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held in Iasi, Romania, October 20-22, 2022,
organised by the
Alexandru Ioan Cuza University of Iasi, Faculty of Economics and Business Administration

Guest editor:
Prof. dr. Seyed Mehdian, University of Michigan-Flint, United States

Editura Universității „Alexandru Ioan Cuza“ din Iași

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Foreword

Cristina Teodora Roman*

Through research, development, and innovation, the academic environment must channel its resources to find answers to the needs and problems of the wider community of which it is a part. Knowledge must return to the community, and for this, the university can only be a powerful center for the propagation of ideas and an engine of development and social change.

I firmly believe that a university is defined, first of all, by the values it serves and promotes in a real way in its daily activity. Our common goal is to promote international cooperation between universities and researchers, stimulate networking activities amongst scholars working in the same field, and facilitate the dissemination of new ideas. In universities and academic research institutes, there are, at this moment, a large number of authentic, dedicated, highly professionally trained researchers ready to tackle the most delicate and sophisticated topics in the field. In order for this intellectual capital not to be wasted these scientific meetings are necessary.

A nation has more chances of economic development, of individual prosperity, and of fulfilling the democratic principles if its citizens and its leaders have a minimum acceptable stock of scientific knowledge.

There's a good likelihood that virtual learning – in some capacity – will need to be a part of education for the foreseeable future. Although the accelerated digitization we witnessed results from an unforeseen event, we can use this opportunity to identify the best pedagogical practices in online education.

The crisis caused by the pandemic had a series of unintended consequences on the educational landscape at all levels, creating a new reality in education.

Previously, when higher education institutions thought of digital transformation, it was to achieve greater access, global reach, personalized instruction, and rapid improvements in pedagogical practices. Now, as schools contemplate the possibility that students may not be allowed on campus in traditional ways for extended periods of time, risk mitigation will become an equally important driver of digital transformation and allow universities to continue enrolling – and serving – students. Universities that build digital capabilities will have the resilience to seamlessly pivot through any crisis, whether an extended Covid-19 outbreak or a future calamity.

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Guest Editor's Introduction

Seyed Mehdian*

The Globalization and Higher Education in Economics and Business Administration (GEBA) Conference has been sponsored by the Alexandru Ioan Cuza University (AICU) and organized by the Faculty of Economics Business Administration (FEBA) in Iasi, Romania since 2008. GEBA allows scholars to exchange views on various aspects of business and economics. The conference seeks to encourage and facilitate international collaboration in Economics and Business Administration in Higher Education.

This special issue contains a staple of the peer-reviewed articles presented at the 2022 GEBA conference.

I hope you enjoy reading the articles in this special issue and find the topics and cores of the articles beneficial in your future research and as a starting point and encouragement for partnerships among scholars in every corner of the globe.

Eight papers included in this volume focus on empirical and theoretical research and their essential contribution to the current literature.

In the first paper, Duarte *et al.* (2023) use GARCH models to compare the volatilities of a set of digital assets such as Bitcoin, Ethereum, Dogecoin, etc., and the volatilities of several currencies such as Yuan, Yen, Euro, etc. The paper's empirical results show high fluctuations in the prices of these assets compared to the volatilities of currencies. This topic is timely and appropriate; there is an increasing interest in research to understand the behavior of prices of cryptocurrencies.

The second paper, by Georgescu *et al.* (2023), investigates the relationship between economic growth and digitalization by employing the input-output Data Envelopment approach. The empirical results of these authors suggest a bidirectional relationship between economic growth and digitalization.

In the third article (Onofrei *et al.*, 2023), the data from European counties from 2004 to 2020 and regression equations are used and provide evidence to suggest environmental effects have a positive impact on attracting direct investments.

The focus of the fourth article (Hurbean *et al.*, 2023) is to examine the association between Business intelligence and analytics systems and an individual's decision-making effectiveness and job performance.

In the fifth paper, Alexeeva-Alexeev (2023) uses a sample of 1510 Information and Communications Technology companies from 23 countries with 17,342 observations from 2004 to 2019 to investigate the motivations behind the financial decisions of these companies. One of the significant findings of this study is that ICT firms are exposed to high volatility of earnings before interest and taxes increase the use of high leverage,

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In the sixth article, Sirbu *et al.* (2023) use the ordered logit regression methodology to examine and identify the impact of the sub-indicator of economic freedom on well-being. The results of this study suggest the quality of institutions responsible for property and monetary policy positively affects subjective well-being.

In the seventh paper, Neacșu and Georgescu (2023) study the relationship between sustainable development and financial performance. These authors suggest that future studies on this topic should focus on analyzing the effect of internal and external factors to enhance their financial performance and organizational strength.

The last paper of this volume, by Ruíz Guillermo *et al.* (2023), uses a definition of progressivity to establish the relationship between this variable and subjective well-being. These authors note that this indicator is not significant in their sample.

In closing, I want to thank AICU and FEBA for inviting me to work as the invited editor for this issue. It has certainly been a pleasure and honor for me. This special issue would not have been possible without resourcefulness and diligence. Special thank goes to all scholars who participated in this conference to share the outcome of their research with the conference participants and those who submitted their articles to be reviewed for this issue. I am also grateful to the anonymous reviewers for their time and thoughtful and constructive feedback in furthering the quality of the manuscripts. Finally, special credit goes to Professor Ovidiu Stoica, the Editor-in-Chief of the Scientific Annals of Economics and Business, who guided and assisted me at every stage of this endeavor.

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Flip the Coin: Heads, Tails or Cryptocurrencies?

António Portugal Duarte*, Fátima Sol Murta, Nuno Baetas da Silva***, Beatriz Rodrigues Vieira§**

Abstract: This paper analysis and compares the volatility of seven cryptocurrencies – Bitcoin, Dogecoin, Ethereum, BitcoinCash, Ripple, Stellar and Litecoin – to the volatility of seven centralized currencies – Yuan, Yen, Canadian Dollar, Brazilian Real, Swiss Franc, Euro and British Pound. We estimate GARCH models to analyze their volatility. The results point to a considerably high volatility of cryptocurrencies when compared to that of centralized currencies. Therefore, we conclude that cryptocurrencies still fall far short of fulfilling all the requirements to be considered as a currency, specifically regarding the functions of store of value and unit of account.

Keywords: centralized currencies; cryptocurrencies; GARCH models; volatility.

JEL classification: E51; G12; G15; G17; G23.

