAR) or the co-integrated SVAR method for the period from 2005 to 2022 using quarterly data.

Since North Macedonia is a small and landlocked country, it is considered in the economic theory that trade will play a crucial role in driving economic growth and providing structural transformation. The country is integrated into regional and European value chains, mainly due to the favorable policy of attraction of foreign direct investments (FDIs) over the past two decades. Trade integration has contributed to North Macedonia's rise to the status of a middle-income country (World Bank 2023). However, there is a lack of trade diversification meaning there is a high concentration of export products and a lack of economic transformation. Also, one-fifth of the population lives in poverty (World Bank 2022).

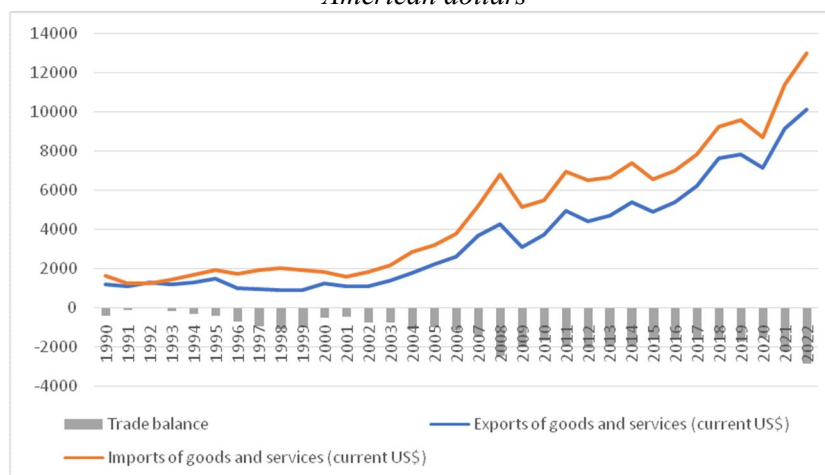
The paper tries to test the hypothesis that suggests that economic growth in smaller economies is encouraged by trade openness due to the expansion of spillover effects and structural transformation of the country (Romer 1990; Feenstra 1996). In addition, seeks to assess the impact of openness to the Macedonian economy, on the variability of GDP, employment, inflation, interest rate and Macedonian denar exchange rate. Moreover, the paper aims to analyze the dynamic movements of interactions among endogenous variables by using an orthogonalized impulse response function.

The subsequent sections of the paper are organized as follows: Section 1 provides an overview of the specifics of the Macedonian economy. Sector 2 provides a concise review of relevant literature and discusses trade openness policies. Section 3 outlines the data and methodology employed, followed by a presentation of the empirical findings in Section 4. The final section offers conclusions drawn from the study.

1. OVERVIEW OF THE MACROECONOMIC POLICY IN NORTH MACEDONIA

North Macedonia is a small, landlocked economy that is import-dependent for many goods and services. Independence gained in 1992 was followed by external shocks such as the UN Security Council sanctions imposed against the rump Yugoslavia in 1992, the unilateral Greek trade embargo against Macedonia in 1994, the collapse of the CMEA trade area, and the loss of traditional East European markets. All these shocks created severe problems in internal trade and significantly decreased trade flows (Petkovski and Slaveski 1997). Export recovery was evident in 1995, and high imports caused a negative trend in the trade balance. Unfortunately, the country has been a net importer throughout its independence until 2022 (Figure 1).

Figure 1. Trade flows of goods and services, and trade balance, 1992-2022, current millions of American dollars



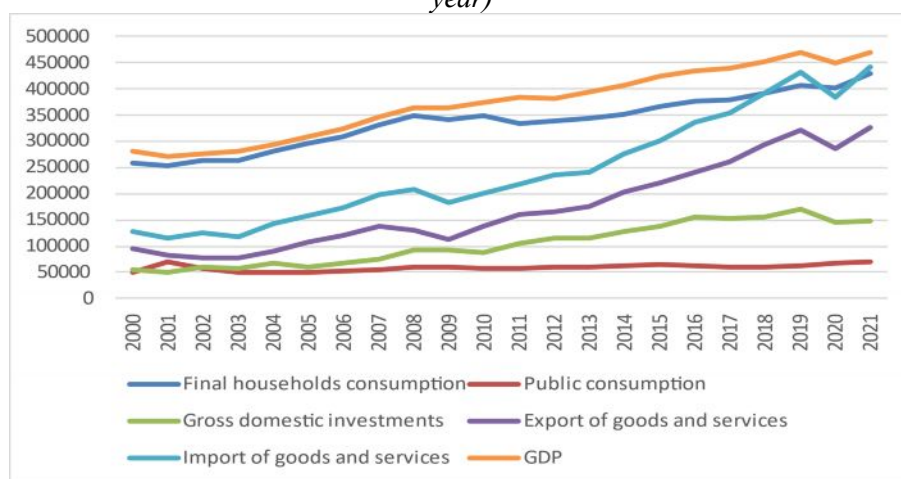
Source: World Bank Development Indicators 2023

The macroeconomic policy mix in North Macedonia has been geared towards export-led growth. The experience of the Central and Eastern European and Baltic countries group has confirmed that the best route to prosperity for small countries, especially the Western Balkans, is to integrate with the global economy by promoting trade liberalization and removing tariff and non-tariff barriers. In support of this policy, a de facto fixed exchange rate regime has existed since 1994. Economic stability

was the primary concern of the monetary and fiscal policymakers. The monetary policy was designed to sustain the stability of the denar to the Deutsche mark (to the Euro after 2002), by imposing strict control of the money supply and the fiscal authority targeted a balanced budget with tight control over the growth of wages. This macroeconomic policy provided certainty for exporters and importers and low inflation, but the economic growth and employment suffered consequently.

Trade liberalization was promoted further with the membership of Macedonia in the World Trade Organization in 2003. After signing the Stabilization and Association Agreement with the EU in 2001, Macedonian goods had free access to the EU Internal Market (asymmetrical approach). The country is participating in the free trade area CEFTA-2006 with other countries from the Western Balkans. Around 90% of Macedonian exports and about half of its imports are oriented towards EU and CEFTA markets (National Bank of Republic of North Macedonia 2023a). Trade relations with the EU also include technical help and cross-border investments, which are essential for the country's economic growth. The free trade regime of the Macedonian economy means that the country has low levels of tariff and non-tariff barriers or has none. The real obstacle in the trade is the non-trade barriers such as different administrative procedures, standards, public procurement, and others that have a structural or, in some cases, political nature.

Figure 2. Real gross domestic product, expenditure method, year; in million denars (2005 as referent year)

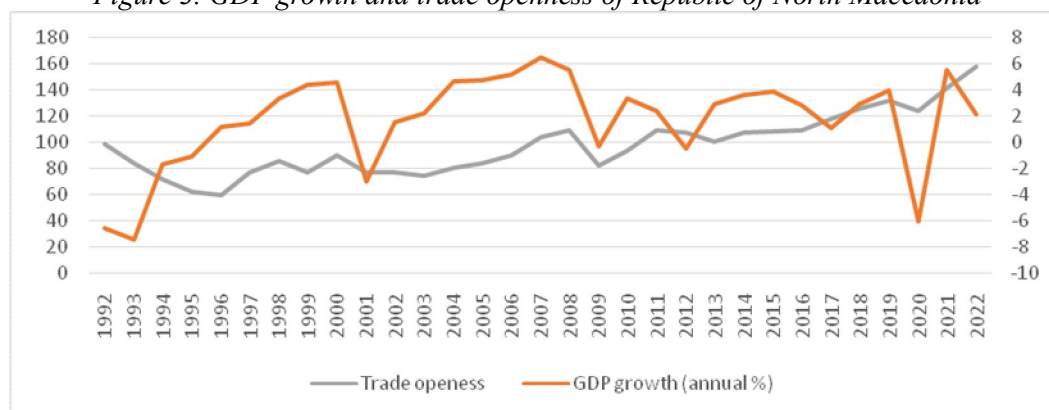


Source: State Statistical Office of the Republic of North Macedonia 2023

The data show that the trade openness of North Macedonia reached 160% of GDP in 2022 (Figure 3).¹ Figure 3 shows that the country has been continuously increasing its trade and financial openness in the past two decades, which have contributed to economic convergence from 20% to 40% of GDP (National Bank of the Republic of North Macedonia 2023b). After the signing of the Stabilization and Association Agreement with the EU, the country also started to gradually liberalise the capital account and faced significant systemic changes (Besimi 2004). In the period before the world financial crisis, from 2001 to 2008, there were large capital inflows and increased domestic spending by firms and households. This resulted in high rates of economic growth (Gligorov 2017). Evidently, in this period, economic growth was primarily driven by investments and exports (Figure 2). The spillover effects of the financial crisis resulted in a negative economic growth rate in 2009.

¹ The degree of trade openness can be calculated as the sum of the export and import of goods and services divided by the GDP. In our calculations we use the value of nominal GDP.

Figure 3. GDP growth and trade openness of Republic of North Macedonia



Source: Authors' calculations. Data for GDP in current US dollars and GDP annual growth rate are extracted from the World Bank Development Indicators database. Data for export and import flow are extracted from Eurostat.

In the aftermath of the crisis in 2012, it is especially evident that new companies were activated in the Technological–Industrial Development Zones (TIRZ). These zones provide tax and customs incentives to attract FDIs in tradable sectors, a significant component of the country's export strategy. The export increase as a percentage of GDP will more than double in 2021 compared to 2000. There is also evident a structural shift in Macedonian exports, with a significant increase in the share of higher-value products such as machinery and transport equipment, as well as chemical products, primarily due to companies in the automotive sector. The current share in 2022 of higher-value exports is 57.2%, compared to 10.7% in 2004, a rise of 46.5 percentage points (National Bank of Republic of North Macedonia 2023a). However, there is a lack of export diversification. The top 5 per cent of exporters (2008–2020) collectively contribute to more than 80 per cent of total exports, and this share has remained unchanged over time, creating concentration in the export sector (World Bank 2023).

In the period after the COVID-19 crisis, the economic growth in Macedonia was mainly driven by consumption, and, to a lesser extent, investment, while net exports did not contribute to the growth level of the recovery. This indicates that the current trade strategy shows signs of fatigue (The World Bank 2022). Trade openness created higher exposure to external shocks arising from the COVID pandemic, the disruption in the global value chains and the war in Ukraine. Recent intensified geopolitical tensions are imposing severe risks to the further course of global economic integration, with possible consequences in several areas, including trade, finance, global value chains, and the overall economic convergence process. In the case of fragmentation of the global economy, costs could be high, especially for small open economies in development, reflecting higher import prices, smaller and segmented markets, reduced access to technology and the workforce, and overall, reduced productivity and standard of living.

2. LITERATURE REVIEW

The link between trade openness and economic growth has been extensively researched in economics and in international trade. For example, the exogenous growth theory highlights the neutral impact of trade on economic growth in the long term (Rivera-Batiz and Romer 1991). However, the modern growth theory offers the theoretical basis for understanding the favourable link between trade openness and economic growth. Endogenous growth theory posits that trade openness facilitates technology spillovers, which leads to enhanced international competitiveness, increased productivity, and increased export revenues (Romer 1990). Lucas (1988) emphasized the importance of trade openness to enhance human capital by exposing workers and firms to new ideas and technology and thus to promote economic growth. Grossman and Helpman (1993) revealed that trade between developing and developed countries may enhance long-run economic growth in developing countries.

The impact of trade openness on economic prosperity is also examined through the lenses of the trade theories. The New Trade Theory developed by Krugman (1979; 1980) emphasizes the positive impact of trade openness on economic growth by using economics of scale and market imperfections. Participating in international trade enables firms to reduce costs through economies of

scale and enhanced efficiency. It also fosters competition and supports innovation by expanding the choice of accessible brands. Melitz (2003) extended Krugman's model by incorporating firm heterogeneity, demonstrating that trade openness leads to a reallocation of resources towards more productive firms, which boosts aggregate productivity and thus economic growth.

Conversely, some theoretical theories propose that trade openness may harm economic growth. This effect can be heightened, particularly in low-income nations (Kim et al. 2012). The reverse scenario is also valid. Spilimbergo (2000) argues that trade between an advanced country and a less developed country can harm the long-term growth rates of the developed country. In addition, the relationship between openness and growth can be bidirectional. In this scenario, economic growth increases openness to trade by developing skills, enhancing efficiency and generating comparative advantages (Lancaster 1980).

The lack of theoretical consensus about the impact of trade openness on economic growth leads to varying empirical outcomes. The literature is full of mixed findings concerning the direction and strength of the relationship between openness and growth. Some of the research supports the notion that there is a direct correlation between trade openness and economic prosperity (Barro 1991; Belloumi 2014; Biwott et al. 2013; Brana 2016; Dollar 1992; Edwards 1992, 1993, 1998; Frankel and Romer, 1999; Freund and Bolaky, 2008; Manni and Afzal 2012; Mercan et al. 2013; Polat et al. 2013; Sala-I-Martin 1997). Several studies investigate the indirect impact of trade openness on economic growth. Cavallo (2009) found that trade openness stabilizes output volatility, while Iamsiraroj (2016) argued it promotes growth by increasing foreign direct investments, despite output volatility being negatively linked to economic growth.

From the long – run perspective, there are numerous country specific studies confirming the positive relationship between trade openness and economic growth (Shahbaz 2012; Khalid and Hayder 2017). Abdulkadhim (2020) found trade openness and electricity consumption as key factors in UAE economic growth. Suryandaru (2023) found trade openness contributes to long-term growth, while external debt negatively impacts growth. Rao and Rao (2009) found co-integration between trade openness and output in Fiji, suggesting a 10% increase in trade openness could increase growth by 2%.

Empirical evidence also exists on the favourable short-term effect of trade openness on economic growth. Khalid (2016) found that trade openness positively impacts economic growth in Turkey from 1960 to 2014, but its long-term impact is insignificant. Alsamara et al. (2019) confirmed these findings, finding that trade openness and financial development positively affect per capita real GDP growth, while energy imports have a negative influence.

The positive relationship between trade openness and growth is confirmed not only in country specific studies, but also in panel models. Gries and Redlin (2012) found a long-term positive relationship between trade openness and economic growth in 158 countries from 1970 to 2009. However, short-term adjustments may be challenging for openness. Different trade patterns in low- and high-income nations have distinct consequences on economic growth. Kim et al. (2016) found a positive long-term relationship between international trade and growth rate and growth volatility, but a negative short-term correlation. Aumal and Özyurt (2010) found that trade openness benefits states with higher per capita income, human capital, and industrialized states, leading to increased regional inequalities. Zohonogo (2017) found a non-linear link between trade openness and economic growth in sub-Saharan African countries.

Trade openness can be a significant factor in the growth of transition economies. Nannicini and Billmeier (2011) found that trade liberalization positively impacted economic growth in transition economies in the 1990s, with open economies expanding their per capita GDP by 44-100% after ten years compared to closed economies. Fetahi-Vehapi et al. (2015) examined the impact of trade openness on South Eastern European countries' economic growth from 1996 to 2012, revealing that initial income per capita and other factors influence the impact of trade openness on economic growth, but insufficient evidence exists to establish a strong relationship between these variables. Silajdzic and Mehic (2018) found that trade openness positively impacts real GDP per capita, with a 10% increase in trade share expected to increase GDP per capita growth rate by 8%.

However, recent research has demonstrated that the relationship between trade openness and economic development is not straightforward. A number of studies have verified that trade openness might possibly exert an adverse or neutral impact on economic growth (Belloumi and Alshehry 2020; Fenira 2015; Hye and Lau 2015; Rigobon and Rodrik 2005). The negative impact of trade openness on economic growth can be explained by the presence of low-quality products in trade (Hausmann et al.

2007) or the undeveloped financial institutions (Kim et al., 2011). Simorangkir (2008) found that trade openness negatively impacts Indonesia's output due to lack of preparation and lower competitiveness of Indonesian products. Financial openness makes the economy vulnerable to capital reversal. However, subsequent research (Nursini 2017) found that trade openness positively impacts economic growth and recommends policies to increase competitiveness. Trade openness has been found to have significant short-term adverse effects on economic growth and inflation in Japan and Korea, but no longer-term effects (Jin 2006). Ulasan (2008) found that trade openness variables, including current openness, real openness, and collected import duties, are not significantly related to economic growth. Vlastou (2010) found that trade openness negatively impacts economic growth, while economic growth does not impact trade openness. Sharma et al. (2018) found that foreign aid, government consumption expenditure, and foreign direct investment have a favorable long-term impact on economic growth, while exchange rate and human capital development have a negative effect.

There is insufficient of previous research examining the impact trade openness on the economic performance of the Republic of North Macedonia. Markoski (2015) found a modest association between openness and GDP growth pace from 2003 to 2013, using linear regression analysis. Mano-Bakalinov (2016) used annual data from 1993 to 2014 to evaluate trade openness's impact on economic growth. The study found that population growth and trade openness positively impacted economic growth. However, the authors have reported comparatively low value of the adjusted R^2 coefficient, suggesting a need for model improvement.

3. DATA AND MODEL

The data being used in this research is quarterly data for the period starting from 2005(Q1) until 2022 (Q4). The data is limited in its scope due to its unavailability. The variables being used include the Gross Domestic Product (GDP), the degree of trade openness (OPEN), the interest rate (IR), the consumer price index (CPI), the exchange rate of Macedonian denar to EURO (EXC), and the number of the labour force (LAB). Trade openness presents trade share calculated from total exports and imports divided by GDP. Definitions of the variables and their sources are given in Table 1. In the model, all variables are expressed in a natural logarithm.

Table 1. Definition of variables

Variables	Definition	Source
GDP	Gross Domestic Product, in current prices, in million Euros	Eurostat
EXP	Export of goods and services from North Macedonia, in million Euros	Eurostat
IMP	Import of goods and services to North Macedonia, in million Euros	Eurostat
OPEN	Trade share calculated as total trade volume (export and import) divided by GDP.	Authors' calculations.
IR	Central Bank policy rates, end of period per cent per year (Units)	Bank for International Settlements
EXC	National Currency Per US Dollar, End of Period, Rate	International Monetary Fund
LAB	Labor force, total	International Labour Organization and United Nations Population Division.
CPI	Consumer Price Index	International monetary fund

The varying empirical outcomes on the relationship between trade and economic growth can be attributed to differences in research methods and country-specific factors (Suryandaru 2023). Furthermore, certain methodological constraints exist when defining trade openness. Specifically, using the trade share, which is calculated by dividing the total value of exports and imports by the gross domestic product (GDP), as a variable for trade openness in regression models might lead to issues of endogeneity (Frankel and Romer 1999). Alternative indicators of trade openness have recently been introduced, as evidenced by the works of Frankel (2001), Sachs and Warner (1995), Squalli and Wilson (2011), and Tang (2011). However, the trade share remains the most used indicator of commercial openness (Tang 2011) and we have use it as such in our paper.

We employ the structural vector autoregression (SVAR) or the co-integrated SVAR method proposed by (Pesaran and Smith 1998) to assess the impact of openness on the Macedonian economy.

In selecting the variables and determining the order of the variables in the model, we adopted the methodology suggested by Simorangkir (2008), Shahbaz (2012) and Khalid (2016), as they address similar issues.