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1. INTRODUCTION

Cryptocurrencies – especially the most famous one, the Bitcoin – are very popular and are a controversial topic in the economic literature nowadays (Kristoufek, 2013; Yermack, 2013; Baur *et al.*, 2018; Aalborg *et al.*, 2019; Cagli, 2019; Makarov & Schoar, 2020; BIS, 2021). Cryptocurrencies use to buy goods and services is increasing and they are becoming an important medium of exchange. However, they are far from assuming all the functions inherent to the centralized currencies, especially the unit of account and store of value. The main reasons for that is their high level of price volatility and their speculative nature (Cheah & Fry, 2015; Dyhrberg, 2016; Blau, 2017; Katsiampa, 2019a; Tiwari *et al.*, 2020) as well as the fact that the cryptocurrencies are associated with illegal activities (Aldridge & Askew, 2017; Durrant, 2018; Choi *et al.*, 2020; Cuervo *et al.*, 2020).

Since the creation of Bitcoin in 2008 (Nakamoto, 2008), cryptocurrencies are seen as an alternative investment, especially in periods of crisis, which can indicate that they may assume the function of store of value or even unit of account. However, the excessive price volatility is a problem and without its elimination, the fulfillment of these functions will be impossible.

This paper analyzes the volatility of seven cryptocurrencies (Bitcoin, Dogecoin, Ethereum, BitcoinCash, Ripple, Stellar and Litecoin), compared to the volatility of seven centralized currencies from different economic backgrounds (Yuan, Yen, Canadian Dollar, Brazilian Real, Swiss Franc, Euro, and Pound Sterling).

Regarding the methodology, we estimate Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) models. Our results point to the existence of strong volatility cryptocurrencies' returns, in line with other papers (Yermack, 2013; Balcilar *et al.*, 2017; Yi *et al.*, 2018; Bouri *et al.*, 2019; Katsiampa, 2019b; Katsiampa *et al.*, 2019; Kumar & Anandarao, 2019; BIS, 2021). The volatility of cryptocurrencies is significantly higher than the volatility of currencies. For that reason, cryptocurrencies will have a hard time being considered a measure of value and a standard of value. For now, they can only fulfill the function of means of payment. This paper gives an additional value to the economic literature because it compares several cryptocurrencies against various currencies from different economic and geographic areas with distinct dynamics. To best of our knowledge this is the first time that the volatility of cryptocurrencies and currencies is compared. Therefore, we contribute empirically to the debate around the role of the cryptocurrencies, in the line of Eichengreen (2019).

The paper has five sections. Section 2 presents a brief literature review. Section 3 is dedicated to describing the data and the methodology. Section 4 presents and discusses the main results. Finally, Section 5 draws the conclusions.

2. LITERATURE REVIEW

We live in a world of fiat money since the development of societies led to an evolution of the concept of money, the most recent being digital money. Commodity money was the first concept in the primitive economies. Later, representative currency appeared. Nowadays, we have fiat money, which is legal and is issued and controlled by central banks – the euro, for example, issued by the European Central Bank (ECB). Fiat money exists in physical forms (banknotes and coins), and bank deposits (a computer record). There are even countries in Europe (e.g. Netherlands and Sweden) where electronic payments are superior to cash payments

because they are more convenient, safer, and cheaper. Recently, cryptocurrencies appeared, the most famous being the Bitcoin. They are not supervised by any regular entity or central bank (Spahn, 2001; Helleiner, 2002; McLeay *et al.*, 2014; Eichengreen, 2019; BIS, 2021).

Jevons (1896) defined three functions that an asset must satisfy in order to be considered money. First, it must be means of payment. This function allows for saving time and reducing transaction costs. Another function is unit of account (it makes possible to compare prices of goods and services, as well as assign them a value). Last but not least, money need to be store of value over time. Economic agents should be able to use a currency for investments, as well as preserve their purchase power.

Despite these three functions that an asset must satisfy to be considered a currency, Hazlett and Luther (2020) are convinced that what matters is whether the asset is accepted by the economic agents. On this point, the world of cryptocurrencies, with an ascending acceptance and use, seems to be gaining ground in replacing currencies in the near future. Nevertheless, at best, cryptocurrencies are only an imperfect substitute for currencies.

The first cryptocurrency considered successful, with the highest capitalization index and the most users on social media and online exchange offices, was Bitcoin, created by Nakamoto (2008). This cryptocurrency resolves a potential problem associated with digital currencies, the double-spending problem. It consists of the lack of a mechanism that prevents the user from using the digital currency for more than one payment (Bação *et al.*, 2018). Bitcoin is a peer-to-peer mechanism and because of its algorithm and the cryptography used in Blockchain, this problem does not exist. This cryptocurrency is traded without the intermediation and supervision of any monetary authority. The transactions are verified by each user and, at the same time, are recorded on Blockchain, which is publicly available (Duarte *et al.*, 2018). Each transaction creates a new block that is connected to the previous transaction. In each block a new code that identifies the transaction is created, called hash, which is also connected to the previous code, called previous hash.

Compared to other cryptocurrencies, Bitcoin has a particularity, its offer is limited to 21 million units. Nowadays, 18 million Bitcoins are in circulation. While the Central Banks have the monopoly of creating money and can control their offer with monetary policies, this does not happen in the cryptocurrency world. This eliminates the possibility of inflationary processes. On the contrary, deflation is more likely.

Despite this advantage, the lack of monetary policy drives the cryptocurrencies out of the realm of currencies. Yermack (2013) highlights the high volatility of Bitcoin and cryptocurrency in general, which can jeopardize the possibility of their being affirmed as a currency. Other authors (Fink & Johann, 2014; Cheah & Fry, 2015; Dyhrberg, 2016; Blau, 2017; Katsiampa, 2019b; Tiwari *et al.*, 2020) empirically confirm this reality, as well as its speculative nature, which does not contribute to the possibility of cryptocurrencies fulfilling the functions of measure and standard of value.

Regarding the measure of value Wallace (2011) mentions the episode of the first purchase of goods through Bitcoin on the 21st of May 2010. Two pizzas were bought for 10,000 Bitcoins which equaled 25 dollars at the time. Today, at the current price of Bitcoin, this purchase would represent more than 500 million dollars. Therefore, cryptocurrencies will have a hard time functioning as a measure of value and standard of value, due to their price instability.

Recently, Hazlett and Luther (2020) point out that since Bitcoin is frequently used as a medium of exchange that can be enough to consider it a currency. Some countries have already accepted Bitcoin (e.g., El Salvador) as a medium of exchange.

The increase in the use of cryptocurrencies as a medium of exchange, with the lack of financial regulation, results in associating their use with criminal activities, such as money laundering, drug or gun trafficking[1]. Cryptocurrencies payments are similar to Cash payments. They use a decentralized system without visible intermediates and allow anonymous transactions, and for that reason, they are often related to illegal activities (Durrant, 2018; Swammy *et al.*, 2019; Choi *et al.*, 2020; Cuervo *et al.*, 2020; BIS, 2021; Hendrickson & Luther, 2021).