A co-integrating VAR model integrates a cointegration matrix into a VAR model, resulting in a general vector error correction model (VECM), as explained by (Pesaran & Pesaran, 1997). This VECM can be represented as follows:

$$\text{Increment}\Delta x_t = a_{ox} + a_{ix}t - \Pi_x q_{t-1} + \sum_{i=1}^{p-1} \Gamma_{ix} \Delta q_{i-1} + \Psi w_t + t_t t = 1, 2, \dots, n \quad (1)$$

Where $q_t = (x_t', z_t')$, x_t is a vector of jointly determined (endogenous) I(1) variables, z_t is a vector of exogenous I(1) variables, w_t is a vector of exogenous/deterministic I(0) variables (excluding the intercepts and/or trends), u_t is a white noise vector of error terms, Γ_{ix} is a short run matrix of parameters, and Π_x is the long run multiplier matrix. The latter can be written as $\Pi_x = \alpha\beta'$, where β contains the long-run cointegration parameters. In this paper, z_t and w_t are absent, $x_t = (\text{GDP}_t, \text{IR}_t, \text{OPEN}_t, \text{EXC}_t, \text{CPI}_t, \text{LAB}_t)$, and the parameters of concern are the cointegration matrix. With the ordering of variables in x_t as follows GDP_t, IR_t, OPEN_t, EXC_t, CPI_t, LAB_t, β' can be written explicitly as follows:

$$\begin{pmatrix} \beta_{11} & \beta_{21} & 1 & 0 & : & 0 \\ \beta_{12} & 1 & 0 & 0 & : & \beta_{52} \end{pmatrix} \quad (2)$$

Where the augmented elements in the fifth column correspond to the linear trend (t). This VAR system may be transformed into a "structural" VAR model (SVAR).

The co-integrating VAR and SVAR parameters are related through $A\Pi_i = -A_i$, for $i = 2, 1, \dots, k$, and $A\Sigma A' = \Omega$. This leads to the establishment of the following relationship:

$$\Sigma = A^{-1} B B' A^{-1} \quad (3)$$

Applying limitations to specific components of the matrices facilitates the determination of structural shocks, known as contemporaneous restrictions. While it is feasible to introduce over-identifying restrictions, our focus in this Structural Vector Autoregression (SVAR) lies not in the elements of matrices A and B, but predominantly in the subsequent analyses of Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD). Therefore, we opt to employ only identifying restrictions as outlined below for heuristic purposes.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} e^{gdp} \\ e^{ir} \\ e^0 \\ e^{exc} \\ e^{cpi} \\ e^{lab} \end{bmatrix} = b_{ij} \begin{bmatrix} e^{gdp} \\ e^{ir} \\ e^0 \\ e^{exc} \\ e^{cpi} \\ e^{lab} \end{bmatrix} \quad (4)$$

Where: a_{ij} : element from A

ε : innovation (error) of variables used by j

b_{ij} : element from B (in this case $i=j$ for $i,j = 1, \dots, 6$)

e_j : structural shocks from variable j.

Examining the factors influencing openness in the Macedonian economy involves conducting both Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) analyses. The research incorporates several key variables, namely GDP, degree of openness (OPEN), interest rate (IR), total labour force (LAB), consumer price index (CPI), and the exchange rate of the Macedonian denar to the Euro (EXC). Given that, in the long run, CPI and exchange rate exhibit no impact on output, the model restricts the parameters of CPI and EXC to zero.

4. RESULTS AND INTERPRETATION

4.1. The coefficients of the long-run cointegrating equation

The analysis starts with conducting stationary test to each variable by using Augmented Dickey Fuller (ADF) test. All variables used in this analysis have non-stationary tendencies and become stationary once they are first differenced I(1) (Table 2).

Table 2. Augmented Dickey-Fuller Unit Root Test

Variables	Level (P-Value)	First Difference (P-Value)
Gross Domestic Product	0.7173	0.0000
Interest Rate	0.3172	0.0000
Trade Openness	0.0031	0.0001
Exchange Rate	0.6627	0.0000
Consumer Price Index	0.0000	0.0000
Labour	0.9576	0.0001

Source: Author calculation

The next step of the empirical analysis is determining the optimal order of VAR. The results from the Akaike information criterion (AIC) point to VAR of order 2, and for that purpose, the model includes 2 lags. Furthermore, the testing for cointegration is conducted using the Johansen cointegration test. The results of cointegration are presented in Table 3. The presented results regarding the use of a cointegrating relationship point to a 5 cointegration rank. The existence of cointegration signifies the presence of five long-term economic relationships among the selected variables.

Table 3. Cointegration Test

Date: 11/03/23 Time: 15:38
Sample (adjusted): 2005Q1 2022Q4
Included observations: 72 after adjustments
Trend assumption: Linear deterministic trend
Series: D(LOG_NOMGDP_USD) D(IR) D(TRADEOP_NEW) D(FXEOP) D(CPI) D(LOG_LABOUR)
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.633561	231.0919	95.75366	0.0000
At most 1 *	0.566328	158.8094	69.81889	0.0000
At most 2 *	0.441393	98.65586	47.85613	0.0000
At most 3 *	0.396577	56.72958	29.79707	0.0000
At most 4 *	0.211883	20.35972	15.49471	0.0085
At most 5	0.043682	3.215893	3.841465	0.0729

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.633561	72.28244	40.07757	0.0000
At most 1 *	0.566328	60.15358	33.87687	0.0000
At most 2 *	0.441393	41.92627	27.58434	0.0004
At most 3 *	0.396577	36.36986	21.13162	0.0002
At most 4 *	0.211883	17.14383	14.26460	0.0171
At most 5	0.043682	3.215893	3.841465	0.0729

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author calculation

The empirical model further relies on performing Cholesky decomposition. The model restricted the parameters of exchange rate and CPI to be 0, since there was no real effect of these variables on the output in the long run. The parameter of the labor force is restricted to be -1, since economy accelerates, the labor force decreases in the long run. This approach is already explained by Simorangkir(2008). The restricted long-run cointegrating equation is called the trade openness equation with a p-value 0.0098 (Table 4). The long-run equation for trade openness is as follows:

$$gdp = -0.32IR - 0.05TRADEOP \quad (5)$$

(0.05) (0.006)

the number in parenthesis is p-value for each parameter.

Table 4. Vector Error Correction Estimate

Vector Error Correction Estimates

Date: 11/03/23 Time: 15:52

Sample (adjusted): 2005Q1 2022Q4

Included observations: 72 after adjustments

Standard errors in () & t-statistics in []

Cointegration Restrictions:

B(1,1)=1, B(1,4)=0, B(1,5)=0, B(1,6)=-1

Convergence achieved after 419 iterations.

Restrictions identify all co-integrating vectors

LR test for binding restrictions (rank = 1):

Chi-square(3)	11.3946
Probability	0.009773

Co-integrating Eq:	CointEq1
LGDP	1
IR	-0.31822 -0.05324 [-5.97702]
TRADEOP	-0.050444 -0.00619 [-8.14938]
EXCHR	0
CPI	0
LLABOUR	-1
C	0.027972

Source: Author calculation

The results show that interest rate elasticity is negative and significant, -0.32. The negative coefficient means that in the long run as the interest rate increases, the economic growth decelerates; therefore, the sign of parameter is in the expected direction, and it is in line with the theory.

The sign of the coefficient of trade openness is negative and significant, namely -0.05. Other things remain constant a one percent increase in trade openness is associated with a decrease in economic growth by 0.05 percent, pointing to an inverse relationship between the trade openness and the economic growth. This finding aligns with prior research conducted by Kim (2011), who observed that increased trade openness negatively impacts both economic growth and real income in less developed countries. Likewise, Hye (2012) documented that a rise in the trade openness index detrimentally affects economic growth in Pakistan.

Careful consideration of causation, possible explanations, and the broader economic context is crucial for a more nuanced interpretation. The negative coefficient might suggest that other factors associated with increased trade openness (such as competition, import exposure, or economic restructuring) could be influencing economic growth. Moreover, the influence of factors like unequal distribution of gains from trade, trade imbalances, or the impact of global economic conditions should

be explored. The complex nature of the relationship between trade openness and economic growth is explained by other authors, as well. Similar views are shared in the empirical study by Huchet-Bourdon et al. (2018), that points to a non-linear relationship between these two macroeconomic variables, emphasizing that trade openness may impact growth adversely for countries specializing in low quality production. Non-linearity is also discussed by Fatima et al. (2020), showing that trade may have a negative impact on GDP growth when countries exhibit a low level of human capital accumulation. A study focusing on South East European Countries by Fetahi-Vetapi et al. (2015) points to a lack of conclusive evidence on the relationship between trade and economic growth, with empirical results that indicate a positive effects of trade openness on economic growth, but conditionally on the initial income per capita and other explanatory variables.

4.2. Forecast error variance decomposition analysis

This paper has expanded the examination of the interrelations among the variables beyond the sampled timeframe through the application of variance decomposition analysis. Employing this method facilitates the assessment of the degree of fluctuation in the dependent variable lagged by its own variance. Moreover, it determines the extent to which independent variables explain the variability observed in the dependent variable.

Since the purpose of the paper is to analyze the impact of openness to Macedonian economy, the main analysis of this paper will just focus on the analysis of shocks to trade openness on the variability of GDP, employment, inflation, and Macedonian denar exchange rate. According to the orthogonalised FEVD results as shown in Table 5, shocks to trade openness are important in explaining fluctuations in GDP, employment, inflation, and exchange rate.

Table 5. Variance Decomposition

Variance Decomposition of LGDP:								Variance Decomposition of EXCHR:							
Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR	Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR
1	0.057543	100	0	0	0	0	0	1	2.534043	27.90372	2.683689	5.578003	63.83458	0	0
2	0.064991	86.15812	6.026104	0.031527	7.712482	0.054822	0.016945	2	2.816965	27.10304	8.951839	8.422405	55.17096	0.015911	0.335848
3	0.077112	79.24753	4.61209	7.917854	5.543056	2.618536	0.060935	3	3.34782	20.10115	6.458279	21.29001	50.88893	0.014141	1.247487
4	0.084696	78.35073	4.527847	7.747567	7.020786	2.299052	0.054017	4	3.741785	25.53597	5.214659	18.2387	49.90082	0.021596	1.088255
5	0.092984	79.4387	3.782164	7.948061	6.8064	1.929349	0.095327	5	4.022939	24.10294	4.574492	18.77735	50.00567	0.276914	2.262627
10	0.119	82.20135	2.597758	7.251946	6.074682	1.595893	0.278373	10	5.148487	24.17702	3.992033	18.95153	50.75825	0.278589	1.842588

Variance Decomposition of D(IR):								Variance Decomposition of CPI:							
Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR	Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR
1	0.575002	0.146337	99.85366	0	0	0	0	1	1.256472	1.145739	11.62955	2.968585	0.237784	84.01835	0
2	0.787725	1.915363	96.87561	0.001554	0.721304	0.485811	0.000358	2	1.646905	0.958012	7.038759	10.89801	0.701542	77.82914	2.574532
3	0.950417	2.560963	92.10365	1.877024	0.536347	2.599472	0.322539	3	1.761555	1.266561	6.248449	12.66389	1.503202	75.59727	2.720621
4	1.031257	2.213047	90.42714	4.273585	0.462625	2.271891	0.351714	4	1.910904	1.269149	7.649017	13.77033	1.278791	73.71467	2.31804
5	1.104652	2.195822	89.0778	5.859441	0.415083	2.130598	0.321252	5	2.13953	1.027344	7.872605	14.00715	1.114104	73.65023	2.328572
10	1.472867	1.92426	89.93196	5.883068	0.341306	1.681312	0.238096	10	2.821203	1.055301	6.99728	15.12281	1.152264	73.36572	2.30663

Variance Decomposition of TRADEOP:								Variance Decomposition of LLABOUR:							
Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR	Period	S.E.	LGDP	IR	TRADEOP	EXCHR	CPI	LLABOUR
1	7.959537	3.139306	4.156311	92.70438	0	0	0	1	0.043767	0.171826	0.580756	4.437045	0.149376	0.741944	93.91905
2	8.331905	3.608994	4.099115	85.49496	0.620557	2.481625	3.694747	2	0.045762	0.559889	2.44493	4.460454	2.755993	2.920742	86.85799
3	8.854528	6.929651	10.75194	75.75868	1.083351	2.198418	3.27796	3	0.055099	0.445031	1.997755	3.090877	2.914919	6.257587	85.29383
4	10.04237	5.855454	25.76042	60.03097	1.265683	4.421417	2.666056	4	0.055859	0.634803	2.025892	3.322417	3.221978	6.335844	84.45907
5	10.56305	7.097573	30.63423	54.36356	1.168133	4.114713	2.621789	5	0.060342	0.544226	1.942924	3.190038	2.778876	5.81409	85.72985
10	12.36562	8.183459	43.43049	41.91681	1.080061	3.199596	2.189591	10	0.07065	0.532371	2.508252	2.639894	2.102735	5.892154	86.32459

Cholesky Ordering: LGDP IR TRADEOP EXCHR CPI LLABOUR

Source: Author calculation

Short- and medium-term fluctuations in GDP are mainly self-explanatory, with these inherent variations accounting for up to 82 percent in the medium term. Additionally, trade openness shocks and exchange rate fluctuations each contribute to approximately 7 percent and 6 percent, respectively, of the medium-term variability in GDP. Shocks to interest rate, inflation and labor force have trivial effects on the variability of the GDP, which could stem from different sources: implementation of effective monetary policy responses that can help mitigate the impact of shocks and contribute to a more stable GDP, existence of flexible labor markets that can limit the impact of labor force shocks on overall economic activity, establishment of well-anchored inflation expectations which might enable firms and households to adjust more smoothly to changes in inflation without significant disruptions to economic output, structural factors that contribute to a more resilient and stable economy, etc.

Fluctuations in interest rates are largely influenced by their own past values, whereas the economic variables such as GDP, trade openness, exchange rates, consumer prices, and labor market conditions have only minor influence on interest rate changes. These insights are relevant for policymakers since the dominance of the autoregressive component underscores the importance of considering past interest rate movements in forecasting and policy decisions. The limited impact of external economic factors on interest rate changes suggests a degree of independence or inertia in the interest rate-setting process.

The variability of exchange rate in the short-term and medium term is primarily explained by more than 50 percent due to its own past values, indicating a strong autoregressive component. In the subsequent periods, the influence of GDP, interest rate, trade openness, and other factors on exchange rate variability is presented. Notably, trade openness consistently contributes around 18-22 percent to the variability in the exchange rate, suggesting a relatively stable impact of trade openness on the exchange rate over time.

The largest contributor to CPI variability is its own past values, suggesting a strong autoregressive component. The interest rate contributes positively to CPI variability, indicating that changes in interest rates have an impact on inflation. In the short term, the influence of interest rates on CPI is relatively low, but it becomes more pronounced over time. The impact of trade openness on CPI is noticeable but relatively modest, reaching up to 15.1 percent. This suggests that changes in trade openness have a limited direct effect on consumer prices. Other factors, such as GDP, exchange rate and labor force also contribute to CPI variability, but their influence is relatively smaller.

The variability of labor force in the short-term and medium term are associated mainly with its own self, namely 86 percent in the medium term. The shocks to CPI, trade openness, interest rate and inflation have very small to cause fluctuations in the labor force.

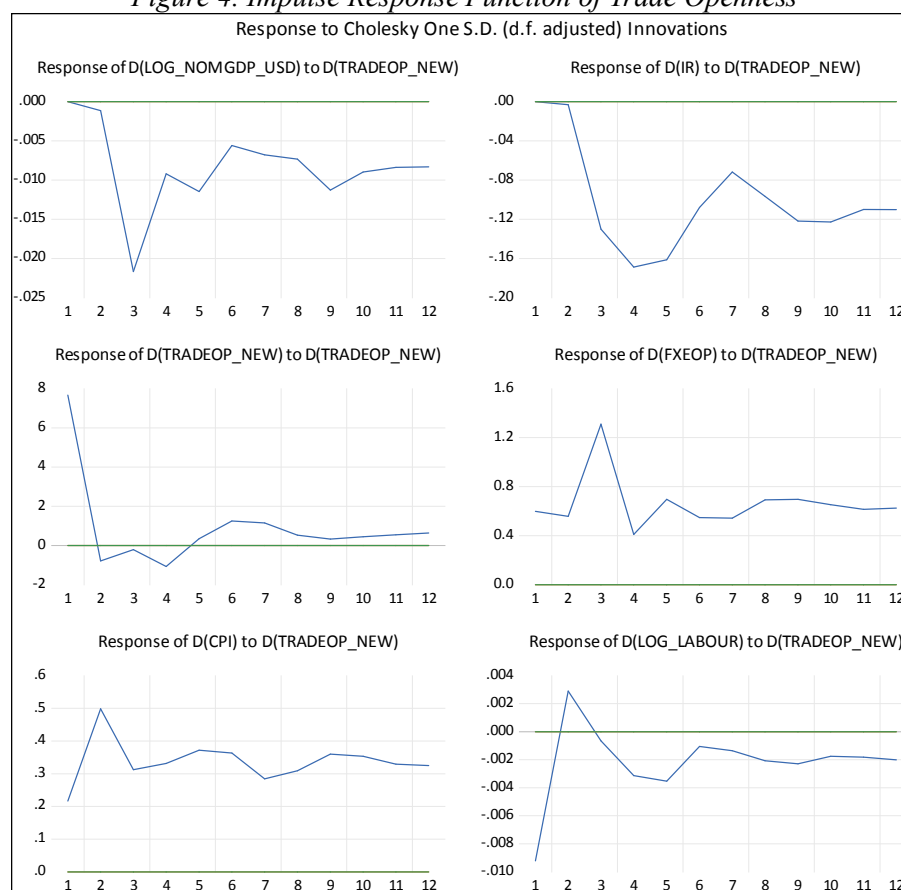
4.3. Impulse Response Function Analysis

The impulse response functions are used to analyze the dynamic interactions among endogenous variables. In vector error correction models, the impulse response functions are expressed through a vector autoregressive model where variables are expressed in their original values. In this example, orthogonal impulse response functions will be considered, where the innovation or shock amounts to one standard deviation in the transformed model. The functions are depicted for a time period of 12 quarters, or three years, to better assess the effect of shocks to Macedonian trade openness.

Dynamic movements of each variable in response to a one standard error shock in trade openness are analyzed using orthogonalized IRFs presented in Graph 4. The results suggest that shocks to trade openness lead to reduced economic growth, with a short-term output decline of 0.02 percent and a consistent long-term decrease of 0.01 percent. These results might suggest that increased trade openness initially leads to more imports than exports, negatively impacting the GDP.

Furthermore, shocks to trade openness will lead to an decrease in interest rate, that ranges between 0.12-0.16 percent. This could imply that increased trade openness is associated with increased capital inflows, which could lead to lower interest rates.

Shock to trade openness will lead to increase the inflation, initially by 0.5 percent and by 0.3 percent in the long term. A positive shock in trade openness might lead to inflationary pressures over time, which could reflect changes in import prices or the competitiveness. A one standard error shock to trade openness has a modest negative effect to labor force, suggesting that increased trade openness could initially lead to lower labor market performance. This could be due to factors like labor market adjustments to new trade conditions or increased competition from abroad.