However, as Steinmetz *et al.* (2021) mentions, this association is made by those who know little about cryptocurrencies. The fact that every transaction is recorded in the Blockchain discourages or even prevents the use of cryptocurrencies for illicit activities since it is possible to know who is involved. According to Pacheco (2018), only 1% of all transactions of Bitcoin relate to illegal activities. However, about 3 to 5% of the fiat money economy results from illicit activities.

The impact that cryptocurrencies have been having on the global economy is high. Nowadays there are more than 6,500 cryptocurrencies in circulation, according to CoinMarketCap[2]. Most central banks have warned about the increase in using cryptocurrencies and their legality, in particular, for the possibility of using them for corruption. Gonzálvez-Gallego and Pérez-Cárceles (2021) believe that using cryptocurrencies should be promoted and not dismissed as long as there are policies that control their use. However, that is a bit ironic: if policies existed, it would no longer be a decentralized system. The authors also mention that the governments need to promote stable financial institutions, because that alone would prevent people from choosing cryptocurrencies instead of currencies. We must keep in mind that the cryptocurrency phenomenon began due to the instability caused by the financial crisis of 2008.

Another option is the creation of centralized cryptocurrencies (BIS, 2021; Auer *et al.*, 2022).This hypothesis is being considered by many central banks, such as the ECB, the Bank of England, and the Central Bank of Sweden, which propose their own digital coins, the Central Bank Digital Currencies (CBDC). The U.S. Federal Reserve is still considering how CBDC may fit into the U.S. money and payments landscape (Board of Governors of the Federal Reserve System, 2022).

The Central Bank of Sweden, Riksbank, although the oldest in Europe, is the first one in the race to create a CBDC, the eKrona. This project is still in a pilot phase, studying what effects this digital currency would have on the economy and Sweden's laws, as well as what the best model would be for its creation (Sveriges, 2021). The goal is that eKrona could work as a complement to physical money and have a system of use accessible to the entire population. It should be noted (Duarte, 2022) that the launch of this project was driven by the increasing dematerialization of money in Sweden, a fact that the central bank believes could result in situations of marginalization, with a user wanting to pay in physical money and the seller no longer accepting it.

Like Sweden's case, China is also in the race to develop a digital currency. According to the BBC[3], cryptocurrency transactions are forbidden in this country since 2019. Still, according to Forbes[4], China intends to create its own digital currency that is supervised and

centralized, going against the initial concept of what a cryptocurrency is (BIS, 2021; Goodell & Al-Nakib, 2021; Lee *et al.*, 2021).

Despite the announcement of these pilot projects, the Bahamas was the first country to effectively launch a global CBDC, called the "Sand dollar", in October 2020. In February 2021, the United Arab Emirates joined China, Hong Kong, and Thailand in a joint cross-border CBDC to test the use of Distributed Ledger Technology (DLT) for foreign currency payments.

The UK, Japan and the ECB are also considering their entry into digital currencies. The digitization of central bank currencies is in fact a global rapidly growing process, particularly in the euro area. It is expected that the launch of a digital euro will revolutionize the lives of all European economic agents through the changes it will introduce in their lives, and in the way payments are made in the future (Duarte, 2022).

The digital euro project was announced by the ECB in July 2021, right in the middle of the Covid-19 pandemic. This does not mean, however, that the ECB will necessarily issue a digital euro immediately, but rather that it will get ready to possibly issue it in the near future, considering any changes in the European legislation that may have to be made. As mentioned by the ECB[5], a digital euro will guarantee that agents in the euro area can maintain cost-free access to a simple, universally accepted, safe and trusted means of payment. The digital euro will still be a euro, like banknotes and coins, but digital, turning the euro area into a global digital player. It will be an electronic form of money issued by the ECB and national central banks and accessible to all economic agents. A digital euro will not replace cash, but rather complement it. The Eurosystem will continue to ensure that European citizens would have access to cash across the euro area, giving them an additional option for making payments, thus contributing to greater accessibility and inclusion in the European financial space. Using a digital euro, agents could have the same level of confidence as with bank currencies, since they would be both backed by the monetary authority. A digital euro would consequently become a digital symbol of progress and integration in Europe[6].

3. DATA AND METHODOLOGY

This paper analyzes the volatility of seven cryptocurrencies (Bitcoin, Dogecoin, Ethereum, BitcoinCash, Ripple, Stellar and Litecoin), compared to the volatility associated with money, specifically Yuan (CNY), Yen (JPY), Canadian Dollar (CAD), Brazilian Real (BRL), Swiss Franc (CHF), Euro (EUR) and Pound Sterling (GBP). These currencies belong to different monetary and geographic areas, thereby allowing a more robust analysis. The data consists of the daily prices of both, cryptocurrencies and currencies.

The cryptocurrency data was collected from the Coindesk site (https://www.coindesk.com/, accessed November 6th, 2021), and refers to the closing prices in American dollars (USD). For each currency, we considered the daily exchange rates in USD. This data was collected from the Federal Reserve Bank of Saint Louis (https://www.stlouisfed.org/, accessed November 6th, 2021).

For each variable, we tried to collect the greatest number of observations possible. Table no. 1 shows the data available (initial observation and final) for the seven cryptocurrencies.

Table no. 1 – Cryptocurrencies (initial observation and final observation)

Criptocurrency	Initial Observation	Final Observation
Bitcoin (BTC)	03/11/2014	05/11/2021
Dogecoin (DOGE)	27/02/2019	05/11/2021
Ethereum (ETH)	16/12/2016	05/11/2021
BitcoinCash (BCH)	01/02/2018	05/11/2021
Ripple (XRP)	01/06/2018	05/11/2021
Stellar (XLM)	01/12/2018	05/11/2021
Litecoin (LTC)	01/02/2018	05/11/2021

Source: authors, using CoinDesk (2021, accessed November 6th, 2021)

The cryptocurrency with the lowest number of observations is Dogecoin (DOGE), with an initial observation only on 27/02/2019. For that reason, in this study the period of analysis starts in that date, in order to have a fair and comparative analysis. The period of the analysis extends from 27/02/2019 to 05/11/2021, which gives us a significant number of observations, since we are working with high-frequency data. It is important to note that the cryptocurrency market functions daily, while the currency market is only available on workdays. Figures no. 1 and no. 2 illustrate the evolution of the daily prices of cryptocurrencies and exchange rates in USD, respectively.

Looking at Figure no. 1, we observe a general growth in the prices of cryptocurrencies since the beginning of 2021. After May 2021, there was a significant increase in almost every cryptocurrency. Bitcoin (BTC) clearly has the highest prices compared to the other cryptocurrencies, presenting its highest value on October 26th, 2021, when one BTC was worth 63.081,80 dollars. In contrast, we have Dogecoin (DOGE), with the lowest prices. The highest price was reached on May 8th, 2021, with a value of 0.72 dollars per unit.