Figure 4. Impulse Response Function of Trade Openness

Source: Author calculation

In summary, the analysis reveals that shocks to trade openness induce short-term declines in economic growth, a reduction in interest rates, an increase in inflation, and modest negative effects on the labor force, potentially attributed to factors such as adjustments in labor markets and heightened competition from foreign markets.

CONCLUSIONS

The relationship between trade openness and economic growth is complex, and the outcomes may vary based on various factors, including the country's institutional framework, policies, and the global economic environment. Besides international trade being a driving force in the world, it is also one of the primary mechanisms for spreading the negative implications, especially during crises. Different theoretical frameworks offer conflicting conclusions about the importance, direction, and strength of the relationship between trade openness and economic prosperity.

There are not many papers that explore the link between trade openness and economic growth in the Republic of North Macedonia and this paper fills the gap in the present literature by providing insights into the trade – growth nexus in the country.

The study's findings indicate a negative and significant relationship between trade openness and economic growth in North Macedonia. The findings suggest that shocks to trade openness result in decreased economic growth, with a short-term output decline of 0.02 per cent and a consistent long-term decrease of 0.01 per cent. The findings are in line with previous research on the adverse relationship between trade openness and economic growth (Belloumi and Alshehry 2020; Fenira 2015; Hye and Lau 2015; Rigobon and Rodrik 2005; Simorangkir 2008). The complexity of this relationship highlights an adverse impact on countries specializing in low-quality production or those with low levels of human capital accumulation, such as North Macedonia. Furthermore, the dynamic effects of shocks to trade openness on interest rates, consumer price index, interest rates, labour force, and exchange rate are investigated using impulse response functions.

The paper suggests that North Macedonia's trade strategy requires reorientation towards trade diversification, especially on services. The country's trade openness in services lags compared to the trade openness in merchandise trade. This reveals untapped potential in the services sector, especially in the digital trade era.

The tradable sector remains small for the size of the economy, not sufficiently diversified and internationalized, with a dominance of larger firms, and not appropriately innovative (Gligorov 2017). Therefore, the policies for attracting FDIs should continue to attract FDIs with an export-oriented focus that will lead to increased job creation, business sustainability, and a more diversified economy overall. The recent crisis stressed the need for greater dependence on renewable energy and further investment in this sector. Better-targeted public investment can also be part of the fiscal policy reforms. The reforms should predominantly focus on increasing productivity, achieving further production and export diversification, on higher value-added products, and a greater focus on the service sector and its export potential.

Also, the potential for intensified trade can be seen in the regional market of other Western Balkan countries (WB6). For that purpose, countries must eliminate non-tariff barriers to trade (NBTs): the differences in technical regulations, licenses and certificates, and other product compliances that increase costs and distort trade. Trade integration in the region can improve the living standards of the countries. This idea is envisaged in the action plan for regional initiatives such as creating a Common Regional Market (CRM) in trade investment, digital, and industrial and innovation areas. A country's ability to achieve greater trade diversification will depend on several factors, including competitiveness, investment, innovation, and education policies. Economic diversification is needed through a complex set of policy actions and strong high-level political support.

Further research can take into consideration the export quality and export variety as key dimensions of countries' integration in world trade, as well as alternative measures for measuring trade openness.

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IMPACT OF DIGITAL TRANSFORMATION ON ECONOMIC GROWTH

УТИЦАЈ ДИГИТАЛНЕ ТРАНСФОРМАЦИЈЕ НА ЕКОНОМСКИ РАСТ

Summary: We are living in a time of exciting, dynamic and fundamental technological changes. The expansion and development of new digital technologies leads to changes in all aspects of business, from strategic to operational. Digital transformation is the integration of digital technologies into the economy, public administration and society as a whole. Digital transformation is one of the main priorities of the European Union, which is already visible from the Lisbon Strategy and the adoption of the Digital Agendas. In this paper, our goal is to determine whether the progress of the European Union countries in the area of digital transformation, shown through the DESI index (digital economy and society index), has a positive impact on the economic growth of member states, measured by gross domestic product per capital.

Keywords: digital transformation, digital technologies, DESI index, GDP, European Union

JEL classification: O32, O33

Резиме: Живимо у времену узбудљивих, динамичних и темељних технолошких промјена. Ширење и развој нових дигиталних технологија доводи до промјена у свим аспектима пословања, од стратегијских до оперативних. Дигитална трансформација представља интеграцију дигиталних технологија у економију, јавну управу и друштво, у цјелини. Дигитална трансформација је један од главних приоритета Европске уније, што је видљиво још из Лисабонске стратегије, те доношењем Дигиталних агенди. У овом раду нам је циљ да утврдимо да ли напредак земаља Европске уније у подручју дигиталне трансформације, приказан кроз DESI индекс (индекс дигиталне економије и друштва) има позитиван утицај на економски раст држава чланица, мјерен бруто домаћим производом по глави становника.

Кључне речи: дигитална трансформација, дигиталне технологије, DESI индекс, БДП, Европска унија

ЈЕЛ класификација: O32, O33

INTRODUCTION

Rapid technological development led to the global digital transformation of society, which became especially pronounced after the COVID-19 pandemic. Encouraging the development of digital technologies has significant advantages, but it also entails adapting to the challenges of the digital transition, ensuring a fair, open and secure digital environment and privacy protection. To secure digital sovereignty and strengthen capacities in digital technologies, the European Union adopted several strategies and agendas to maintain competitiveness with the US and Japanese economies.

Since 2014, the European Commission has been publishing data on the Digital Economy and Society Index (DESI), which monitors the member states' progress in digitization. This Index has been calculated since 2021. For the Western Balkans countries, including Bosnia and Herzegovina. However, data for all subdimensions for 2021 were not available for our country.

The subject of the paper is the impact of digital transformation on economic growth. The goal is to determine if there exists a link between the Digital Economy and Society Index and economic growth, i.e. whether an increase in the value of individual components of the Index affects an increase in the gross domestic product.

Primary and secondary data sources were used for the purposes of the paper. The paper analyzed the data of individual components of the Index and gross domestic product per capita of 27 member states of the European Union (excluding Great Britain) from 2016 to 2021. A balanced panel model was defined based on the data, and the Eviews program was used for analysis.

The paper is divided into four chapters. The subject and goal, reference and methods of data collection, and the structure of the paper are presented in the introduction.

The second chapter refers to digital transformation, its stages, the development of digital transformation in Europe, the Western Balkans and Bosnia and Herzegovina, and the Digital Economy and Society Index.

The third chapter deals with the results of previous studies, the analysis of the DESI index of the European Union countries, and the presentation and analysis of the obtained results.

The fourth chapter refers to study conclusions and recommendations for future research related to this or a similar topic.

1. DIGITAL TRANSFORMATION

Digital transformation refers to the intensive application of digital technology and resources to turn these resources into new revenues, business models and ways of doing business. Transformation occurs when a company decides in a relatively short time to fundamentally change its business processes, strategies, activities, and hierarchical and organizational structure, aiming to properly connect those processes and strategies and ultimately provide a better competitive advantage to the company on the market (Spremić 2017).

Digital transformation in business involves using new technologies such as artificial intelligence and cloud computing to drive growth, simplify operations and increase competitive advantage. Its influence can be seen in every industry, driven by the development of online business and the ongoing digitization of business and society (Marr 2023).

1.1. Digital Transformation Phases

Digital changes have three phases: digitization, digitalization and digital transformation. Digitization is the encoding of analogue information into a digital format so that computers can store, process and transmit it (Verhoef et al, 2021). Digitization creates digital versions of analogue/physical things such as paper documents, photos, sounds, etc., but does not add value to the business.

Digitalization is the use of digital technologies to change existing business processes. Companies apply digital technologies through digitalization to optimize existing business processes by enabling more efficient coordination between processes and/or creating additional user value by improving the user experience (Verhoef et al. 2021).

Digital transformation is a deep and accelerated transformation of business activities, processes, competencies and models to fully utilize the possibilities of digital technologies and their impact on society in a strategic and prioritized manner (i-scoop 2023)

New trends in digital transformation are implantable technologies, wearable internet, internet of things (IoT), smart cities, big data, robotics, driverless cars, blockchain, sharing economy, and 3D printing (Pihir et al. 2018).

Implementing new digital technologies leads to new development trends called Industry 4.0 or the fourth industrial revolution. Industry 4.0 is primarily defined as the intelligent networking of machines and processes for industry with the help of information and communication technology (i-scoop 2023)

The World Trade Organization highlights the following trends and technologies of Industry 4.0: the Internet of Things (IoT), big data analytics, 3D printing, advanced (autonomous) robotics, smart sensors, augmented reality, cloud computing, energy storage, artificial intelligence, nanotechnology, synthetic biology, simulation, human-machine interface, mobile devices, cyber security, quantum computing, and horizontal and vertical integration (Ferrantino et al. 2019).

1.2. The development of digital transformation in Europe

At the meeting of the European Council in Lisbon in 2000, the Lisbon Strategy was adopted, with a common strategic goal for the European Union to become the most competitive and dynamic economy in the world based on knowledge, capable of sustainable economic growth, with more and better jobs, stronger social cohesion, and a sustainable environment by 2010 (European Parliament 2019). The strategy was a response to the progress of the US and Japanese economies, especially in terms of "knowledge" and dominance in information and communication technologies.

Following the Lisbon Strategy, the ten-year Digital Agenda was published in 2010. It emphasized information and communication technologies' crucial role in achieving European goals. The digital agenda was further developed in 2015 as part of the Single Digital Market Strategy, which aimed to ensure a fair, open and secure digital environment.

The second Digital Agenda for Europe 2020-2030 focused on the profound changes introduced by digital technologies, the essential role of digital services and markets and the EU's new technological and geopolitical ambitions (Ratcliff et al. 2023). Measures for secure digital services and markets are defined, and a digital compass is proposed with four goals relating to skills, enterprises, infrastructure and public services.

The European Union adopted a number of legislative acts, regulations and directives to implement the measures and goals defined in the Strategies and Agendas.

1.3. Digital transformation and the Western Balkans countries

Considering the global importance of digital transformation and the realization of set goals, and the need to strengthen cooperation within the entire European area, the Digital Agenda for the Western Balkans was launched at the digital assembly of the European Commission in Sofia in 2018. Its goal is to support the transition to a digital economy and realise the benefits of digital transformation, such as faster economic growth, more employees and better services. The Commission launched the Agenda with six Western Balkan partners – Albania, Bosnia and Herzegovina, Kosovo¹, Montenegro, the Former Yugoslav Republic of Macedonia and Serbia (EU u Srbiji 2024).

Developing countries, including the countries of the Western Balkans, face three major challenges in promoting and implementing digital technologies:

1. poverty – having no financial means to afford new products and services;
2. lack of skills – basic and standard skills in developing countries are by 10% up

20% lower compared to developed countries, while advanced technologies require digital skills, the ability to understand digital media, find information, and the like;

3. digital differences – advanced technologies require stable and fast fixed internet connections, which represents a significant deficiency in developing countries, bearing in mind that almost half of the world's population still does not have access to the network (UNCTAD 2021)

In November 2023, the European Commission adopted the Growth Plan for the Western Balkans, whose goals, among others, are to strengthen economic integration through a common regional market and with the joint European market, as well as an increase in 6 billion euros financial aid to support reforms. The growth plan should enable faster convergence of the Western Balkans with the European market, i.e. increase the average GDP per inhabitant. One of the strengthening activities with European integration is a single digital market, which undoubtedly points to further activities of the countries of the Western Balkans regarding the need for fast and efficient digital transformation.

1.4. Digital transformation and Bosnia and Herzegovina

The Council of Ministers of Bosnia and Herzegovina adopted the Information Society Development Policy of Bosnia and Herzegovina for the period 2017-2021, whose main goal is to plan activities to maximize the social and economic potential of ICT, especially the Internet as a significant means of economic and social activity.

Adoption of this Policy and the Policy of Information Security Management in the Institutions of Bosnia and Herzegovina, for the period 2017 - 2022, Bosnia and Herzegovina has defined its strategic commitment regarding the development of the information society and the improvement of information security in its territory.

Considering the complexity of the state regulation and jurisdiction, the implementation of the adopted documents is sluggish and significantly slows down the digitization process and the electronic business of companies. In addition, it is necessary to adopt several other strategic documents, such as the strategy for the development of the information society, the strategy for the development of broadband Internet access, and the like, which is very important for the further progress of the state in the field of digital transformation..

¹ According to United Nations Security Council Resolution 1244

1.5. DESI index

Since 2014, the European Commission has been monitoring the digital progress of member states through the Digital Economy and Society Index (DESI) report, which summarizes indicators of Europe's success in the field of digitization and monitors the progress of EU member states. DESI was developed following OECD guidelines and recommendations.

DESI enables four main types of analysis:

- General performance assessment: to obtain a general characterization of the performance of individual member states by observing their overall index score and the scores of the main dimensions of the index.

- Zooming: to specify the areas in which the performance of Member States can be improved by analyzing the results of sub-dimensions of the index and individual indicators.

- Monitoring: to assess whether there is improvement over time.

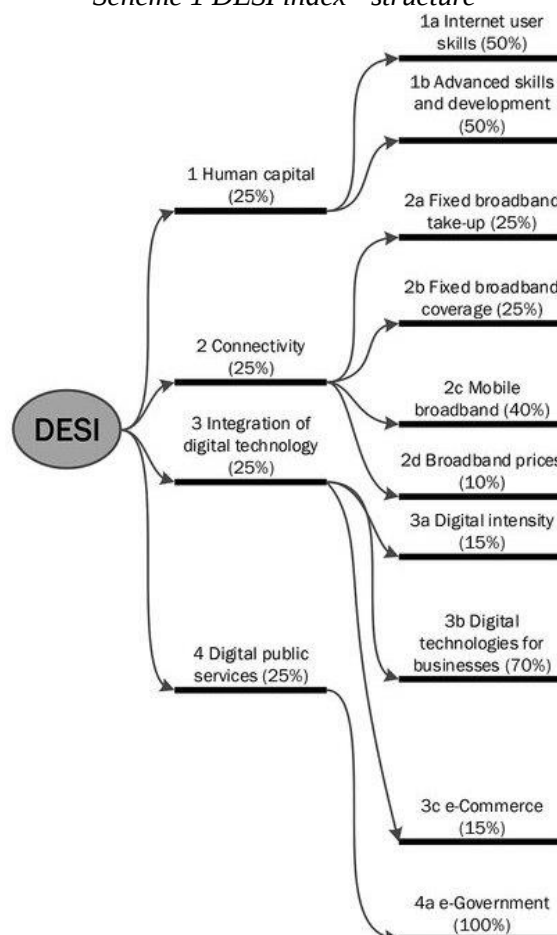
- Comparative analysis: grouping member states according to their index results, comparing countries at similar stages of digital development in order to highlight the need for improvement in relevant policy areas.

The DESI index has a three-layer structure and, according to the original methodology, it consisted of five main dimensions, each divided into a set of sub-dimensions composed of individual indicators. The main dimensions were: connectivity, digital skills, internet use, integration of digital technologies and public digital services.

In 2021, the Commission adapted DESI to reflect the two main policy initiatives that will have an impact on the digital transformation in the EU in the coming years: recovery and resilience, facility and digital decadal compass. The indicators are structured around four main areas in the Digital Compass, replacing the previous five-dimensional structure. (Picture 1)

DESI scores and rankings from previous years have been recalculated for all countries to reflect changes in indicator selection and corrections to baseline data have been made (European Commission 2024).

Scheme 1 DESI index - structure



Source: Machunga 2023

2. METHODOLOGY

This paper examines whether there is a relationship between the DESI index and economic growth. Therefore, the hypothesis is: An increase in the value of the components of the Digital Economy and Society Index leads to economic growth, i.e. an increase in the gross domestic product per capita in the European Union. Based on the obtained data, we could define recommendations for the direction of the legislation and the economy of Bosnia and Herzegovina regarding digital transformation.

2.1. Previous studies results

Olczyk and Kuc-Czarnecka analyzed the influence of the DESI index on GDP per capita from 2015 to 2020, concluding that economic growth, measured by GDP per capita, can be well explained by both the original and optimized DESI. They believe their results are important to policymakers for measuring, supporting and heightening digital transformation. These results reveal that for immediate and rapid analyses of the development of digital transformation or some international comparisons in this area, it is appropriate to consider only a few indicators, such as broadband Internet coverage (fixed, high-speed, 4G), the level of software skills and the percentage of companies analyzing big data and sell products and services online. These indicators are the most significant from the point of view of the level of digital transformation (Olczyk et al, 2022).

Ovidiu Mura and Donath determined the positive impact of digitization on economic growth in the EU-28, i.e. on GDP per capita, while including the DESI index as an independent variable only confirmed this positive impact (Mura 2023). Turuk examined the impact of DESI index components on GDP per capita in Central and Eastern European countries and found that the Connectivity and Human Capital components have no significant impact, while the Internet Use, Digital Technology Integration, and Digital Public Services components have a significant impact (Turuk 2020).

Examining the impact of digital evolution on economic growth using the International Digital Economy and Society Index (I-DESI), Török concluded that digital development has a positive effect on economic growth. However, digitalization cannot be successful without a correspondingly qualified user base. That is, digital education and training must be a priority to achieve an adequate digital transformation, above all in the wishes of the EU members lagging in the digital transition (Török 2024).

Similarly to the previous study, Aleksandrova, Truntsevsky and Polutova concluded that the positive impact of digital transformation on economic growth is possible only if the economic environment is prepared to accept such a transformation. An important part is the willingness of companies and the population to accept such changes. Three aspects should be taken into account to develop effective digitalization: the rate of economic growth, the state of digital life and the resilience of the environment (Aleksandrova et al. 2022). Examining the impact of broadband access on GDP per capita in a sample of 57 countries for the period from 2001 to 2016, Kabaklari and Atasoy noticed a positive impact, too. Nevertheless, their study also included the control variables in the analysis, i.e. human capital, openness of the economy to trade and gross investments in fixed capital. They also determined that these components have a positive effect on economic growth (Kabaklari et al. 2019). Zhang found that broadband Internet access was important in mitigating China's economic losses during the first months of 2020 and had a more significant impact on economic growth during the COVID-19 pandemic than in "normal" times (Zhang 2021).

In the study, Clerq et al. evaluated the regional, i.e. urban-rural, effects of high-speed broadband coverage in 1348 regions of the EU in the period 2011-2018. They concluded that the expansion of lower-speed access (30Mbit/s) accelerates economic growth in rural and urban areas, and the expansion of higher-speed access (30Mbit/s to 100Mbit/s) impacts rural areas. However, they noticed a lack of private capital investment for the necessary network expansion. Hence, the recommendation would be a public-private partnership and state aid (Clerq et al. 2023).

The need for state intervention was highlighted by Campbell et al., stating that since 1996, the Federal Government has been participating in the financing of network construction in sparsely populated areas, given that the return on investment is not sufficient to cover the expenses. Participation is present in the funds' formation through grants, imposition through auctions and the like (Campbell et al, 2021).