As for the seven currencies (Figure no. 2), they do not present significant changes in their exchange rate. Still, some currencies, for example, the Brazilian Real (BRL) show a high depreciation, in particular since January 2020. In contrast, we have the Yuan (CNY), which, since May 2020, has shown a significant trend of appreciation. In both cases, the relative volatility of these currencies is low, which naturally gives them an advantage compared to cryptocurrencies in being considered a measure of value and a standard of value.

Since the main focus of this paper is to analyze the volatility of the cryptocurrencies and comparing it with the volatility of the chosen currencies, following e.g., Bouri *et al.* (2019); Katsiampa (2019b); Kumar and Anandarao (2019) we started by computing the return (the first difference of the logarithm).

The econometric model that is used to study the volatility of the series of our study is the Generalized AutoRegressive Conditional Heteroskedasticity (GARCH), developed by Robert Engle (Engle, 1982; Bollerslev, 1986). The ARCH/GARCH models are frequently used to model financial time series that show clusters of volatility over time. There are periods with high instability alternating with stable periods.

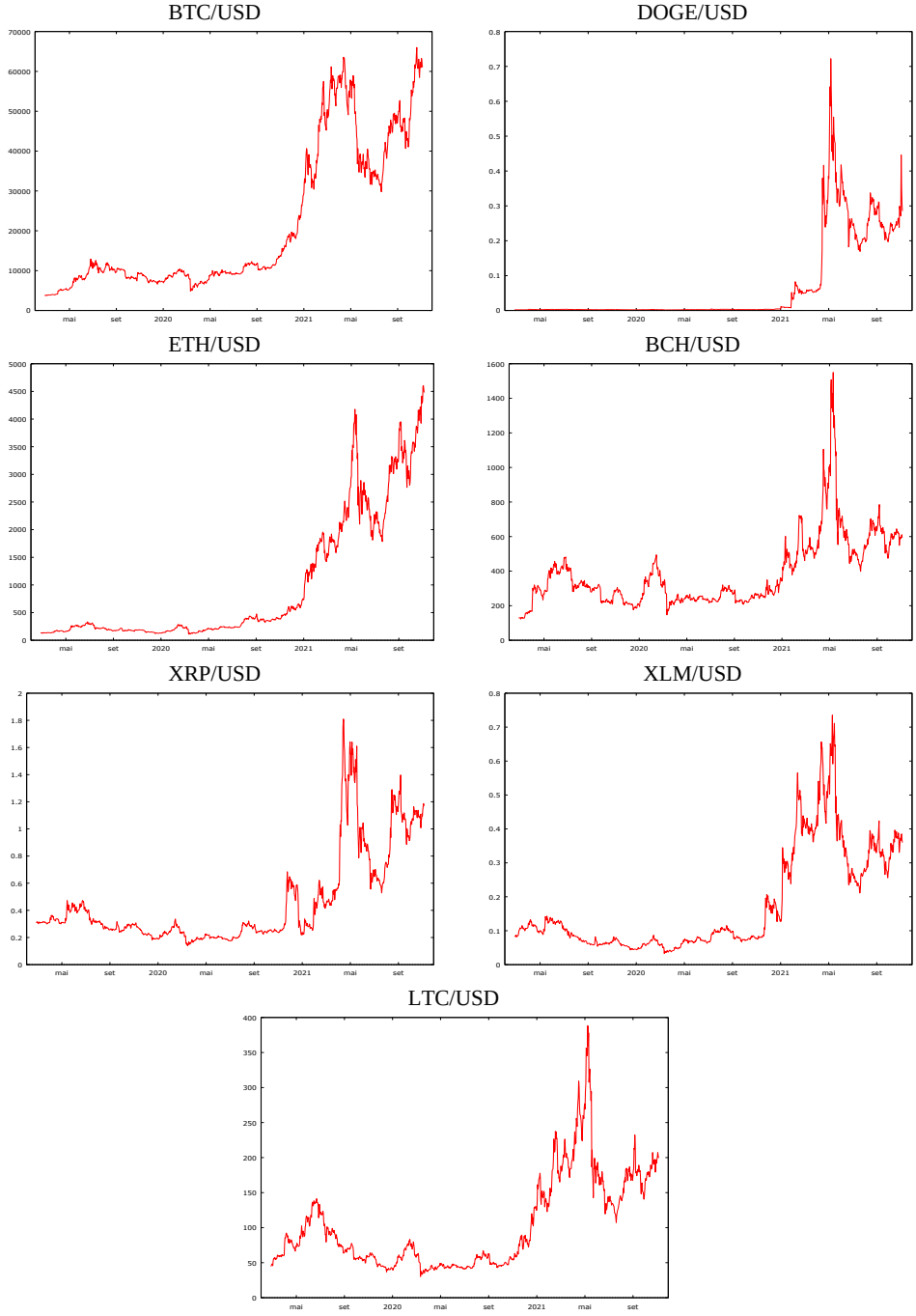

Figure no. 1 – Cryptocurrency daily prices in USD

Source: authors, using CoinDesk (2021, accessed November 6th, 2021)

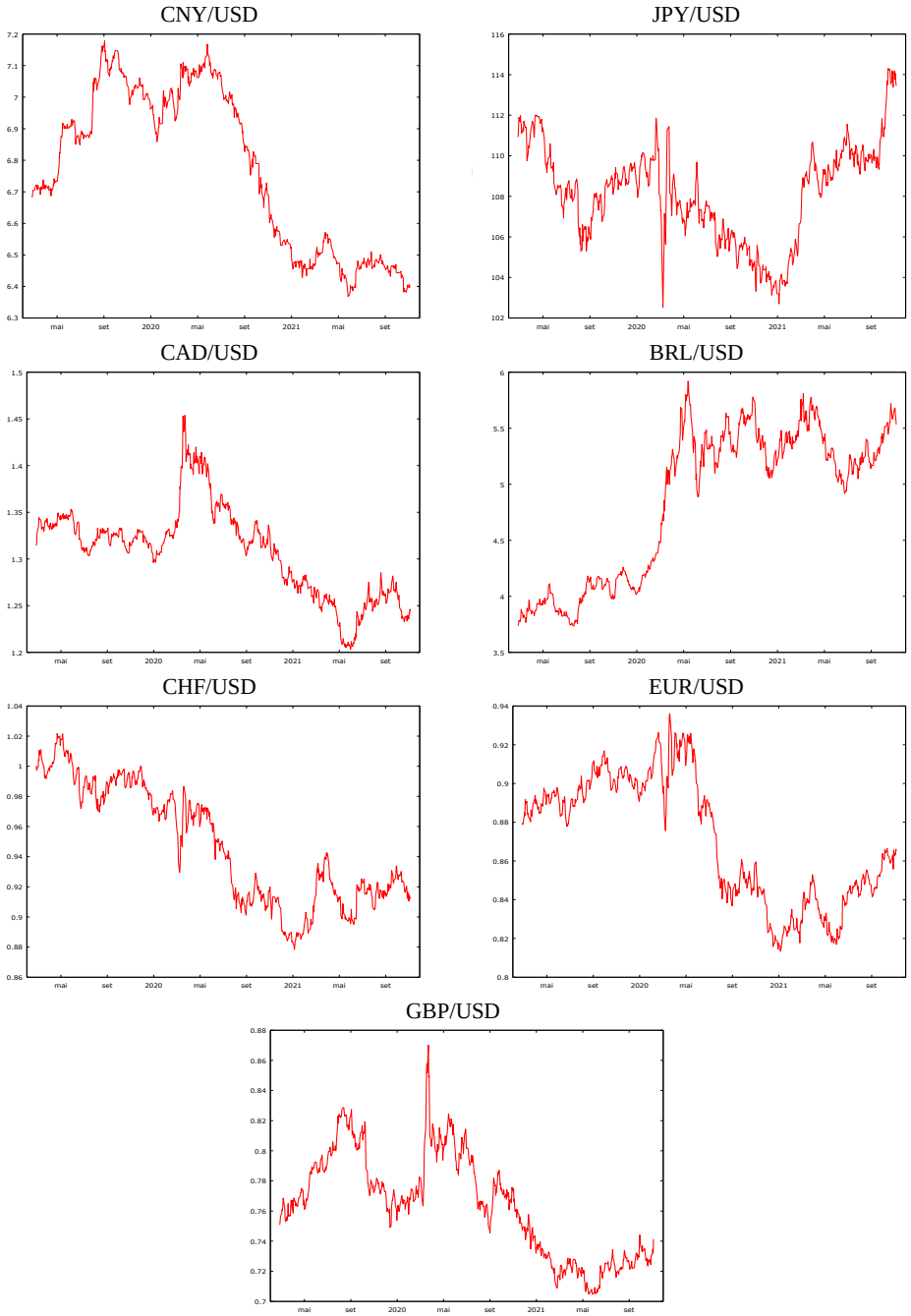

Figure no. 2 – Daily exchange rates in USD

Source: authors, using Federal Reserve Bank of Saint Louis (2021, accessed November 6th, 2021)

The estimated models (using the program GRETL) follow the formulation:

$$Y_t = a_0 + \varepsilon_t \quad (1)$$

where Y_t represents each series of volume and return and ε_t follows a process of type:

$$\varepsilon_t = z_t \sigma_t \quad (2)$$

with $z_t \sim i.i.d.(0,1)$ and σ_t follows a process of type $GARCH(p,q)$:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 \quad (3)$$

where $\omega \geq 0, \alpha_i \geq 0$ e $\beta_i \geq 0$.

The selection of the GARCH model aims to determine the autoregressive component (p) and the coefficient of the error terms (q). Next, we present the results of the estimation of GARCH models for the series of both cryptocurrencies and currencies.

4. MONEY AND CRYPTOCURRENCIES: A VOLATILITY ANALYSIS

We will analyze the descriptive statistics, the stationarity, and the volatility of the returns of cryptocurrencies and currencies. Figures no. 3 and no. 4 show the behavior of the returns of cryptocurrencies and the seven currencies in USD, respectively. The figures presented suggest the existence of periods with high and persistent volatility, alternating with periods with low volatility. In the particular case of cryptocurrencies, there are clearly peaks that can translate into phases of high instability.

Tables no. 2 and no. 3 document the descriptive statistics and statistical tests for cryptocurrency and exchange rate daily returns for the entire sample period[7].

Table no. 2 – Descriptive statistics and statistical tests for cryptocurrency daily returns for the entire sample period

	d_l_BTC	d_l_DOGE	d_l_ETH	d_l_BCH	d_l_XRP	d_l_XLM	d_l_LTC
Mean (%)	0.2828	0.508	0.3573	0.1551	0.136	0.1487	0.1518
Median (%)	0.2265	-0.0502	0.2702	0.2024	-0.0438	0.1545	0.0777
Minimum (%)	-49.03	-47.206	-58.166	-60.055	-45.028	-42.347	-47.592
Maximum (%)	17.775	115.28	23.407	42.553	36.964	57.835	25.931
Std. Dev. (%)	4.1432	8.6672	5.2698	6.2305	5.793	6.1894	5.5944
C.V.	14.653	17.063	14.751	40.163	42.609	41.648	36.861
Skewness	-1.5664	4.7489	-1.5658	-0.6481	0.066	0.7796	-1.0985
Excess kurtosis	21.67	52.986	18.026	16.957	10.871	13.967	11.493
ADF Test Statistics							
Without Constant	-14.55***	-16.28***	9.19***	-14.38***	-22.42***	-32.87***	-14.41***
With Constant	-14.73***	-16.38***	-9.44***	-14.39***	-22.43***	-32.87***	-14.43***
KPSS Tests Statistics							
Without Trend	0.09	0.27	0.19	0.05	0.11	0.11	0.08
With Trend	0.09	0.09	0.05	0.05	0.02	0.06	0.07
ARCH-LM Test Statistics (various lags)							
LM (5)	8.55	122.96***	24.16***	17.04***	46.99***	22.85***	35.91***
LM (10)	12.55	127.79***	27.54***	26.07***	48.33***	25.66***	48.11***

Notes: "Std. Dev." is the standard deviation. "C.V." is the coefficient of variation. For the ADF and KPSS tests, the number of lags is defined according to the Akaike (AIC) information criteria. "*", "**" and "***" stand for the 10%, 5% and 1% statistical significance levels, respectively; "d" identifies the first difference of the series. "l" is the logarithm of the variable.