Therefore, there are many prior studies that have determined the positive impact of the development of digital technologies on economic growth, and their importance, readiness and necessary knowledge in their use, as well as the development of broadband infrastructure, were particularly highlighted during the pandemic. However, there is a gap in the development level, application and investment in digitization in developed and developing countries.

2.2. Variables explanation and data analysis

The paper used data on the values of individual components of the DESI index, namely DESI 2017-DESI 2022 and gross domestic product per capita for 2016-2021, considering that the calculated DESI index represents indicators for the previous year. Data on the recalculation of the DESI index according to the new methodology are available on <http://www.eurostat.com/> for all of the European Union. Based on that, a balanced panel model was defined, with data for 27 member countries (except Great Britain) for a six-year period.

The Eviews program was used for the analysis, with the following meaning of variable abbreviations: dependent variable - GDP - grosses domestic product per capita, and independent variables: HC - Human capital, CON01 - Connectivity, IDT - Integration of digital technologies, DPS - Digital public services.

The Jarque-Bera test, i.e. the data normality distribution test, was done before the data analysis, indicating no normal data distribution, so logarithmic transformation was performed.

After that, a VIF (Variance Inflation Factor) test was performed to determine whether there is a problem of multicollinearity in the data, i.e. whether any of the independent variables are strongly related to other independent variables, which could affect the estimation of the parameter values, their significance, and direction of influence on the dependent variable.

Table 1 VIF (Variance Inflation Factor) test

Variance Inflation Factors
Date: 02/09/24 Time: 22:59
Sample: 2016 2021
Included observations: 162

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LCON01	0.010580	57.23124	1.395226
LDPS	0.015692	120.3268	2.610551
LHC	0.072051	468.1284	3.419948
LIDT	0.021555	92.42534	3.400701
C	0.196508	217.6022	NA

Source: author's calculation

The value of the Centered VIF for all independent variables is less than 10, so there is no problem of multicollinearity, i.e. no independent variable is in a strong linear relationship with other independent variables, and i.e. it is a weak correlation.

After that, all three models follow - the constant coefficients, the fixed effects and the random effects model.

Table 2 The constant coefficients model

Dependent Variable: LBDP
Method: Panel Least Squares
Date: 02/09/24 Time: 23:00
Sample: 2016 2021
Periods included: 6
Cross-sections included: 27
Total panel (balanced) observations: 162

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCON01	-0.021083	0.102858	-0.204976	0.8379
LDPS	-0.134722	0.125268	-1.075469	0.2838
LHC	1.641566	0.268423	6.115595	0.0000
LIDT	0.519538	0.146815	3.538737	0.0005
C	5.579100	0.443292	12.58560	0.0000

Source: author's calculation

Table 3 The fixed effects model

Dependent Variable: LBDP
 Method: Panel Least Squares
 Date: 02/09/24 Time: 23:01
 Sample: 2016 2021
 Periods included: 6
 Cross-sections included: 27
 Total panel (balanced) observations: 162

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCON01	-0.062635	0.032046	-1.954540	0.0528
LDPS	0.354806	0.071949	4.931324	0.0000
LHC	0.328176	0.191653	1.712347	0.0892
LIDT	0.117187	0.067673	1.731658	0.0857
C	8.342469	0.376860	22.13677	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Source: author's calculation

Table 4 The random effects model

Dependent Variable: LBDP
 Method: Panel EGLS (Cross-section random effects)
 Date: 02/09/24 Time: 23:03
 Sample: 2016 2021
 Periods included: 6
 Cross-sections included: 27
 Total panel (balanced) observations: 162
 Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCON01	-0.077896	0.031323	-2.486836	0.0139
LDPS	0.330550	0.070208	4.708130	0.0000
LHC	0.531741	0.180161	2.951476	0.0036
LIDT	0.122568	0.066414	1.845513	0.0668
C	7.937243	0.359434	22.08259	0.0000

Source: author's calculation

Given that the constant coefficients model assumes there are no differences between the data matrix in the cross-sectional dimension, the Lagrange Multiplier Test was performed for the random effects model.

Table 5 LM (Lagrange Multiplier)

Lagrange Multiplier Tests for Random Effects
 Null hypotheses: No effects
 Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	357.3975 (0.0000)	0.141865 (0.7064)	357.5393 (0.0000)

Source: author's calculation

The Breusch-Pagan test shows a p-value less than 0.05, indicating there are random effects, i.e. the model of constant coefficients is inadequate. Thus, the Hausman test was performed to determine which model is more satisfactory, the random or fixed effects one.

Table 6 Hausman test

Correlated Random Effects - Hausman Test
 Equation: EQ01
 Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	15.456791	4	0.0038

Source: author's calculation

Given that the p-value is less than 0.05, we reject the null hypothesis, i.e. the fixed effects model is more adequate, so its data are used for the interpretation of the results.

In the fixed effects model, the statistically significant variable, at the 1% level, is Digital Public Services, with a positive effect. At the 5% level, the statistically significant variable is Connection, with a negative effect. At the 10% level, statistically significant variables are Human capital and Integration of digital technologies with a positive effect.

Therefore, if the value of the Digital Public Service component increases by 1%, the gross domestic product per capita will increase by 0.35%. If the value of the Connectivity component increases by 1%, the gross domestic product per capita will decrease by 0.06%. If the value of the Human Capital and Integration of Digital Technologies components increases by 1%, the gross domestic product per capita will increase by 0.32% and 0.11%, respectively.

The conducted analysis confirmed the hypothesis that an increase in the value of the Digital Economy and Society Index leads to economic growth. The three components of the Index, Digital Public Services, Human Capital and Integration of Digital Technologies show a positive impact, where the impact of Digital Public Services stands out as statistically significant.

The negative impact of Connectivity contradicts the findings of previous studies, so this result should be additionally investigated. Further research should be aimed at examining whether an increase in the individual values of the subdimensions of the DESI index components, such as skills of internet users, fixed broadband internet access - coverage, business digitization or e-governance affect economic growth. At the same time, considering the unequal development of the countries of the European Union, the tests could be directed separately to developed countries, developing countries, and especially to countries that are in the accession process, to determine their shortcomings and weaknesses.

CONCLUSION

Digital transformation and digitization have become inevitable processes in all social aspects. Digital technologies occupy a central place in defining business strategies, but they also bring innovations, opportunities for growth and development, and easier communication with business partners and the world.

The paper examined the impact of digital transformation on economic growth, and analyzed the impact of individual components of the Digital Economy and Society Index (DESI), as an indicator of Europe's success in the field of digitalization, on the increase in gross domestic product per capita, as an indicator of economic growth. The DESI index has been calculated for the countries of the European Union since 2014, and it was calculated for the countries of the Western Balkans for 2021 and 2022. The report also included Bosnia and Herzegovina, with the fact that data was not available for all sub-dimensions for 2021.

Based on the results of the panel analysis, it was specified that the components of Digital Public Services, Human Capital and Integration of Digital Technologies have a positive effect on economic growth, while Connectivity has a slightly negative effect. Further research should focus on analyzing the impact of the sub-dimensions of each component of the index, as we would get more detailed and precise data for individual areas, such as the level of digital skills, use of Internet access, coverage, e-business, digitalization of enterprises and the like.

Certainly, the further legislation of Bosnia and Herzegovina should be aimed at adopting adequate strategies and action plans with a clear definition of development directions in the field of digitization and digital transformation. In addition, the active participation of the economy and individuals is necessary to ensure the required competitiveness and follow existing trends.

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THE PERCEPTION OF SUSTAINABILITY COMPETENCES IN LOGISTICS AND SUPPLY CHAINS

ПЕРЦЕПЦИЈА ОДРЖИВОСТИ КОМПЕТЕНЦИЈА У ЛОГИСТИЦИ И ЛАНЦИМА СНАБДЕВАЊА

Summery: *The European Union (EU) has adopted a huge number of guidelines and policies to promote sustainability in different sectors. The study focuses on the twin green and digital transformation, which is particularly highlighted in the context of the European Green Deal, a comprehensive strategy to tackle climate change and environmental degradation while embracing digital innovation for economic growth and societal progress. These guidelines and policies show the EU's commitment to promoting sustainability in different sectors and to achieving the objectives of climate change, environmental protection and sustainable development. One of the areas that plays an important role for the individuals as well as for the economy is logistics and supply chain management. The main research question of this study is to investigate the relationship between the basic sociodemographic characteristics and their perception of the importance of sustainability competences in logistics and supply chains in the future. The study was carried using survey questionnaire on employees in the field of logistics and supply chains in Slovenia. The results show the main statistically significant differences in these perceptions are primary based on differences in employees demographic characteristics, such as gender, age and level of education of the employees.*

Keywords: Sustainable competences, Sustainability, Environmental impact, Corporate social responsibility

JEL Classification: Q56, M14, L91, D23

Резиме: Европска унија (ЕУ) усвојила је низ смерница и политика за промовисање одрживости у различитим секторима. Студија се фокусира на двоструку зелену и дигиталну трансформацију, која је посебно наглашена у контексту Европског зеленог договора, свеобухватне стратегије за борбу против климатских промена и деградације животне средине уз истовремено прихватање дигиталних иновација за економски раст и напредак друштва. Ове смернице и политике показују посвећеност ЕУ промовисању одрживости у различитим секторима и постизању циљева климатских промена, заштите животне средине и одрживог развоја. Једна од области која игра важну улогу како за појединце, тако и за привреду је логистика и управљање ланцем снабдевања. Главно истраживачко питање ове студије је да се истражи однос између основних социјалнодемографских карактеристика и њихове перцепције значаја компетенција одрживости у логistici и ланцима снабдевања у будућности. Студија је спроведена коришћењем анкетног упитника о запосленима у области логистике и ланца снабдевања у Словенији. Резултати показују да су главне статистички значајне разлике у овим перцепцијама примарно засноване на разликама у демографским карактеристикама запослених, као што су пол, старост и степен образовања запослених.

Кључне ријечи: одрживе компетенције, одрживост, утицај на животну средину, корпоративна друштвена одговорност

ЈЕЛ класификација: Q56, M14, L91, D23

INTRODUCTION

Europe has to become the world's first climate-neutral continent under the EU's climate law. As part of this, the European Union wants to prepare all sectors of the economy for the challenge, starting by reducing emissions by at least 55% by the end of this decade. The "Fit for 55" legislation puts the European Union on track to meet its climate targets by 2030. In doing so, Europe aims to shape the green transition for the benefit of citizens and industry (European Commission 2023).

The European Union has also developed The European sustainability competence framework. The development of a European sustainability competence framework is one of the policy actions set out in the European Green Deal as a catalyst to promote learning for environmental sustainability in the European Union. GreenComp defines a set of sustainability competences to be used in educational programmes to help learners develop knowledge, skills and attitudes that promote ways of thinking, planning and acting with empathy, responsibility and care for our planet and public health (Joint Research Centre 2022a).

In the context of the EU directives, it is important to mention the green and digital transition in the field of logistics and supply chain management, with the help of technology such as digital twins, virtual equivalents of the real world, which can, among other things, model traffic in order to optimise traffic flows, reduce congestion and, at the same time, reduce emissions. To make the most of the transition, it will require proactive and integrative management. It will require the cooperation of business, government and civil society (Joint Research Centre 2022b).

To cross these bridges between the sustainable and the digital, it is important having the right skills to do so. Competencies are a combination of elements such as knowledge, skills, abilities, capabilities and resources. In supply chain management (SCM), competence is a key factor for achieving superior performance and competitiveness. Research has shown that supply chain competencies lead to improved performance both operationally and financially (Derwik and Hellström 2017).

The purpose of this research is to identify the perception of employees in Slovenian companies operating in the field of logistics and supply chain management regarding the importance of sustainability competences in the future. The main research question addressed in this study is: Are there statistically significant differences in the perception of the importance of sustainable competences in the future regarding to the socio-demographic characteristics of employees in logistics and supply chain management?

1. THEORETICAL FRAMEWORK

1.1 Sustainable competences

Sustainability means different things to different people at different times. Often, sustainability and sustainable development are used interchangeably, despite their conceptual differences. Sustainability can be described as a long-term goal, such as achieving a more sustainable world, while sustainable development, as the word suggests, refers to the many processes and pathways used to promote development or achieve progress in a sustainable way.

Sustainability means prioritising the needs of all life forms and the planet by ensuring that human activities do not exceed planetary boundaries.

Sustainability competence is about enabling learners to embody sustainable values and to consider complex systems in order to take or demand action that restores and maintains ecosystem health and enhances equity, and to create visions for a sustainable future (Joint Research Centre 2022a),

The key competences for sustainable development identified by UNESCO are: systems thinking, foresight, normative and strategic competence, collaboration, critical thinking, self-awareness and integrated problem-solving (Norren and Beehner 2021).

The United Nations has defined sustainability competences in three groups: core values, core competences and managerial competences. Core values include: integrity, professionalism, respect for diversity. Core competences include: communication, teamwork, planning and organising, accountability, creativity, customer orientation, commitment to continuous learning, technological

awareness. Managerial competences include: leadership, vision, empowering others, building trust, performance management, judgement/decision making (United Nations 2010).

The European Union defined sustainability competences are divided into four groups, which are: embodying sustainability values, embracing complexity in sustainability, envisioning a sustainable future in acting for sustainability. Embodying the values of sustainability includes the competences: valuing sustainability, supporting fairness and promoting nature. Embracing integrity in sustainability includes the competences: systems thinking, critical thinking and problem framing. Envisaging sustainable futures includes the competences: future literacy, adaptability and exploratory thinking. The acting for sustainability competences are: political agency, collective action and individual initiative (Joint Research Centre 2022a).

1.2 Sustainable competences in logistics and supply chain management

Supply chain management and logistics activities have a number of positive impacts on society in terms of mobility and accessibility, infrastructure, employment, etc. On the other hand, they have a negative impact on the environment, as they depend on fossil fuels and non-renewable natural resources, which have a negative impact on the health and safety of the population, causing air pollution, congestion, accidents, etc. (Abbasi and Nilsson, 2016).

Due to the high impact of supply chain management and logistics on environmental standards, the focus is on improving the performance of supply chain management and logistics in relation to environmental impact. Sustainable competitive advantage is based on a combination of efficient and effective logistics operations and well-functioning, customised and in-company developed information systems (Sandberg and Abrahamsson 2011).

In the field of logistics and supply chain management, the most frequently identified sustainability competences are: systems thinking competence; communication skills; cross-functional team working, stakeholder management – communication, supplier relationship management – communication, functional-oriented competences, source-to-contract, demand management – category strategy, demand management – tender analysis; supplier relationship management – application of tools, sustainability and compliance, basic individual knowledge on this field, basic sustainability knowledge; commitment to change; self-reflection (Schulze et al. 2018).

1.3 Socio-demographic characteristics and sustainable behaviour

There are many studies on sustainable behaviour that have examined socio-demographic characteristics to profile sustainable consumers by gender, age and education level.

More than 30 years ago, studies did not show statistical correlations between sustainable consumers and gender. However, new studies on gender show that women are more likely than men to be environmentally conscious (Park et al. 2011; Mohr and Schlich 2015; Panzone et al. 2016; Santos et al. 2022).

In terms of age, most studies show that young or middle-aged people are more socially responsible consumers, but the results are mixed. Some results have shown a significant and positive correlation between age and green sensitivity and behaviour, while others have shown a significant and negative correlation - green consumers are older than average (Park et al., 2011). Mohr and Schlich (2015) found that middle-aged consumers are more likely to adopt sustainable food purchasing patterns. A study by Panzone et al. (2016) shows that younger consumers are more concerned about the environment, but older consumers have higher scores for green consumer behaviour.

With regard to education, research shows that education is related to sustainable consumer attitudes and behaviour. There is a positive relationship between education and sustainable consumer behaviour (Park et al. 2011). Alborzi et al. (2017) studied sustainable behaviour in terms of washing clothes in households and found that households with lower levels of education show more unsustainable behaviour than the group of households with university education. Similarly, in a food study, consumers with higher levels of education were more likely to adopt sustainable consumption behaviours (Mohr and Schlich 2015). That university education predicts greater environmental concern, while postgraduate education is negatively associated with preferences for sustainability from a food perspective, is also shown in a study by Panzone et al. (2016).

In the view of previous studies related to socio-demographic data and our survey, the following hypotheses in this study are set:

H1: There are statistically significant differences in the perception of the importance of sustainable competences in logistics and supply chain management in the future, depending on the gender of the respondents.

H2: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the age group of the respondents.

H3: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the level of education of the respondents.

H4: There are statistically significant differences in the perception of the importance of sustainable competences in logistics and supply chain management in the future, depending on whether or not respondents have a formal education in logistics and supply chain management.

H5: The perception of the importance of sustainable competences in logistics and supply chain management in the future does not differ according to the size of the company where the respondents are employed.

H6: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the sector in which the respondents' company operates.

2. METHODS

In the research, the perception of the employees working in companies operating in logistics and supply chains in Slovenia on the importance of sustainability competences in logistics and supply chains in the future was investigated.

A survey questionnaire was developed. The first part included socio-demographic data such as: gender, age, level of education, logistics and supply chain education, size of the company, sector the company is part of. The second part of the questionnaire consisted of 22 listed sustainability competences from the field of logistics and supply chains, which respondents rated on a Likert scale from 1 (not at all important) to 5 (very important) how important they think the listed competences will be in the future. The sustainability competences listed in the questionnaire were obtained from scientific articles related to sustainability competences in logistics and supply chain management, as well as from the European Union and the United Nations Sustainability Competences Guidelines (Giangrande, 2019; Norren and Beehner, 2021; Vuorikari et al., 2022). The survey questionnaire was sent to employees of companies working in logistics and supply chain management and it was carried out between January and August 2023. A total of 617 respondents completed the survey.

The results of the questionnaire were analysed using the SPSS software platform for advanced statistical analysis. The statistical test of reliability was 0.90, indicating a very high level of consistency between the items on the scale (Table 1). Kolmogorov-Smirnov test of normality show statically significance. However, due to enough size of the sample, in the following parametric t-test for independent samples and ANOVA for independent samples were used to validate the hypotheses.

Table 1 Statistical reliability test - Cronbach's alpha

Cronbach's Alpha	N of Items
0,9	22

Source: Own source

3. RESULTS AND DISCUSSION

In the following lines, results of the survey are presented. Table 2 shows socio-demographic data related to gender, age, educational level, education related to logistics and supply chains, size of the company and the sector to which the organisation works (Table 2).

Of the 617 respondents, the majority were male (53%), followed by female (46%) and 1% identified as other. The average age of respondents was 43.5 years. The youngest respondent was 18 years old and the oldest 65 years old. By age group, the highest number of respondents were aged between 41 and 50 (41%) and the lowest number were aged between 18 and 30 (8%). In terms of highest level of education completed, the highest proportion of respondents had completed vocational secondary education (26%). It can be seen that 70% of them have completed at least secondary education or more. Most respondents have qualifications in logistics, transport and business, economics (57%). The smallest share of respondents (8%) has a qualification in a completely different field. Two thirds of respondents (69%) work in small or medium-sized enterprises. This was also the aim of the research, to cover an equal share of small, medium-sized and large enterprises.