Source: authors, using CoinDesk (2021, accessed November 6th, 2021)

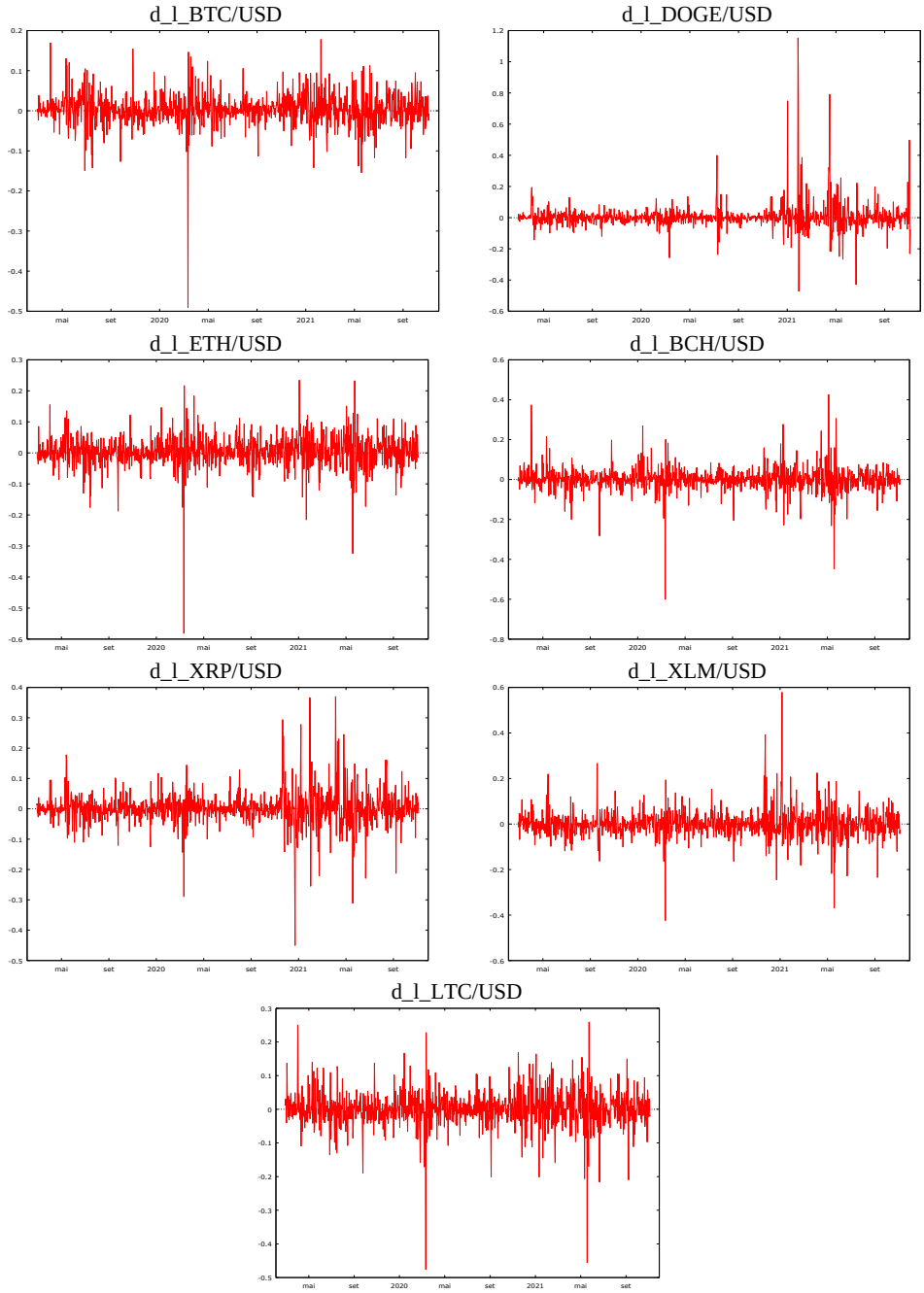

Figure no. 3 – Cryptocurrency daily returns in USD

Notes: "d" identifies the first difference of the series. "l" is the logarithm of the variable

Source: authors, using CoinDesk (2021, accessed November 6th, 2021)

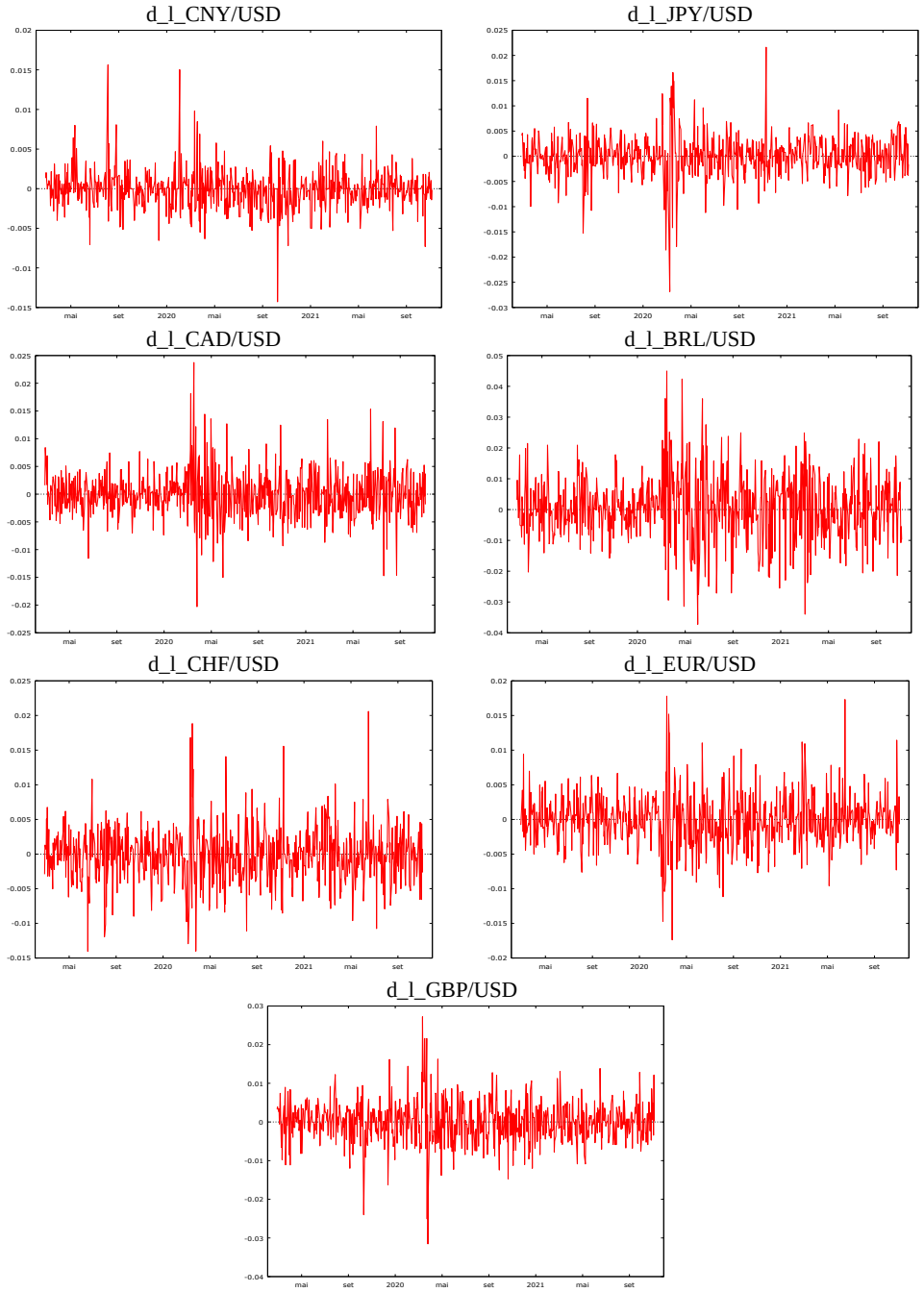

Figure no. 4 – Exchange rate daily returns in USD

Notes: "d" identifies the first difference of the series. "l" is the logarithm of the variable

Source: authors, using Federal Reserve Bank of Saint Louis (2021, accessed November 6th, 2021)

Analyzing the descriptive statistics of the logarithmic rates of change of the cryptocurrencies (Table no. 2), DOGE presents the highest average return, followed by ETH and BTC. This result was not expected. Due to the popularity of the BTC, it was expected that among the seven cryptocurrencies, it would present the highest average return, which does not happen. This may be explained by the low variation in prices of BTC compared to the other cryptocurrencies. Nevertheless, BTC presents an average return twice as high as XRP and XLM, which is something to keep in mind when looking at cryptocurrencies as speculative investments. BitcoinCash (BCH) and Litecoin (LTC) are the cryptocurrencies with the lowest average return, presenting almost the same results.

Table no. 3 – Descriptive statistics and statistical tests for exchange rate daily returns for the entire sample period

	d_l_CNY	d_l_JPY	d_l_CAD	d_l_BRL	d_l_CHF	d_l_EUR	d_l_GBP
Mean (%)	-0.0062	0.0032	-0.0079	0.0559	-0.013	-0.0023	0.0018
Median (%)	0	0.0091	-0.0076	0.0632	-0.0103	-0.0089	-0.0093
Minimum (%)	-1.4285	-2.685	-2.0298	-3.7261	-1.4054	-1.7384	-2.7216
Maximum (%)	1.5644	2.1638	2.375	4.4981	2.0597	1.7799	3.1547
Std. Dev. (%)	0.2409	0.3988	0.4172	1.0307	0.3938	0.3673	0.549
C.V.	38.643	124.12	53.055	18.439	30.385	160.62	298.61
Skewness	0.653	-0.4011	0.3871	0.0016	0.3289	0.298	0.0911
Excess kurtosis	6.9366	6.232	3.6961	1.369	2.8159	2.9889	3.8641
ADF Test Statistics							
Without Constant	-28.52***	-8.21***	-14.93***	-17.34***	-12.31***	-23.06***	-11.35***
With Constant	-28.52***	-8.22***	-14.93***	-17.39***	-12.36***	-23.04***	-11.35***
KPSS Tests Statistics							
Without Trend	0.51**	0.15	0.11	0.11	0.05	0.1	0.09
With Trend	0.15**	0.02	0.05	0.05	0.03	0.1	0.06
ARCH-LM Test Statistics (various lags)							
LM (5)	4.83	101.77***	43.77***	81.04***	21.62***	51.65***	114.36***
LM (10)	5.22	147.28***	135.19***	94.21***	35.6***	84.21***	138.77***

Notes: "Std. Dev." is the standard deviation. "C.V." is the coefficient of variation. For the ADF and KPSS tests, the number of lags is defined according to the Akaike (AIC) information criteria. "*", "**" and "***" stand for the 10%, 5% and 1% statistical significance levels, respectively; "d" identifies the first difference of the series. "l" is the logarithm of the variable.

Source: authors, using Federal Reserve Bank of Saint Louis (2021, accessed November 6th, 2021)

Focusing on the standard deviation, it points out the high level of volatility of the returns (Table no. 2) connected to cryptocurrencies, with particular emphasis on the volatility of DOGE, BCH e XLM. Bitcoin is the cryptocurrency with the lowest level of volatility.

On the other hand, analyzing the descriptive statistics of the logarithmic rates of change in the exchange rates (Table no. 3), we can see with some surprise that the highest medium return belongs to BRL. This result can be explained by the high volatility of this currency during the period in analysis, which is still significantly lower when compared to the volatility of the other seven cryptocurrencies mentioned earlier. In contrast, the Swiss franc (CHF), the Canadian dollar (CAD), and the yuan (CNY) have the lowest medium returns, even presenting negative values. CNY, EUR, CFH, and JPY have the most stable behavior (the lowest standard deviations), which was expected, since they have such an important role as international reserve currencies. Curiously, of the seven currencies that were studied and belonged to different monetary and geographic areas, the Pound Sterling (GBP), after BRL, is the one that shows the highest volatility. We can interpret this result by the loss of

importance of the Britain currency as a unit of account and international store of value, due to the BREXIT.

Comparing Tables no. 2 and no. 3, we observe that the mean of returns of all currencies is significantly lower than the mean of returns of cryptocurrencies. We can also clearly see the high discrepancy of their standard deviation values, with cryptocurrencies presenting much higher volatility than currencies. Even the highest standard deviation value of currencies (1.0307 of BRL) is significantly lower than the lowest standard deviation value of cryptocurrencies (4.1432 of BTC). This result empirically confirms the difficulty that cryptocurrencies will have in assuming the functions of unit of account and store of value in the near future.

For the analysis of the stationary characteristics of the series, we ran two tests, a test of unit root, the Augmented Dickey-Fuller (Dickey & Fuller, 1979) - ADF - and a stationary one, Kwiatkowski-Phillips-Schmidt-Shin (Kwiatkowski *et al.*, 1992) - KPSS. As we can see, every series are I(0). We can proceed with the study of volatility.

The methodology used to study the volatility of the cryptocurrency returns and exchange rates was the GARCH model. The LM test does not reject the null hypothesis of ARCH effects on Bitcoin and Yuan (see again Tables no. 2 and no. 3). In this case, we expect that the optimum model only has variance lags. For the remaining cases, it will be a GARCH model. In the process of choosing the best model, the information criteria of Schwarz-BIC (Schwarz, 1978) was used, as we can see in Table no. 4.

The numbers in bold in Table no. 4 identify the chosen model. After selecting the most appropriate GARCH model for each series, we analyzed the unconditional variance of each model. Tables no. 5 and no. 6 present the results of the estimates of the selected models for the cryptocurrencies and the exchange rates, respectively.