Most of the respondents' companies are in the freight forwarding, transport, logistics services sector (37%). These companies were also the target group of the research. This is followed by respondents from the retail trade, wholesale sector, where there is also a lot of logistics and supply chain management present.

Table 2 Socio-demographic data

Gender	Frequency	Valid Percent (%)
Female	281	45,5
Male	329	53,3
Other	7	1,1
<i>Total</i>	<i>617</i>	<i>100,0</i>
Age by group	Frequency	Valid Percent (%)
From 18 to 30 years	47	7,7
From 31 to 40 years	175	28,8
From 41 to 50 years	251	41,4
From 51 to 65 years	134	22,1
<i>Total</i>	<i>607</i>	<i>100,0</i>
Highest completed education	Frequency	Valid Percent (%)
Primary school	4	0,7
Vocational secondary education	162	26,3
Higher education	131	21,2
Technical degree or 1st Bologna degree	116	18,9
Master degree or 2st Bologna degree	102	16,6
Master of Science	88	14,3
PhD	12	2,0
<i>Total</i>	<i>615</i>	<i>100,0</i>
Educated (regardless of level) in which of the listed fields	Frequency	Valid Percent (%)
Yes; logistics, transport	165	26,7
Yes; business, economics	186	30,2
Yes; other social sciences	64	10,4
Yes; engineering (e.g. mechanical engineering, computer science)	152	24,6
I have no formal education in the above fields	41	6,6
Other	9	1,5
<i>Total</i>	<i>617</i>	<i>100,0</i>
Number	Frequency	Valid Percent (%)
Micro - 10 employees or less	33	5,4
Small - between 11 and 50 employees	207	33,8
Medium - between 51 and 250 employees	218	35,6
Large - over 250 employees	154	25,2
<i>Total</i>	<i>612</i>	<i>100,0</i>
The sector in which the organisation works	Frequency	Valid Percent (%)
Education/research	20	3,3
Non-governmental, non-profit organisation	5	0,8
Service activity	71	11,6
Craft activity (e.g. hairdresser, metal worker, electrician, etc.)	28	4,6
Public sector (e.g. municipal administration, ministries, administrative units, etc.)	17	2,8
Freight forwarding, transport, logistics services	225	36,7
Manufacturing	79	12,9
Retail trade, wholesale	168	27,4
<i>Total</i>	<i>613</i>	<i>100,0</i>

Source: Own source

The first hypothesis was tested using t-test for independent samples (Table 3), comparing female and male gender variables and statistically significant differences between perceptions of sustainable competences in the future.

Table 3 Perception of sustainable competences according to female and male gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean	t-value	p
Sustainable competences	Female	239	4,3395	0,37501	0,02426	0.224	0.823
	Male	299	4,3322	0,37647	0,02177		

Source: Own source

The first hypothesis was: There are statistically significant differences in the perception of the importance of sustainable competences in logistics and supply chain management in the future, depending on the gender of the respondents. The results show that there are no statistically significant differences between female and male genders in their perception of the importance of sustainable competences in logistics and supply chains in the future.

The second hypothesis was tested by ANOVA test. It was investigated whether there are statistically significant differences in the perception of future sustainable competences in logistics and supply chain management according to age (Table 4).

Table 4 Perception of sustainability competences by age group

Sustainable competences						
	N	Mean	Std. Deviation	Std. Error	F	Sig.
From 18 to 30 years	43	4,2431	0,33999	0,05185	2,594	0,052
From 31 to 40 years	154	4,2919	0,39232	0,03161		
From 41 to 50 years	220	4,3692	0,36322	0,02449		
From 51 to 65 years	119	4,3739	0,37611	0,03448		
Total	536	4,3379	0,37459	0,01618		

Source: Own source

The second hypothesis was: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the age group of the respondents.

The results show that there are also no statistically significant differences between the different age groups in their perception of the importance of sustainability competences in logistics and supply chain management in the future.

The third hypothesis relates to statistically significant differences in the perception of future sustainable competences in the field of logistics and supply chain management according to the level of education of the respondents (Table 5).

Table 5 Perception of sustainability competences by education

Sustainable competences						
	N	Mean	Std. Deviation	Std. Error	F	Sig.
Primary school	3	4,6212	0,33505	0,19344	1,898	0,079
Vocational secondary education	139	4,2652	0,38773	0,03289		
Higher education	115	4,3877	0,29169	0,02720		
Technical degree or 1st Bologna degree	107	4,3161	0,43814	0,04236		
Master degree or 2st Bologna degree	86	4,3298	0,42292	0,04560		
Master of Science	81	4,3906	0,26754	0,02973		
Doctor of Science	10	4,4091	0,53182	0,16817		
Total	541	4,3350	0,37536	0,01614		

Source: Own source

The third hypothesis was: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the level of education of the respondents.

The results show that there were no statistically significant differences in the perception of sustainability competences in logistics and supply chain management according to the level of education completed by the respondents.

The fourth hypothesis relates to statistically significant differences in the perception of future sustainability competences in logistics and supply chain management depending on whether or not the respondents have a education in logistics or related fields (Table 6).

Table 6 Perception of sustainability competences by logistics qualification

Sustainable competences							
	N	Mean	Std. Deviation	Std. Error	F	Sig.	Post-hoc
Yes; logistics, transport (1)	145	4,3984	0,30558	0,02538	3,235	0,007	1 > 5
Yes; business, economics (2)	162	4,3499	0,40851	0,03210			
Yes; other social sciences (3)	53	4,2770	0,40570	0,05573			
Yes; engineering (e.g. mechanical engineering, computer science) (4)	137	4,3152	0,38393	0,03280			
I have no formal education in the above fields (5)	37	4,1523	0,34538	0,05678			
Other (6)	9	4,4596	0,28788	0,09596			
Total	543	4,3353	0,37471	0,01608			

Source: Own source

The fourth hypothesis was: There are statistically significant differences in the perception of the importance of sustainable competences in logistics and supply chain management in the future, depending on whether or not respondents have a formal education in logistics and supply chain management.

The results show that there are statistically significant differences between employees with a logistics and transport qualification and those without a formal logistics and supply chain qualification. Employees without a logistics and transport qualification have a lower perception of the future relevance of sustainable competences in logistics and supply chain management.

Hypothesis five tested for statistically significant differences in perceptions of future sustainability competences in logistics and supply chain management according to the size of the respondents' company (Table 7).

Table 7 Perception of sustainability competences by company size

Sustainable competences							
	N	Mean	Std. Deviation	Std. Error	F	Sig.	Post-hoc
Micro - 10 employees or less (1)	29	4,1019	0,32202	0,05980	5,704	0,001	1 < 3
Small - between 11 and 50 employees (2)	183	4,3351	0,33637	0,02487			
Medium - between 51 and 250 employees (3)	187	4,3952	0,36704	0,02684			
Large - over 250 employees (4)	140	4,3107	0,41936	0,03544			
Total	539	4,3371	0,37420	0,01612			

Source: Own source

The fifth hypothesis was: The perception of the importance of sustainable competences in logistics and supply chain management in the future does not differ according to the size of the company where the respondents are employed.

The results show that there are statistically significant differences between respondents employed in micro-sized companies compared to respondents employed in medium-sized companies. On average, respondents employed in micro companies rated the importance of sustainable competences in the field of logistics and supply chain management in the future lower (4.1) than respondents employed in medium-sized companies (4.4).

For the sixth hypothesis, we verified statistically significant differences in the perception of sustainability competences in logistics and supply chain management according to the sector in which the company operates (Table 8).

Table 8 Perception of sustainability competences by organizational sector

Sustainable competences						
	N	Mean	Std. Deviation	Std. Error	F	Sig.
Education/research	15	4,2848	0,57968	0,14967	0,878	0,523
Non-governmental, non-profit organisation	5	4,2727	0,20072	0,08977		
Service activity	61	4,3942	0,36728	0,04703		
Craft activity (e.g. hairdresser, metal worker, electrician, etc.)	24	4,2746	0,32846	0,06705		
Public sector (e.g. municipal administration, ministries, administrative units, etc.)	13	4,3986	0,46988	0,13032		
Freight forwarding, transport, logistics services	200	4,3634	0,32256	0,02281		
Manufacturing	73	4,3325	0,36895	0,04318		
Retail trade, wholesale	149	4,2904	0,42301	0,03465		

Source: Own source

The sixth hypothesis was: The perception of the importance of sustainable competences in logistics and supply chain management in the future varies according to the sector in which the respondents' company operates.

There were no statistically significant differences in the perception of future sustainability competences in the field of logistics and supply chain management according to the sector in which the company operates.

5. CONCLUSIONS

The results of the survey show that the perception of respondents in the field of logistics and supply chain management regarding sustainability competences is at a high level. On average, the rating of sustainability competences in terms of importance in five years' perspective is 4.3.

From our socio-demographic characteristics, we found that there are statistically significant differences in the perception of future sustainability competences in logistics and supply chain management depending on whether or not employees have a degree in logistics or supply chain management. It can therefore be concluded that education on relevant issues is key to the development of a better future.

There are also statistically significant differences in perceptions of future sustainability competences according to company size. Employees in micro enterprises rate the importance of future sustainability competences in logistics and supply chain management lower than those in medium-sized enterprises. It can be concluded that smaller companies are not as focused on sustainability because they do not have the resources to pay attention to it (time, money, human resources, knowledge, etc.).

This study analysed perceptions of sustainability competence according to socio-demographic characteristics. In future research, it would be useful to investigate other characteristics such as the lifestyle and attitudes of individuals and their perceptions of sustainability competences in the field of logistics and supply chain management.

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REVIEW PAPERS

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STREAMLINING CONSTRUCTION: MAXIMIZING EFFICIENCY THROUGH EFFECTIVE WASTE MANAGEMENT: THEORETICAL REVIEW

РАЦИОНАЛИЗАЦИЈА ИЗГРАДЊЕ: МАКСИМИЗИРАЊЕ ЕФИКАСНОСТИ КРОЗ ЕФИКАСНО УПРАВЉАЊЕ ОТПАДОМ: ТЕОРИЈСКИ ПРЕГЛЕД

Summary: The construction boom in Albania after the '90s had a significant impact on the country's economy. It brought about rapid urbanization, job creation, and increased investment opportunities. The construction sector became a major contributor to GDP growth, attracting both domestic and foreign investments. It also stimulated demand for various industries, such as manufacturing and services, leading to overall economic development. With increased construction activities, there was a rise in construction waste generation. This highlighted the need for effective waste management practices to minimize environmental impact. Waste management is a crucial aspect of construction projects, yet it hasn't received as much emphasis as in other industries. This paper aims to highlight the importance of waste management in construction and the need for effective strategies to minimize waste. In the construction industry, waste refers to any material, energy, or time that is not utilized efficiently and adds no value to the project. Construction waste can include excess materials, unused resources, inefficient processes, and environmental damage. The presence of waste in construction not only leads to financial losses but also has negative environmental and social impacts. This paper presents a review on studies that have systematically investigated the occurrence of waste in the construction industry, including concepts adopted, metrics, and type of feedback provided relating to efficiency improvement.

Keywords: Construction, Environmental accounting, Sustainable development, Waste management

JEL Classification: Q53, Q56

Резиме: Грађевински бум у Албанији после 90-их имао је значајан утицај на економију земље. То је донело брзу урбанизацију, отварање нових радних места и повећане могућности улагања. Грађевински сектор је постао главни фактор раста БДП-а, привлачећи и домаће и стране инвестиције. Такође је стимулисала потражњу за разним индустријама, као што су производња и услуге, што је довело до укупног економског развоја. Са повећањем грађевинских активности дошло је до пораста производње грађевинског отпада. Ово је нагласило потребу за ефикасним праксама управљања отпадом како би се минимизирао утицај на животну средину. Управљање отпадом је кључни аспект грађевинских пројеката, али није добио толики нагласак као у другим индустријама. Овај рад има за циљ да истакне значај управљања отпадом у грађевинарству и потребу за ефикасним стратегијама за смањење отпада. У грађевинској индустрији, отпад се односи на било који материјал, енергију или време који се не користи ефикасно и не додаје вредност пројекту. Грађевински отпад може укључивати вишак материјала, неискоришћене ресурсе, неефикасне процесе и штету по животну средину. Присуство отпада у грађевинарству не само да доводи до финансијских губитака већ има и негативне еколошке и друштвене утицаје. Овај рад представља преглед студија које су систематски истраживале појаву отпада у грађевинској индустрији, укључујући усвојене концепте, метрику и врсту повратних информација које се односе на побољшање ефикасности.

Кључне ријечи: грађевинарство, еколошко рачуноводство, одрживи развој, управљање отпадом

ЈЕЛ класификација: Q53, Q56

Paper presented at the 13th International Scientific Conference "Jahorina Business Forum 2024:
Circular Economy - The Model of New Business"

INTRODUCTION

Waste management is a crucial aspect of any industry, including construction. When it comes to construction companies, effective waste management is essential for various reasons. It not only helps in reducing environmental impact but also contributes to cost savings and regulatory compliance. Construction projects generate a significant amount of waste, including materials, debris, and hazardous substances. Proper waste management practices ensure that these wastes are handled, treated, and disposed of responsibly and sustainably. By implementing efficient waste management

strategies, construction companies can minimize their ecological footprint and promote a cleaner and healthier environment for everyone.

One of the key benefits of effective waste management in construction is the reduction of environmental impact. Construction activities can have a significant impact on land, air, and water quality. By implementing waste management practices such as recycling, reusing, and proper disposal, construction companies can minimize the amount of waste that ends up in landfills or gets released into the environment. This helps in conserving natural resources, reducing pollution, and preserving ecosystems.

In addition to environmental benefits, proper waste management can also result in cost savings for construction companies. By implementing recycling programs and reusing materials, companies can reduce their procurement costs. Instead of purchasing new materials, they can utilize recycled or reclaimed materials, which are often more cost-effective. Moreover, by properly managing hazardous waste, construction companies can avoid potential fines and penalties associated with non-compliance with environmental regulations.

Efficient waste management also plays a crucial role in ensuring the health and safety of workers and the general public. Construction sites can be hazardous environments, and improper waste management can increase the risk of accidents, injuries, and exposure to harmful substances. By implementing proper waste handling and disposal procedures, construction companies can minimize these risks and create a safer working environment for their employees. This includes providing appropriate training and personal protective equipment to workers involved in waste management activities.

1. PROBLEM DEFINITION

The generation of construction waste has been identified as a major problem due to its direct impacts on the environment as well as the efficiency of the construction industry.

In Albania, the main objective of environmental statistics is the production of user-understandable statistics, standardized according to the normative acts of the EU and suitable for use in the design of policies and the management of activities with environmental impact on a national and wider scale. The data collected are air quality (SO₂, NO₂, O₃, LGS, PM₁₀, CO, Pb), data on GHG and other emissions into the atmosphere, data on land management in contaminated areas (hot spots), data on solid urban and inert waste, pesticides imported and used in agriculture, the general water balance in Albania, data on river waters, data on lake waters, data on bacteriological water pollution of the seas on the beaches of Albania, etc.

In 2022, in Albania, it turns out that around 820,322 thousand tons of urban waste has been managed. The annual amount of urban waste managed per inhabitant, on a national scale, in 2022, is 295 kg/per inhabitant, from 311 kg/per inhabitant in the previous year.

In 2022, the amount of non-urban waste managed together with urban waste is 11.6% compared to of the total amount, from 13.8% that was in 2021, marking a decrease of 2.2%.

In 2022, about 76.6% of the total amount of waste was deposited in landfills and waste fields, while in 2021, 79% were deposited, marking a decrease of about 2.4% of the total amount of landfills and waste fields approved as temporary deposits by municipalities relevant.

In 2022, 18.9% of the total amount of waste was recycled, while last year this indicator was 18.8%. In 2022, they were treated by burning in an incinerator for elimination and energy purposes about 4.4% of the total amount of waste, thus marking an increase in this indicator by 2.4%, compared with the same indicator in 2021.

However, facts and situations have shown that this is not the best way of managing waste, the main producer of which turns out to be construction.

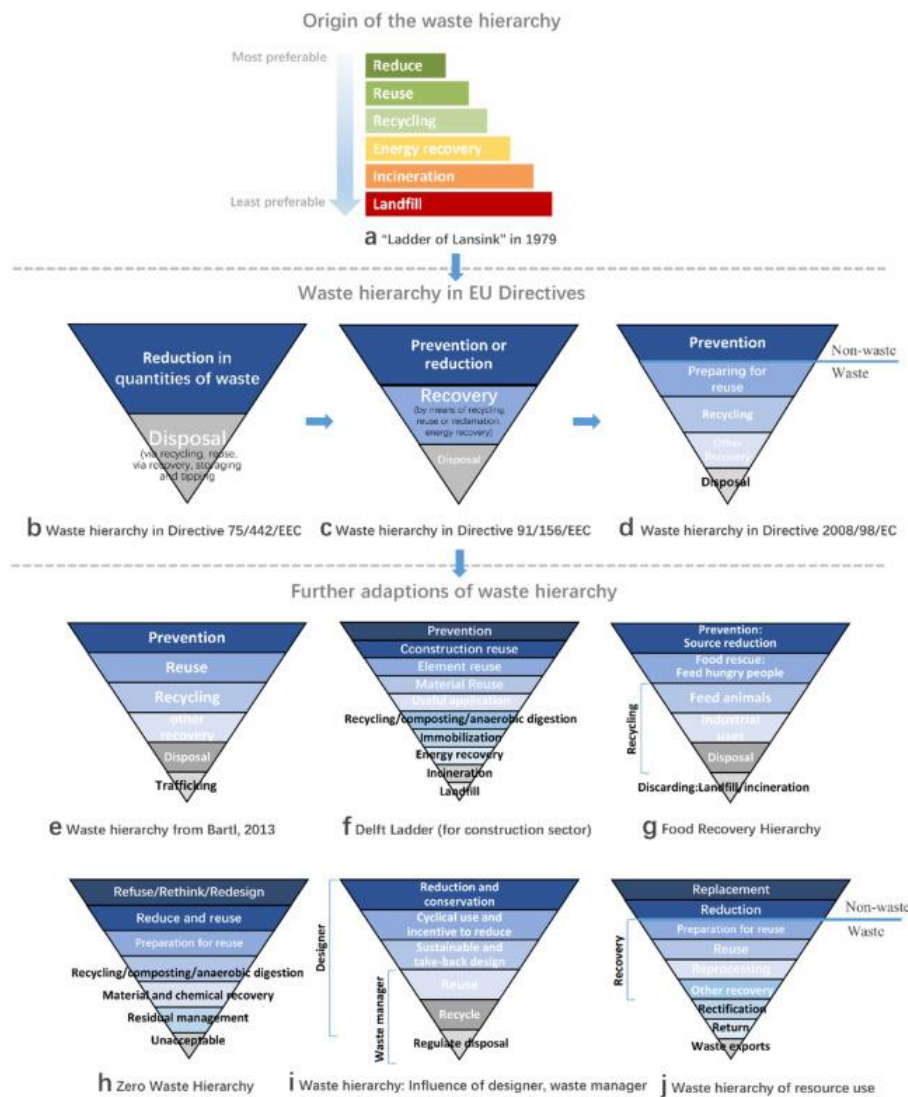
The challenge in waste management, in a universal way, but especially for a country in constant change, requires the development of critical thinking and handling in financial terms, through accounting waste management methods.

2. PRACTICES OF WASTE MANAGEMENT WORLDWIDE

Different countries, and different economic and not only, adapt different methods of waste management. China, the United States (US), and the European Union (EU) as the three largest economies are considered as well as the three main generators of Construction and demolition waste. Studies show that the circular economy shares a similar evolutionary trajectory as the waste hierarchy. Both the waste hierarchy and the circular economy envisage a new way of managing waste by rethinking, redesigning, and reusing products to improve resource effectiveness and reduce the generation and negative impact of waste from the life cycle of pre-use, use, and post-use stages.

The European Union is mainly focused on drafting and implementing laws, regulations, and conventions that directly direct waste management.

Fig. 2. Development of waste hierarchy in Europe.



Source:

Panel a was depicted based on the ladder of Lansink (Recycling.com 2019); Panel b is designed based on the Directive 75/442/EEC (EC, 1975); Panel c was plotted based on the Directive 91/156/EEC (EC, 1991); Panel d was pictured based on the Directive 2008/98/EC (EC 2008); Panel e is derived from Bartl (2013); Panel f is from Hendricks and Te Dordthorst (2001); Panel g is from the US Environmental Protection Agency's Food Recovery Hierarchy (Ceryes et al. 2021); Panel h was redesigned based on Zero Waste Hierarchy (2019); Panel i is from Cole et al. (2019); Panel j is a "hierarchy of resource use" proposed by Gharfalkar et al. (2015) (Zhang et al. 2022).

Apart from the EU, other countries such as China, Japan, the USA, Korea, and Vietnam also took the 3Rs and prioritized the “reduce” option as the essential principle for waste management policymaking (Sakai et al. 2011).

Studies on the effectiveness of waste management methods have been done in China, as one of the countries with very high levels of impact. In particular, four cities, including Beijing, Shenzhen, Xi'an and Changsha, were examined as cases in the analysis. It was found that (1) more attention should be given to construction waste management in all cities, as approximately 44% of all cities do not have their own regulations; (2) the focus of these policies shift from the end of the construction waste chain to the beginning of the construction waste management chain, and then to the whole chain; (3) financial and technological instruments could greatly improve performance; and (4) new technologies and instruments could facilitate communications between stakeholders to improve construction waste performance.

In the United States, waste management focuses on three elements, waste reduction, recycling, and reuse as essential to sustainable resource management. Most of the construction and demolition waste currently generated in the US is legally destined for landfills regulated under Code of Federal Regulations (CFR) 40, subtitles D and C. In some areas all or a part of the construction and demolition waste stream is illegally deposited on land, or in natural drainages including water, in violation of regulations for the protection of human health, commerce and the environment. US businesses and citizens legally dispose of millions of tons of building-related waste in solid waste landfills each year.

In Australia, the findings reveal twenty-six critical solutions for waste management.

From the exploratory factor analysis, five solution factors for waste management were derived. These factors were: team building and supervision; strategic guidelines in waste management; proper design and documentation; innovation in waste management decisions; and life cycle management. Evidence suggests that both technologies and attitudes require improvement to eliminate/minimize waste generation in construction projects.

3. ENVIRONMENTAL MANAGEMENT ACCOUNTING AND LIFECYCLE ASSESSMENT FOR CONSTRUCTION PROJECTS

Constructing a building and using it for many years produces long-lasting impacts on human health and the environment. Waste is produced in different types and quantities throughout the life-cycle of a building with the bulk of the waste being produced during the C&D phases (Yeheyis et al. 2012). Life cycle assessment (LCA) is the rapidly evolving science of illuminating these impacts in terms of their quality, severity, and duration. A building generates environmental impacts throughout its life cycle. The various stages of a typical life cycle as defined in LCA are: the production and construction stages, the use stage: the end-of-life stage, and externalized impacts beyond the system boundary (Kotaji et al. 2003).

Life Cycle Assessment (LSA) of buildings is defined as comparative analysis tool which is used to evaluate environmental hazards and consumption of resources associated with the product, process or the activity over the entire life of the product (Sharma et al. 2011).

Within the last decade research on LCA has gained attention increasing considerably from manufacturing of building materials and construction processes (Abd Rashid and Yusoff 2015).

On the other hand, Environmental management accounting (EMA) can be integrated with life cycle waste management to enhance sustainability and efficiency in construction practices. EMA focuses on the identification, measurement, and management of environmental costs and impacts within an organization. EMA can be integrated with life cycle waste management:

- **Cost Analysis:** EMA can help in analyzing the costs associated with waste management throughout the construction life cycle. This includes costs of waste generation, segregation, collection, disposal, and recycling. By understanding the financial implications, companies can make informed decisions to minimize waste and associated costs.
- **Performance Monitoring:** EMA provides tools and techniques to monitor and track environmental performance indicators related to waste management. This allows companies to assess their progress, identify areas for improvement, and set targets for waste reduction and recycling.
- **Decision-making:** EMA provides valuable information for decision-making processes. By integrating EMA with life cycle waste management, companies can evaluate the environmental and financial consequences of different waste management strategies. This

enables them to make more sustainable choices, such as selecting materials with lower waste generation potential or opting for recycling options.

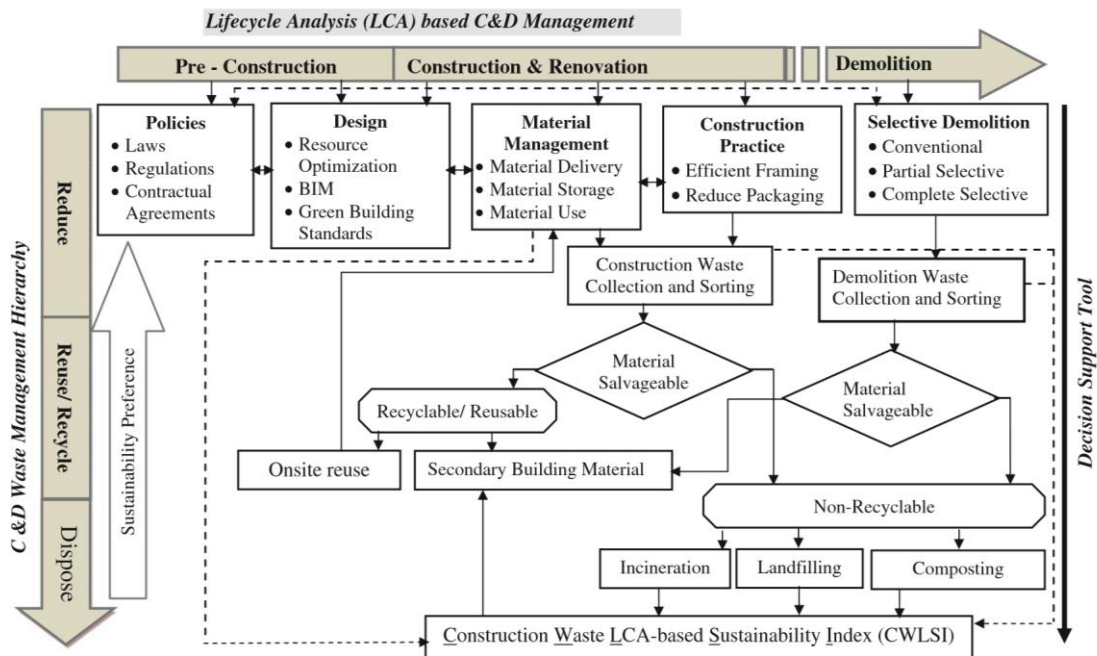
- **Reporting and Accountability:** EMA facilitates the reporting of environmental data and performance metrics related to waste management. This helps companies demonstrate their commitment to sustainability, comply with regulations, and engage stakeholders in their waste reduction efforts.

By integrating EMA with life cycle waste management, construction companies can effectively manage and reduce waste while considering the environmental and financial aspects. It promotes a holistic approach to sustainability in construction practices.

Following in the footsteps of traditional LCA product evaluation applications, several studies have focused on the environmental evaluation of building materials. The objective of such research efforts is to enable selection of environmentally preferred materials and products by identifying sources of the most significant environmental impacts (Cabeza et al. 2014).

We referred to these studies, based also in the framework in Fig. 2, to extract the main areas where the evaluation of the situation in the construction industry will begin.

Fig.2 Conceptual framework for lifecycle-based integrated C&D waste management system



Source: Yeheyis et al. 2012

The basic points, where the evaluation of the state of waste management in the construction industry consists on the following areas:

- Apply lean principles*
- Proper selection of materials*
- Develop the market for recycled products*
- Consider environmental aspects in design and tendering stages*
- Understand attitudes and behaviours towards WM*
- Change people's attitudes and encourage industry*
- Onsite management systems*
- Proper planning of construction activities*
- Assign implementation responsibility for WM to designated people*
- Adequate supervision*
- Training and education*
- Simplification of design*
- Financial rewards and incentives and enhance of communication*
- Regular meetings*

Lifecycle costing
Transparency in reporting
Sense of collective responsibility
Promoting prefabrication methods
Relationship building among stakeholders
Implementation and enforcement of policies and regulations
Increase landfill charges
Adoption of transparent environmental reporting

Each of the items above will be translated in a more detailed information, in order that the assessment can be clear to the respondents and gain much more detailed and fair information.

These areas will be used in preparing a questionnaire that will be targeted to construction companies, public authorities relating to construction permits, environmental institutions and financial accountants within the scope of identifying which is the situation, weaknesses and strengths if any, and integrate the environmental indicators along with economic indicators, generated from EMA.

CONCLUSIONS

Buildings play major role in energy consumption of the total available energy. In the estate sector, whether residential or commercial, the energy is consumed at a high rate and hence contributes a lot in the consumption of fossil fuels and emission of various hazardous gases which leads to global harms like ODP, greenhouse effect acidification etc.

There are many different alternatives for building construction if they could be implemented during the construction phase of a building. This review of the problem on Albanian context comes from the rapid growth of the industry during these 25 years, and its impact in the economy takes an important part. Not only economic, but also environmental impact should be considered at this level.

Through this study we attempt to investigate areas and indicators, on how to implement waste management strategies during life cycle assessment of construction projects and translate these strategies into key indicators that will be further used for performance evaluation on environmental Accounting context.

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THE EFFECTS OF DISCLOSING KEY AUDIT MATTERS IN THE AUDITOR'S REPORT

ЕФЕКТИ ОБЈЕЛОДАЊИВАЊА КЉУЧНИХ РЕВИЗИЈСКИХ ПИТАЊА У РЕВИЗОРСКОМ ИЗВЈЕШТАЈУ

Summary: *The aim of this paper is to determine whether the disclosure of key audit matters in the auditor's report increased the communication and informational value of the auditor's report, the quality of financial statements and the quality of the audit through the analysis of the results of a large number of empirical studies. Most experimental studies show that key audit matters have the potential to effectively direct the attention of users of financial statements to relevant areas, influence the decisions of users of financial statements and reduce the tendency of managers to perform aggressive financial reporting. However, a larger number of studies have found that there is a lack of a broader capital market reaction to the disclosure of key audit matters and that the disclosure of key audit matters does not lead to a reduction in earnings management. Furthermore, most research show that the introduction of the obligation to disclose key audit matters does not lead to an increase in the audit fee and the auditor's report lag, but that there are possible negative effects of the introduction of the obligation to disclose this information in terms of managers' reluctance to share information about their accounting choices with auditors and the reduction of scepticism assessment and sceptical actions of auditors.*

Keywords: *Key audit matters (KAM), Investor behaviour, Quality of financial statements, Audit quality*

JEL classification: *M41, M42*

Резиме: *Циљ овог рада је да се кроз анализу резултата већег броја емпиријских истраживања утврди да ли се са објелодањивањем кључних ревизијских питања у ревизорском извјештају повећала комуникациона и информациона вриједност ревизорског извјештаја, квалитет финансијских извјештаја и квалитет ревизије. Већина експерименталних студија показује да кључна ревизијска питања имају потенцијал да ефикасно усмјере пажњу корисника финансијских извјештаја на релевантна подручја, да утичу на одлуке корисника финансијских извјештаја и да смање склоност менаџера да врше агресивно финансијско извјештавање. Ипак, у већем броју истраживања утврђено је да изостаје шира реакција тржишта капитала на објелодањивање кључних ревизијских питања и да објелодањивање кључних ревизијских питања не доводи до смањења управљања зарадом. Такође, већина истраживања показује да увођење обавезе објелодањивања кључних ревизијских питања не доводи до раста ревизорске накнаде и кашњења ревизорског извјештаја, али да постоје могући негативни ефекте увођења обавезе објелодањивања ових информација у смислу неспремности менаџера да дијеле информација о својим рачуноводственим изборима са ревизорима и смањења скептичног процјењивања и скептичног дјеловања ревизора.*

Кључне ријечи: *кључна ревизијска питања, понашање инвеститора, квалитет финансијских извјештаја, квалитет ревизије*

ЈЕЛ класификација: *M41, M42*

INTRODUCTION

The auditor's report is the most important output of the audit process. Through the auditor's report, the auditor communicates the results of the audit to the users of financial statements. The auditor's report is the only source of information about the conducted audit that is available to owners and other external stakeholders. In order to be more effective in communication, the auditor's report is standardized by containing a description of the financial statements that were the subject of the audit, a description of the audit itself and certain responsibilities of the management and the auditor, as well as the auditor's opinion on whether the audited financial statements provide a true and fair view of the achieved company performance.

The form and content of auditor's reports have been the subject of frequent criticism. Auditors have been criticized for using highly standardized language in the auditor's report (Asare and Wright 2012; Church et al. 2008; Cordoş and Fülöp 2015). When preparing the auditor's report, auditors respect the form and specific wording defined by audit standards. The use of standardized language has resulted in the fact that the text of different auditor's reports containing an unmodified audit opinion is almost identical (Church et al. 2008; Gray et al. 2011). Users value the audit opinion, but

pay less attention to the other elements of the auditor's report because their content is familiar to them even without detailed reading (Turner et al. 2010).

Users felt that auditor's reports did not have sufficient informational value (Church et al. 2008). Auditors were criticized for not explaining how they obtained the opinion given in the auditor's report, for not pointing out key areas of risk and for not communicating sufficiently with shareholders and potential investors whose interests they are supposed to protect (Vanstraelen et al. 2012; Cordoş and Fülöp 2015). A number of accounting scandals and the global financial crisis have led stakeholders, especially institutional investors and financial analysts, to want more information about the audit, auditor and financial statements (Mock et al. 2013). Stakeholders expect to receive information that will help them better understand the financial statements, as well as to assess the risks associated with the financial position and profitability of the company. They are aware of the fact that auditors have much more information about the audited company than they disclose in the auditor's report (Tušek and Ježovita 2018). Auditors, on the other hand, tend to minimize the risk of litigation by providing in their auditor's reports the minimum level of information required by auditing standards (Hegazy and Kamareldawla 2021). This indicates the existence of an information gap, i.e. the gap between the information users want about financial statements and audits and what is available through the company's audited financial statements and the auditor's report. The information gap is closely related to the expectation gap, which refers to the difference between users' expectations of an audit and what auditors perceive to be their responsibility (IAASB 2011). This created the need for making significant changes to the auditor's report in order to reduce misperceptions.

In response to expressed concerns that auditor's reports are not sufficiently transparent and do not have the expected communication and informational value for users, the International Auditing and Assurance Standards Board issued six revised and one new standard regarding auditor's reporting in 2015 (IAASB 2015a). Revised and new standards became effective for audits of financial statements for periods ending on or after December 15, 2016. The most significant change relates to the introduction of International Auditing Standards (IAS) 701: Communicating of Key Audit Matters in the Independent Auditor's Report. This standard requires the auditor of a listed company to disclose key audit matters in the auditor's report (IAASB 2015b).

Key audit matters (KAM) are matters that, according to the auditor's professional judgment, were of the greatest importance in the audit of the financial statements for the current period. They are selected from the matters that required significant attention of the auditor during the audit and about which the auditor communicated with those charged with governance. KAM include areas identified as having significant risks of material misstatement, involving significant judgment by the auditor or management, or where the auditor encountered significant difficulties during the audit. KAM may also include circumstances that required a significant modification of the auditor's planned approach to the audit. The description of KAM in the auditor's report should include an explanation of why a particular matter is considered highly significant in the audit, how the matter was addressed in the audit, as well as a reference to related disclosures in the financial statements.

The idea of auditor disclosure of KAM is not entirely new. Namely, since 2003, auditors in France have been required to provide comments in the auditor's report called "Justification of Assessments" (JOA). JOA are very similar to KAM in that auditors should provide information that will enable the users of the auditor's report to better understand the reasons that have led the auditor to form a particular audit opinion on the financial statements (Haut Conseil des Commissaires aux Comptes 2006). Since 2012, auditors in the United Kingdom have been required to disclose in their reports information regarding the significant risks of material misstatements (RMM) (FRC 2013). In 2017, the US Public Company Accounting Oversight Board (PCAOB) introduced the obligation to disclose critical audit matters (CAM) in auditor's reports. CAM is defined as any matter that the auditor communicates or should communicate to the audit committee as it relates to material accounts or disclosures and involves particularly challenging, subjective, or complex audit judgments (PCAOB 2017). The definitions of KAM, according to the provisions of the IAASB (2015b) and CAM, according to the provisions of the PCAOB (2017), differ to some extent, but the way in which they are determined is very similar.

KAM bring information specific to the audited company into the auditor's report. The goal of their inclusion in auditor's reports is to increase the transparency of the conducted audit, reduce information asymmetry and increase the communication and informational value of the auditor's report (IAASB 2015a). Auditing standard setters believe that this information will help "investors and other financial statement users focus on aspects of the company's financial statements that the auditor

also found to be challenging” (PCAOB 2013) and that this information provides “...roadmap to help users better navigate complex financial statements and focus them on matters likely to be important to their decision-making” (IAASB 2011). The disclosure of KAM should reassure users that all significant matters have been identified and properly addressed during the audit (Gutierrez et al. 2018). Representatives of regulatory bodies also believe that including KAM in the auditor's report will encourage managers to think more carefully about the quality of processes and controls regarding financial reporting (Katz 2013). This means that the disclosure of KAM could not only increase transparency for users of financial statements, but also influence the behaviour of managers and the quality of financial statements. The standard setters also consider that the KAM disclosure could affect the auditor's behaviour in terms of increasing the auditor's professional scepticism (IAASB 2015c).

The question arises whether the expected effects from the introduction of KAM in the auditor's report are really realized in practice. This paper deals with this question. The aim of the paper is to determine whether the communication and informational value of the auditor's report, the quality of financial statements and the quality of the audit increased with the disclosure of KAM in the auditor's report, through the analysis of the results of a large number of empirical studies. With that in mind, the rest of the paper is structured as follows. In the second section, the impact of KAM disclosure in the auditor's report on the behaviour of investors is analysed. In the third section, the impact of their disclosure on the behaviour of managers and the quality of financial statements is considered. In the fourth section, the impact of the obligation to disclose KAM in the auditor's report on auditor behaviour and audit quality is considered. The fifth section includes concluding remarks.

1. THE INFLUENCE OF THE KAM DISCLOSURE ON THE INVESTORS' BEHAVIOUR

Ideally, KAM should improve investors' understanding of what auditors do to reach an audit opinion on financial statements. Through KAM, auditors disclose identified risks and their responses to those risks. Through this information, investors become better acquainted with the work of auditors, which should increase their trust in auditors and audit opinion. Also, investors receive additional information about the company whose financial statements are subject to audit. This is information related to areas of the financial statements that are subject to managerial judgment and increased uncertainty regarding the existence of material misstatements. The inclusion of such information in the auditor's report should contribute to the reduction of information asymmetry and should be reflected on the behaviour of investors when making decisions.

However, researchers examining the impact of KAM disclosure on the aggregated reactions of financial markets have come to conflicting results. On the one hand, Alves Júnior and Galdi (2019) and Altawalbeh and Alhajaya (2019) found that financial markets react to the KAM disclosure in auditor's reports. Namely, Alves Júnior and Galdi (2019) determined that the KAM disclosure affects abnormal returns on the financial market, on a sample of Brazilian public companies. Altawalbeh and Alhajaya (2019) found that the KAM disclosure in auditor's reports affects the abnormal trading volume, on a sample of Jordanian public companies. These two studies show that KAM have an informational value for investors and influence their behaviour in the capital market.

On the other hand, a large number of studies have shown that the financial market does not react to the disclosure of KAM or similar information. Bédard et al. (2014) found that JOA disclosure does not affect either the abnormal return or the abnormal trading volume, on a sample of public companies in France. Gutierrez et al. (2018) as well as Lennox et al. (2018) found that RMM disclosure also does not affect either abnormal return or abnormal trading volume, on a sample of UK companies. Li (2017) found that KAM disclosure does not affect abnormal return, on a sample of Chinese companies, and Kitipong et al. (2020) found that KAM disclosure does not affect either abnormal return or abnormal trading volume, on a sample of Thai companies. Also on a sample of Thai companies, Boonyanet and Promsen (2018) found that KAM disclosure has little impact on share prices. Based on the results of these studies, it could be concluded that the inclusion of KAM in the auditor's report has a symbolic value rather than an informational value (Bédard et al. 2014).

Obtaining conflicting results can be explained in several ways. Lennox et al. (2018) believe that the information disclosed as KAM is reliable, but that the financial market does not react to it because that information was already available to investors from other sources. Examining the first year of KAM disclosure in New Zealand, Al-mulla and Bradbury (2022) found that investors considered risks even before they were disclosed in auditor's reports as KAM. Wei et al. (2017) found

that in Australia, one-third of matters disclosed as KAM in the first year of IAS 701 implementation had already been disclosed in the previous year's annual report of audited companies. This means that for certain investors the information disclosed as KAM is not completely new.

Furthermore, investors cannot be seen as a homogeneous group and it cannot be expected of all of them to react in the same way to the disclosure of certain information. Investors have different levels of risk aversion. Velte and Issa (2019) point out that risk-averse investors might leave the company due to risk information disclosed as KAM, while risk-neutral and risk-seeking investors might respond to increased transparency by investing more in the company. Li (2020) and Köhler et al. (2020) believe that the different levels of professional abilities of investors affect the possibility of interpreting and therefore using the information contained in the auditor's report. It follows that the individual characteristics of investors are very important for explaining the impact of KAM disclosure on investor behaviour and that investigating the aggregated reaction of the financial market is not sufficient. It is necessary to investigate the perception and reactions of individual investors or certain categories of investors.

Using an experimental method, Köhler et al. (2020) investigated whether KAM disclosure has informational value for professional and non-professional investors. They found that professional investors' assessments of the company's economic situation are influenced by disclosed KAM and that KAM have no informational value for non-professional investors because they have difficulty interpreting this information. Carver and Trinkle (2017), Sirois et al. (2018), Christensen et al. (2014), Rapley et al. (2021) and Moroney et al. (2021) focused their attention only on non-professional investors, also using the experimental method. Carver and Trinkle (2017), as well as Köhler et al. (2020), found that for non-professional investors, CAM disclosure reduces the readability of the auditor's report and does not affect their assessments. On the other hand, Sirois et al. (2018) found that KAM have the role of directing users' attention. They found that non-professional investors pay more attention to disclosures in financial statements that are mentioned in the auditor's report as KAM than to other components of financial statements. This shows that KAM has the potential to help non-professional investors navigate complex financial statements and focus their attention on relevant issues. Therefore, auditors must choose KAM carefully. Christensen et al. (2014) found that non-professional investors who received an auditor's report with CAM were more likely to change their investment decision compared to investors who received a standard auditor's report or received this information in management reports. Rapley et al. (2021) found that, relative to situations where no CAM was identified by auditors, CAM disclosure reduces the investment intentions of non-professional investors. Moroney et al. (2021) determined that the auditor's report has a communication value for non-professional investors only in the case when the audit was performed by a Non-Big 4 audit firm. According to these authors, the communication value of the auditor's report is manifested in the form of an increase in the perceived value of the audit and the perceived credibility of the auditor. They also determined that in the case when the audit was performed by a Big 4 audit firm, the perceived value of the audit and the credibility of the auditor are equally high, regardless of whether KAM is included in the auditor's report, because stakeholders believe that the Big 4 audit firms perform a higher quality audit compared to Non-Big 4 audit firms.

Whether KAM will have informational value for investors and other users of financial statements depends on the characteristics of KAM themselves. Prasad and Chand (2017), as well as Kitiwong and Sarapaivanich (2020), found that the informational value of KAM can be reduced or even lost if KAM are too general and stated in a standardized form. Li (2017) points out that the KAM disclosed in the auditor's reports of different companies belonging to the same industry are almost the same. Such disclosures may not provide specific information about areas of the financial statements that require the special attention of users of financial statements. KAM should be specific for each subject of audit, regardless of whether they belong to the same or different industry. Furthermore, Li (2020) points out that although the situation with audited companies changes from year to year, it is not uncommon for auditors to disclose the same KAM every year. Prasad and Chand (2017) argue that the informational value of KAM can be reduced in the case of disclosing a large number of KAM and giving too extensive explanations of KAM. In this case, the users cannot understand the essence of the KAM and the audit opinion. Kohler et al. (2020) indicate that KAM can be incomprehensible to users because they are complex and contain technical terms. With all of the abovementioned in mind, Pries and Scott (2018) state that although auditors in their auditor's reports meet the specific requirements of IAS 701, they still do not seem to meet the objective of the standard. Text...

2. THE IMPACT OF KAM DISCLOSURE ON THE BEHAVIOUR OF MANAGERS AND THE QUALITY OF FINANCIAL STATEMENTS

Agency theory assumes the existence of a conflict of interest between managers and owners. This theory assumes that managers will engage in actions that maximize their own utility at the expense of owners in situations where they assume that their behaviour will not be discovered (Gold et al. 2020). Fields et al. (2001) argue that managers consciously use inherent market imperfections, such as information asymmetry, to mislead owners about the company's underlying performance. Managers do this by using flexibility in accounting choices to intentionally influence the outcome of financial statements (Gold et al. 2020). They do this in order to gain personal benefit in the form of retaining managerial positions, preserving their reputation and obtaining larger bonuses. Personal benefits accrue due to owners' limited ability to detect earnings management.

Accountability theory assumes that the expectation that managers will be called upon to justify their position to owners and other stakeholders affects their judgment and the quality of their decisions (Gold et al. 2020). Presumably, in such circumstances, they feel more pressure to provide justifiable explanations. Because of this, they are ready to put more effort into judgment and decision-making. With this in mind, Gold et al. (2020) assume that in the case of KAM disclosure, managers expect their estimates to be more scrutinized by auditors, investors and other users of financial statements compared to the case of an unmodified auditor's report that does not contain KAM. This means that greater transparency can reduce the likelihood of earnings management due to a higher risk of detection by owners and other market participants (Barghathi et al. 2021). In other words, greater transparency of auditor's reports should increase the level of management responsibility and lead to an improvement in the quality of financial statements.

Gold et al. (2020) believe that if the auditor once disclosed a certain matter in the auditor's report as KAM, it is reasonable to assume that this area of financial statements will be the subject of the auditor's interest in the audits that will be carried out in the following years. Managers may expect the auditor to spend additional time and resources auditing those matters (Reid et al. 2019). Furthermore, managers could change their reporting behaviour also because the possibility of disclosing certain areas of financial statements as KAM gives auditors more bargaining power compared to managers. Reid et al. (2019) believe that auditors could ask managers to give up aggressive financial reporting in exchange for no longer highlighting a certain area of financial statements in the auditor's report as an area of increased risk of misstatement. As a result, managers may use a more conservative approach in areas of financial reporting that require managerial judgment to avoid the auditor commenting on those matters in a negative light.

Gold et al. (2020) also believe that managers could change their behaviour in financial reporting due to the increased attention of investors. As already mentioned in the previous section, Sirois et al. (2018) found that investors pay more attention to disclosures in financial statements that are mentioned in the auditor's report as KAM. This means investors will examine matters identified as KAM more closely, which could increase their ability to detect earnings management. Therefore, managers could abandon earnings management and opt for conservative financial reporting, thereby improving the quality of financial reporting (PCAOB 2017).

Li (2020) found that KAM disclosure affects managers' willingness to communicate more with the auditor. Cade and Hodge (2014) found that managers share less information with auditors about their accounting choices when they are told that the auditor will disclose such choices. This is a potentially negative effect of disclosing KAM in the auditor's report. Gold et al. (2020), using the experiment method, empirically confirmed that managers' propensity to make aggressive financial reporting decisions is reduced in situations where KAM is disclosed in auditor's reports compared to situations where auditor's reports do not contain KAM. Reid et al. (2019) also found that RMM disclosure is associated with a reduction in opportunistic earnings management, which leads to an improvement in the quality of financial statements. They also found that investors believe that the quality of financial reporting is better after the implementation of audit standards that require the disclosure of RMM. These authors also examined whether the quality of financial statements is affected by the actual disclosure or the threat of disclosure of RMM. If the actual disclosure of RMM affects the quality of financial statements, one would expect the quality of financial statements to be higher when more RMM are disclosed. However, the authors did not find empirical confirmation of this.

It should also be noted that a certain number of authors who examined the relationship between the disclosure of KAM and measures indicating the existence of earnings management in financial statements did not find empirical confirmation that the disclosure of KAM in the audit report leads to a decrease in earnings management (Gutierrez et al. 2018; Wei et al. 2017; Al-mulla and Bradbury 2022).

Given that standardization of information potentially reduces the informational value of KAM, Gold et al. (2020) examined whether disclosure of non-firm-specific KAM, compared to disclosure of firm-specific KAM, has less impact on managerial behaviour and the quality of financial statements. They assumed that in situations where investors are provided with less precise information, their ability to evaluate managerial estimates and identify earnings management is reduced, which is why they pay less attention to that information and that managers are aware of it. However, they did not find empirical confirmation of this. Even in the case of KAM disclosures with non-firm-specific content, managers show a lower tendency to make aggressive financial reporting decisions compared to managers who received an auditor's report without KAM. This means that the mere presence of KAM in the auditor's report, regardless of its content, can serve as a mechanism for reducing aggressive financial reporting and improving the quality of financial statements. This result may seem logical, bearing in mind that at the time of making decisions on accounting estimates, managers do not know what the auditor will disclose in his/her auditor's report. The very possibility or threat of KAM disclosure can influence management behaviour, as Reid et al. (2019) confirmed. However, it should be borne in mind that managers try to influence the auditors and the content of their auditor's reports. In a study conducted by Barghathi et al. (2021), auditors employed by Big 4 audit firms confirmed that the disclosure of KAM in the auditor's report led to a reduction of earnings management practices, while auditors employed by Non-Big 4 audit firms indicated that they were under great pressure from clients and their own management to hide earnings management practices in order not to lose clients. This shows that only including KAM in the auditor's report is not enough to reduce earnings management practices. It is necessary for regulatory bodies to adopt stricter rules that will ensure uniformity in auditing practices.

3. THE IMPACT OF KAM DISCLOSURE ON AUDITORS' BEHAVIOUR AND AUDIT QUALITY

While the impact of KAM disclosure on investor behaviour is directly aligned with the goals of implementing ISA 701, the question arises whether identifying and disclosing KAM affects auditor behaviour and audit quality. Bédard et al. (2019) believe that the requirements placed on auditors regarding the disclosure of additional information in auditor's reports increase their sense of responsibility. Kitipong et al. (2020) point out that increased accountability should encourage auditors to obtain more and better audit evidence and to exercise more professional scepticism in their audits. Hasen and Ozlanski (2016) believe that the KAM disclosure requirement leads auditors to expand audit procedures to minimize audit risk. This should lead to an improvement in audit quality, whereby audit quality refers to the auditor's ability to detect the existence of material misstatements and his/her willingness to report on them.

Whether the introduction of the obligation to disclose KAM in the auditor's report led to auditors performing the audit more thoroughly, the researchers determined by examining the impact of KAM disclosure on the amount of the audit fee and the auditor's report lag. The amount of the audit fee reflects the audit costs. Audit costs are correlated with the volume of activities performed by members of the audit team. Auditor's report lag refers to the time between the financial statements date and the auditor's report date. It is suggested that auditors may increase the scope of substantive audit procedures and implement quality control processes associated with identifying and disclosing KAM, in response to increased risk (IAASB 2012). Also, audit managers and partners could review the work of junior members of the audit team in more detail and spend more time discussing with the audit client management about the form and content of KAM (Kitipong et al. 2020). This could increase the cost of the audit. Further, the auditor's report lag could be increased because the activities of identifying and documenting KAM are performed as part of the final audit (PCAOB 2013). Also, discussing the form and content of the KAM with the management of the audit client before issuing the auditor's report can delay the issuance of the auditor's report (Bédard et al. 2014). The auditor's

response to additional work may be to reduce efforts on other audit activities, increase the number of audit team members, or delay the issuance of the auditor's report.

Some believe that including KAM in the auditor's report will not significantly increase audit costs because KAM is nothing new to auditors (PCAOB 2011). Even before the introduction of the obligation to disclose KAM in the auditor's report, auditors were obliged to pay attention to what is defined as KAM during the audit. The difference is that before it was the internal information of the auditor, and now the auditors are obliged to share this information with the users of financial statements and the auditor's report. Bédard et al. (2014) believe that the same activities can be performed with different clients and that the audit firm has the ability to standardize these activities, which will lead to a reduction in costs. The same KAM can appear at the same audit client year after year. Therefore, in the coming years, auditors can spend less effort on identifying and documenting KAM as well as discussing with managers about KAM, which should also affect the reduction of audit costs.

Researchers have obtained contradictory results regarding the impact of the obligation to disclose KAM and similar information (JOA and RMM) in auditor's reports on the amount of the audit fee and the auditor's report lag. Li et al. (2019) and Kitipong et al. (2020) found empirical evidence that in the period after the introduction of the KAM disclosure obligation, there was a significant increase in audit fees compared to the period before the introduction of this obligation for auditors. Wei et al. (2017) found that audit fees increased only for Non-Big 4 audit firms. On the other hand, Al-mulla and Bradbury (2022), Bédard et al. (2019), Gutierrez et al. (2018), Pries and Scott (2018) and Reid et al. (2019) found that the KAM disclosure does not affect the amount of the audit fee. Pries and Scott (2018) stated that at the time covered by the research, the audit market in Australia, where the research was carried out, was quite competitive and this may have influenced the fact that there was no increase in audit fees. Reid et al. (2019) indicate that the introduction of the obligation to disclose KAM in the auditor's report led to an improvement in the quality of financial statements without creating additional audit costs. They point out that the improvement in the quality of financial statements is not a consequence of performing additional audit procedures, but rather a change in the behaviour of managers concerning financial reporting due to the threat of disclosure of KAM in the auditor's report. Regarding the impact of the KAM disclosure obligation on the auditor's report lag, Kitipong et al. (2020) found that after the introduction of this obligation for auditors, the audit report lag increased, while Al-mulla and Bradbury (2022), Bédard et al. (2019) and Reid et al. (2019) found no evidence of this. Kitipong et al. (2020) state that the inconsistency of evidence on the impact of KAM disclosure on audit fees and auditor's report lag may be due to country-level factors and the application of different research methodologies.

Ratzinger-Sakel and Theis (2019) and Asbahr and Ruhnke (2019) found that the disclosure of KAM in the auditor's report can have a negative impact on auditor behaviour and audit quality. Although it was assumed that the obligation to disclose KAM would positively influence auditor judgment and lead to an increase in professional scepticism (AASB, 2015c), Ratzinger-Sakel and Theis (2019), using an experimental method, found that auditors show less professional scepticism when they are required to consider KAM than when they do not consider KAM. Namely, auditors, under the conditions of KAM disclosure, are more willing to agree to the accounting treatment that their clients want. The authors of this study believe that it is acceptable for auditors to be biased when users of financial statements are forewarned of the potential inaccuracy of accounting estimates. The results of an experimental study conducted by Asbahr and Ruhnke (2019) show that identifying and disclosing KAM does not affect the auditor's assessment of the reasonableness of accounting estimates, i.e. the scepticism of his/her assessment, but rather affects the scepticism of his/her actions. Namely, the auditors showed less willingness to insist on correcting the amount in the financial statements or demanded a smaller amount of correction when the performed accounting assessment was reported in the form of KAM. This shows that auditors may unconsciously perceive the KAM disclosure as a substitute for the need to adjust amounts in the financial statements. The results of these two studies are important for auditor standard setters. They indicate the possibility that the KAM disclosure has side effects, that is, unwanted consequences on the auditor's behaviour, his/her judgment and the quality of the audit.

CONCLUSIONS

So far, a number of research studies have been conducted in which the effects of KAM disclosure in the auditor's report have been examined. In these studies, conflicting results and conclusions are often obtained regarding the impact of KAM disclosure on the behaviour of investors, managers and auditors. Most experimental studies show that KAM have the potential to effectively direct the attention of users of financial statements to relevant areas, influence the decisions of users of financial statements and reduce the tendency of managers to perform aggressive financial reporting. These results are promising. Auditors should be aware of the guiding role of KAM in audit reports and carefully decide what to disclose as KAM. Also, the auditing standard setters should bear in mind that users may inappropriately rely on the auditor's disclosures as a substitute for reading financial statements. This can lead to discarding otherwise useful information in financial statements that is not mentioned in the auditor's report, while placing too much emphasis on information that is explicitly stated in the auditor's report.

In addition to this, it should be borne in mind that in the majority of studies that examined the aggregated reaction of the financial market to the disclosure of KAM, it was determined that the broader reaction of the capital market to the disclosure of this information is absent. Furthermore, in the majority of studies that examined the relationship between the disclosure of KAM and measures indicating the existence of earnings management in financial statements, no empirical evidence was found that the disclosure of KAM in the auditor's report leads to a reduction in earnings management. The question arises as to what is the real economic significance of including this information in the auditor's report.

Most research show that the introduction of the KAM disclosure obligation does not lead to an increase in the audit fee and the audit report lag. This means that in most cases the auditors do not perform the audit more thoroughly due to the disclosure of KAM, that is, identifying and disclosing KAM does not increase the efforts and scope of the auditor's work. It could be concluded from this that the introduction of the KAM disclosure obligation did not lead to an increase in audit costs. For some, this could be reason enough to retain KAM disclosures in auditor's reports regardless of uncertainty about the benefits to be achieved. However, it should be borne in mind that the inclusion of too much information in the auditor's report can reduce the overall effectiveness of the auditor's communication and that certain studies point to possible negative effects of the introduction of the KAM disclosure obligation in terms of managers' reluctance to share information about their accounting choices with auditors and the reduction of sceptical assessment and sceptical action of auditors.

In order to be able to see the real effects of KAM disclosure in the auditor's report, it is necessary to determine the reasons for obtaining contradictory results in studies on the impact of KAM disclosure on investor behaviour, the quality of financial statements and audit quality. One of the possible reasons is the application of a different research methodology. Obtaining conflicting results may be a consequence of the fact that the research is conducted in countries with different institutional frameworks, different degrees of financial markets development, different levels of financial reporting quality and audit quality. The results of the research may be influenced by specific characteristics of investors, managers or auditors or characteristics of KAM disclosure. Most of the studies in which no empirical confirmation of the impact of KAM disclosure on investor behaviour on the financial market was found were carried out in developed countries, while studies in which the impact of KAM disclosure on investor behaviour was confirmed were carried out in developing countries. It is believed that the absence of financial market reactions to the disclosure of KAM is due to the fact that this information was available to investors even before the publication of the auditor's report. It is possible that investors in developed countries are better informed, that is, that they have a greater volume and better quality of information at their disposal compared to investors in developing countries, and that this is reflected in the effects of KAM disclosure. The informational value of KAM can be reduced or even lost if KAM are too general and stated in a standardized form, if the same KAM are stated every year even though the circumstances of the audited client change from year to year, if a large number of KAM are disclosed and too extensive explanations are given and if KAM are complex and contain technical terms.

Additional research needs to be carried out. It is necessary to apply the same research methodology to different samples, the samples of different categories of investors, managers and auditors, to apply it in countries characterized by different institutional frameworks, different degrees of financial markets development, financial reporting quality and audit quality, and that the obtained results are compared. The researchers should focus on the factors that determine whether certain effects of KAM disclosure in the auditor's report will be manifested.

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INSTRUCTIONS FOR AUTHORS

The Proceedings of the Faculty of Economics in East Sarajevo (*Зборник радова Економског факултета у Источној Сарајеву*) is an economic journal with a general orientation and it is published yearly. We publish original scientific papers, scientific reviews, preliminary reports, conference papers, professional papers and book reviews. Only original papers not previously published or simultaneously submitted for publishing elsewhere, should be submitted. Submitted papers need to be prepared according to the The Proceedings of the Faculty of Economics in East Sarajevo Instructions for Authors.

Papers should be submitted electronically, as an open document (Word and PDF format), zrefis@ekofis.ues.rs.ba, in due time. Submissions that do not reach the scheduled date or do not meet the recommendations in the Instructions will not be submitted for review and will not be published in the Proceedings.

Authors should strictly adhere to the submission instructions for authors. Papers that do not adhere to the instructions will not enter the reviewing process.

A paper must be written in text processor *Microsoft Word*, using font *Times New Roman* (size 12), in the Cyrillic alphabet, spacing (1). **Page setup:** A4, Margins: top 2 cm; bottom 2 cm; left 2,5 cm; right 2,5 cm. Paper needs to have the length of up to 30,000 characters (16 pages). The exception from this are reviews which may be up to 50,000 characters long. A paper needs to be proof read.

Paper title. In the upper left corner there should be the family name, title and author's name (Times New Roman, 12). Example: Last name PhD (MA.) name or last name and name, BSc in Economics. The footnote on the first page shows scientific title of the author, name and address of the institution the author is employed with as well as the e-mail address of the author. The precise title of the paper (TNR, 14, bold) is three spaces below, in the middle of the page, written in capital letters.

Summary. Summary, with the length of 50-150 words, should be at the beginning of the paper, under the title, two spaces below (TNR, 11, italic). Key words are at the end of the summary, a single line below (up to five key words). At least one classification code of the Classification System for the Journal Articles, as used by the Journal of Economic Literature (JEL: http://www.aeaweb.org/journal/jel_class_system.php), should be included, also a single line below.

Headings and subheadings.

- a) INTRODUCTION (TNR, 12, bold), text TNR 12, two spaces after keywords.
- b) The main headings in the paper should be TNR 12, in capital letters, bold, aligned to the left margin. Among the titles in the paper there should be a single blank line. Main headlines are marked by ordinal number 1.; 2., etc..
- c) Subtitles, the second level, TNR 12, bold, aligned to the left margin.
- d) Subtitles, third level, TNR 12, aligned to the left margin.
- e) CONCLUSION (TNR, 12, bold), text TNR 12.

Language of the paper. Papers shall be submitted in English and Serbian (Croatian, Bosnian) language.

Summary in English. In the top left corner is the name and surname of the author (TNR, 12). Three spaces below is the TITLE OF THE PAPER in English (TNR, 14, bold). Then, two spaces below follows the Summary (TNR 12, bold), followed by text (TNR 11, italic). After the text, a single line below are Key words (TNR 12, bold): Key word 1, key word 2, ... key word 5 (TNR 11, italic) and a single space below JEL classification (TNR 12, bold): E04, B12 (TNR 11, italic).

The Proceedings of the Faculty of Economics in East Sarajevo uses THE CHICAGO MANUAL OF STYLE (AUTHOR – DATE SYSTEM).

Reference to individuals, articles and book in the text – Basic structure of an in-text citation. Citation in the text usually appears in parentheses and includes only the first two elements in a reference list—the author and the year of publication (hence the name of the system), with no intervening punctuation. In addition, a page number or other locator may be added, following a comma. Terms such as editor or translator, abbreviated in a reference list, are not included in a text citation.

Quotations. Any quotation, regardless of its length, needs to be followed by reference including page number. For any quotation longer than 350 characters, an author must have written approval by copy rights owner that needs to be enclosed.

Tables, charts, and pictures. Tables and graphs need to be made in *Word* or some other Word compatible format. Tables and graphs from statistical programs should be transferred into Word format. Same data may not be presented both in tables and charts. Every table, chart, or picture should be marked with number and adequate name, e.g.: Table 2: The Reliability of the Variables. The name of the table, graphic or image is placed above, TNR 11, normal, two lines between the table and the text. Pictures need to be sent in electronic form with the resolution of at least 300 dpi. If illustration from printing source is used, written authorization by copy rights owner is necessary. Source should be placed below tables, charts, and pictures. Quotations in the given Source are used in the same way as in the text. If the tables, charts, and figures are author'(s) calculations, reviews or estimations, that should also be emphasized.

Statistics. The results of statistical tests need to be provided in the following form: $F(1.9) = 25.35$; $p < .001$ or similar. Lower numbers of conventional P levels should also be stated (e.g.: .05, .01, .001).

References. The Proceedings of the Faculty of Economics in East Sarajevo uses **The Chicago Manual of Style** for references. Reference section must be single-spaced, beginning on a new page following the text, giving full information. Use full names of authors or editors using initials only if that is the usage of the particular author/editor. List all author/editors up to/ including 10 names. Authors of articles and books and material without specific authors or editors, such as government documents, bulletins, or newspapers, are to be listed alphabetically. Most references in the Reference section should be referenced (included) in the text.

Appendix. In the appendix, only those descriptions of material that would be useful for readers to understand, evaluate, or revise research should be provided.

Footnotes and abbreviations. Footnotes should be avoided. If necessary, references in the footnotes should be used in the same way as in the text. Abbreviations should also be avoided, except from exceptionally usual ones. The abbreviations stated in tables and pictures should be explained.

Reviews and publishing. All papers are anonymously reviewed by two anonymous reviewers. On the basis of reviews, the editorial staff makes decision on paper publishing and informs the author.

THE CHICAGO MANUAL OF STYLE - AUTHOR-DATE SYSTEM

The following examples illustrate the author-date system. Each example of a reference list entry is accompanied by an example of a corresponding in-text citation. For more details and many more examples, see [chapter 15](#) of *The Chicago Manual of Style 17*.

BOOK

Reference list entries (in alphabetical order)

Grazer, Brian, and Charles Fishman. 2015. *A Curious Mind: The Secret to a Bigger Life*. New York: Simon & Schuster.

Smith, Zadie. 2016. *Swing Time*. New York: Penguin Press.

In-text citations

(Grazer and Fishman 2015, 12)

(Smith 2016, 315–16)

For more examples, see [15.40–45](#) in *The Chicago Manual of Style*.

Two or more authors

In references:

Ward, Geoffrey C., and Ken Burns. 2007. *The War: An Intimate History, 1941–1945*. New York: Knopf.

In text:

(Ward and Burns 2007, 52)

For four or more authors, list all of the authors in the reference list; in the text, list only the first author, followed by *et al.* (“and others”):

In references:

Johnson, Norine G., Michael C. Roberts, and Judith Worell. 2001. *Beyond Appearance: a New Look at Adolescent Girls*. Washington, DC: American Psychological Association.

In text:

(Johnson et al. 2010)

CHAPTER OR OTHER PART OF AN EDITED BOOK

In the reference list, include the page range for the chapter or part. In the text, cite specific pages.

Reference list entry

Thoreau, Henry David. 2016. “Walking.” In *The Making of the American Essay*, edited by John D’Agata, 167–95. Minneapolis: Graywolf Press.

In-text citation

(Thoreau 2016, 177–78)

In some cases, you may want to cite the collection as a whole instead.

Reference list entry

D’Agata, John, ed. 2016. *The Making of the American Essay*. Minneapolis: Graywolf Press.

In-text citation

(D’Agata 2016, 177–78)

For more details, see [15.36](#) and [15.42](#) in *The Chicago Manual of Style*.

TRANSLATED BOOK

Reference list entry

Lahiri, Jhumpa. 2016. *In Other Words*. Translated by Ann Goldstein. New York: Alfred A. Knopf.

In-text citation

(Lahiri 2016, 146)

E-BOOK

For books consulted online, include a URL or the name of the database in the reference list entry. For other types of e-books, name the format. If no fixed page numbers are available, cite a section title or a chapter or other number in the text, if any (or simply omit).

Reference list entries (in alphabetical order)

Austen, Jane. 2007. *Pride and Prejudice*. New York: Penguin Classics. Kindle.

Borel, Brooke. 2016. *The Chicago Guide to Fact-Checking*. Chicago: University of Chicago Press. ProQuest Ebrary.

Kurland, Philip B., and Ralph Lerner, eds. 1987. *The Founders’ Constitution*. Chicago: University of Chicago Press. <http://press-pubs.uchicago.edu/founders/>.

Melville, Herman. 1851. *Moby-Dick; or, The Whale*. New York: Harper & Brothers. <http://mel.hofstra.edu/moby-dick-the-whale-proofs.html>.

In-text citations

(Austen 2007, chap. 3)

(Borel 2016, 92)

(Kurland and Lerner 1987, chap. 10, doc. 19)

(Melville 1851, 627)

JOURNAL ARTICLE

In the reference list, include the page range for the whole article. In the text, cite specific page numbers. For articles consulted online, include a URL or the name of the database in the reference list entry. Many journal articles list a DOI (Digital Object Identifier). A DOI forms a permanent URL that begins <https://doi.org/>. This URL is preferable to the URL that appears in your browser's address bar.

Reference list entries (in alphabetical order)

Keng, Shao-Hsun, Chun-Hung Lin, and Peter F. Orazem. 2017. "Expanding College Access in Taiwan, 1978–2014: Effects on Graduate Quality and Income Inequality." *Journal of Human Capital* 11, no. 1 (Spring): 1–34. <https://doi.org/10.1086/690235>.

LaSalle, Peter. 2017. "Conundrum: A Story about Reading." *New England Review* 38 (1): 95–109. Project MUSE.

Satterfield, Susan. 2016. "Livy and the *Pax Deum*." *Classical Philology* 111, no. 2 (April): 165–76.

In-text citations

(Keng, Lin, and Orazem 2017, 9–10)

(LaSalle 2017, 95)

(Satterfield 2016, 170)

Journal articles often list many authors, especially in the sciences. If there are four or more authors, list up to ten in the reference list; in the text, list only the first, followed by *et al.* ("and others"). For more than ten authors (not shown here), list the first seven in the reference list, followed by *et al.*

Reference list entry

Bay, Rachael A., Noah Rose, Rowan Barrett, Louis Bernatchez, Cameron K. Ghalambor, Jesse R. Lasky, Rachel B. Brem, Stephen R. Palumbi, and Peter Ralph. 2017. "Predicting Responses to Contemporary Environmental Change Using Evolutionary Response Architectures." *American Naturalist* 189, no. 5 (May): 463–73. <https://doi.org/10.1086/691233>.

In-text citation

(Bay et al. 2017, 465)

For more examples, see [15.46–49](#) in *The Chicago Manual of Style*.

NEWS OR MAGAZINE ARTICLE

Articles from newspapers or news sites, magazines, blogs, and the like are cited similarly. In the reference list, it can be helpful to repeat the year with sources that are cited also by month and day. Page numbers, if any, can be cited in the text but are omitted from a reference list entry. If you consulted the article online, include a URL or the name of the database.

Reference list entries (in alphabetical order)

Manjoo, Farhad. 2017. "Snap Makes a Bet on the Cultural Supremacy of the Camera." *New York Times*, March 8, 2017. <https://www.nytimes.com/2017/03/08/technology/snap-makes-a-bet-on-the-cultural-supremacy-of-the-camera.html>.

Mead, Rebecca. 2017. "The Prophet of Dystopia." *New Yorker*, April 17, 2017.

Pai, Tanya. 2017. "The Squishy, Sugary History of Peeps." *Vox*, April 11, 2017. <http://www.vox.com/culture/2017/4/11/15209084/peeps-easter>.

Pegoraro, Rob. 2007. "Apple's iPhone Is Sleek, Smart and Simple." *Washington Post*, July 5, 2007. LexisNexis Academic.

In-text citation

(Manjoo 2017)

(Mead 2017, 43)

(Pai 2017)

(Pegoraro 2007)

Readers' comments are cited in the text but omitted from a reference list.

In-text citation

(Eduardo B [Los Angeles], March 9, 2017, comment on Manjoo 2017)

For more examples, see 15.49 (newspapers and magazines) and 15.51 (blogs) in *The Chicago Manual of Style*.

BOOK REVIEW

Reference list entry

Kakutani, Michiko. 2016. "Friendship Takes a Path That Diverges." Review of *Swing Time*, by Zadie Smith. *New York Times*, November 7, 2016.

In-text citation

(Kakutani 2016)

INTERVIEW

Reference list entry

Stamper, Kory. 2017. "From 'F-Bomb' to 'Photobomb,' How the Dictionary Keeps Up with English." Interview by Terry Gross. *Fresh Air*, NPR, April 19, 2017. Audio, 35:25.
<http://www.npr.org/2017/04/19/524618639/from-f-bomb-to-photobomb-how-the-dictionary-keeps-up-with-english>.

In-text citation

(Stamper 2017)

THESIS OR DISSERTATION

Reference list entry

Rutz, Cynthia Lillian. 2013. "*King Lear* and Its Folktale Analogues." PhD diss., University of Chicago.

In-text citation

(Rutz 2013, 99–100)

WEBSITE CONTENT

It is often sufficient simply to describe web pages and other website content in the text ("As of May 1, 2017, Yale's home page listed . . ."). If a more formal citation is needed, it may be styled like the examples below. For a source that does not list a date of publication or revision, use *n.d.* (for "no date") in place of the year and include an access date.

Reference list entries (in alphabetical order)

Bouman, Katie. 2016. "How to Take a Picture of a Black Hole." Filmed November 2016 at TEDxBeaconStreet, Brookline, MA. Video, 12:51. https://www.ted.com/talks/katie_bouman_what_does_a_black_hole_look_like.

Google. 2017. "Privacy Policy." Privacy & Terms. Last modified April 17, 2017.
<https://www.google.com/policies/privacy/>.

Yale University. n.d. "About Yale: Yale Facts." Accessed May 1, 2017. <https://www.yale.edu/about-yale/yale-facts>.

In-text citations

(Bouman 2016)

(Google 2017)

(Yale University, n.d.)

For more examples, see 15.50–52 in *The Chicago Manual of Style*. For multimedia, including live performances, see 15.57.

SOCIAL MEDIA CONTENT

Citations of content shared through social media can usually be limited to the text (as in the first example below). If a more formal citation is needed, a reference list entry may be appropriate. In place of a title, quote up to the first 160 characters of the post. Comments are cited in reference to the original post.

Text

Conan O'Brien's tweet was characteristically deadpan: "In honor of Earth Day, I'm recycling my tweets" (@ConanOBrien, April 22, 2015).

Reference list entries (in alphabetical order)

Chicago Manual of Style. 2015. "Is the world ready for singular they? We thought so back in 1993." Facebook, April 17, 2015. <https://www.facebook.com/ChicagoManual/posts/10152906193679151>.

Souza, Pete (@petesouza). 2016. "President Obama bids farewell to President Xi of China at the conclusion of the Nuclear Security Summit." Instagram photo, April 1, 2016. <https://www.instagram.com/p/BDrmfXTtNCt/>.

In-text citations

(Chicago Manual of Style 2015)

(Souza 2016)

(Michele Truty, April 17, 2015, 1:09 p.m., comment on Chicago Manual of Style 2015)

PERSONAL COMMUNICATION

Personal communications, including email and text messages and direct messages sent through social media, are usually cited in the text only; they are rarely included in a reference list.

In-text citation

(Sam Gomez, Facebook message to author, August 1, 2017)

The author receives a copy of the Proceedings in which his/her paper was published. Only those papers that are written in accordance with the above guidelines will be sent for review. For reviewers, the papers are anonymous.

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The journal was, according to the Ministry of Science and Technology Republic of Srpska, won 34 out of a possible 40 points, and thus classified in the first category of scientific journals.

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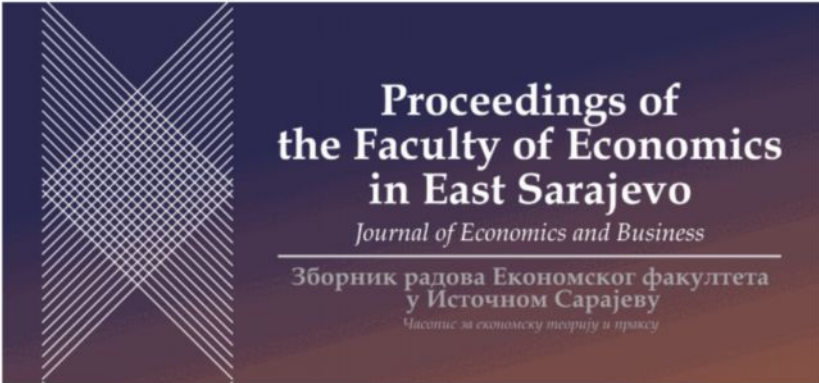
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