Table no. 4 – (G)ARCH model selection

(G)ARCH (*p*,*q*) model selection Schwarz (BIC) information criteria						
	(0,1)	(0,2)	(1,1)	(1,2)	(2,1)	(2,2)
d_l_BTC	-3450.232	-3446.625	-3489.033	-3491.084	a	**-3509.871**
d_l_DOGE	b	**-2678.794**	b	b	b	b
d_l_ETH	-2982.069	-2986.311	-3075.275	-3074.848	a	**-3082.319**
d_l_BCH	-2659.053	-2668.585	**-2745.068**	-2738.418	a	a
d_l_XRP	-2998.355	-3027.558	-3086.216	b	**-3094.440**	a
d_l_XLM	-2784.267	-2816.023	**-2849.884**	-2840.674	-2844.176	-2836.228
d_l_LTC	-2879.011	-2875.415	**-2935.018**	-2929.011	a	-2926.342
	(0,1)	(0,2)	(1,1)	(1,2)	(2,1)	(2,2)
d_l_CNY/USD	b	b	**-6459.048**	a	-6455.156	a
d_l_JPY/USD	-5828.954	-5827.362	**-5865.031**	-5858.285	-5859.034	-5852.438
d_l_CAD/USD	-5705.541	-5724.915	**-5773.718**	-5767.464	-5767.163	-5766.025
d_l_BRL/USD	b	-4458.165	**-4496.329**	-4490.367	-4489.770	-4485.982
d_l_CHF/USD	**-5794.890**	-5788.760	-5789.775	-5782.537	-5787.542	-5777.204
d_l_EUR/USD	b	-5875.617	**-5923.988**	-5917.693	a	a
d_l_GBP/USD	-5328.610	-5381.250	**-5398.501**	-5394.213	-5391.836	-5387.770

Notes*:* The letters *a* and *b* identify errors. In the case of the letter *a*, the matrix is not positively defined, and, in the case of the letter *b*, the norm of gradient exceeded the maximum of 5. X/USD represents the exchange return of the currencies in comparison to USD. "d" identifies the first difference of the series. "l" is the logarithm of the variable.

Source: authors, using CoinDesk (2021, accessed November 6th, 2021) and data from Federal Reserve Bank of Saint Louis (2021, accessed November 6th, 2021)

Table no. 5 – Parameter estimates of daily cryptocurrency returns for selected optimal (G)ARCH models

	BTC	DOGE	ETH	BCH	XRP	XLM	LTC
a_0	0.00325***	0.007***	0.0045***	0.0021	-0.0003	-0.0004	0.0024
ω	0.0003***	0.0017***	0.00049**	0.0003***	0.0005***	0.0005***	0.0002***
α_1	0.0257*	0.913***	0.0464	0.113***	0.559***	0.353***	0.0906***
α_2	0.224***	0.086***	0.1979**	-	-	-	-
β_1	0.0029	-	3.55e-12	0.822***	0.191***	0.577***	0.8493***
β_2	0.596***	-	0.594**	-	0.222***	-	-
LR ratio test for (G)ARCH terms							
	91.103***	695.83***	135.94***	120.118***	327.079***	205.636***	92.241***
Unconditional Variance							
	2.13e-03	2.96e+09	3.07e-03	4.66e-03	1.89e-02	7.50e-03	3.40e-03

Source: authors, using CoinDesk (2021, accessed November 6th, 2021)

Table no. 6 – Parameter estimates of daily exchange rate returns for selected optimal (G)ARCH models

	CNY	JPY	CAD	BRL	CHF	EUR	GBP
a_0	-0.00011	0.0001	0.0000959	0.00037	-0.00011	0.000054	-0.000063
ω	0.0000006	0.000001***	0.0000005**	0.0000019*	0.000011***	0.0000006**	0.000004***
α_1	0.0501***	0.1078***	0.0752***	0.0794***	0.2824***	0.0678***	0.1639***
α_2	-	-	-	-	-	-	-
β_1	0.834***	0.775***	0.891***	0.903***	-	0.8856***	0.707***
β_2	-	-	-	-	-	-	-
LR ratio test for (G)ARCH terms							
	18.806***	132.516***	104.716***	97.094***	38.384***	76.115***	114.872***
Unconditional Variance							
	5.87e-06	1.42e-05	1.66e-05	1.13e-04	1.60e-05	1.30e-05	2.86e-05

Source: authors, using Federal Reserve Bank of Saint Louis (2021, accessed November 6th, 2021)

The unconditional variance points out the volatility of each series or its variance in the long term. The results show that the return of cryptocurrencies it is more volatile when compared to the exchange rate return. In particular, Dogecoin (DOGE) is the cryptocurrency that presents the highest value, while Bitcoin (BTC) has the lowest. Focusing on the exchange rate, Yuan (CNY) presents the lowest volatility and the Brazilian Real (BRL) the highest. Even though the Brazilian Real has the highest volatility, the volatility of cryptocurrencies is substantially higher, confirming the idea that they cannot replace the currencies.

The results are in line with some papers on the same topic (Yermack, 2013; Balcilar *et al.*, 2017; Yi *et al.*, 2018; Bouri *et al.*, 2019; Katsiampa, 2019b; Katsiampa *et al.*, 2019; Kumar & Anandarao, 2019; BIS, 2021) that used similar methodologies.

Regarding the volatility of the cryptocurrencies, we can state that, although we are in the presence of an admirable world of cryptocurrencies, the volatility of their returns is very high. That being said, the cryptocurrencies will have a hard time replacing the currencies, if they ever do.

5. CONCLUSION

This paper aimed to study the volatility of seven main cryptocurrencies (Bitcoin, Dogecoin, Ethereum, BitcoinCash, Ripple, Stellar and Litecoin) that are traded in exchange

offices and compare it to the volatility of seven currencies (Yuan, Yen, Canadian Dollar, Brazilian Real, Swiss Franc, Euro, and Pound Sterling) that belong to different and distinct monetary areas.

This study tried to find and analyze similarities and differences between the world of crypto-currencies and currencies. We started by analyzing the behavior of the cryptocurrencies and the exchange rates. After, we investigated the stationary characteristics of their returns. Finally, we used GARCH models to examine the levels of volatility of both returns and compared it.

The results suggest that the mean of returns of all currencies is significantly lower than the mean of returns of cryptocurrencies. Also, the volatility of the returns of cryptocurrencies is considerably higher when compared to the currencies. Among the seven cryptocurrencies that were studied, DOGE (Dogecoin) presented the highest, followed by Ripple (XRP). Surprisingly, Bitcoin is the cryptocurrency with the lowest volatility. Still, when compared with the volatility of any exchange rates, the volatility of the most famous cryptocurrency is considerably higher.

In this context, we conclude that cryptocurrencies are far from checking all the boxes to be considered a currency, especially the unit of account and the store of value functions. By a stretch of good will, cryptocurrencies can be seen as an imperfect substitute for currencies. Even so, we do not discard the possibility of them being accepted as currencies in the future. But, right now, the currencies are by far safer and more stable, while the cryptocurrencies are, for the most part, seen and sought after as speculative assets.

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Notes

[1] The recent war in Ukraine has drawn even more attention to the use of cryptocurrencies in this context. One of the most famous historical cases is the Silk Road, a dark-web market that allowed transactions of drugs (DeVries, 2016). Another one is Mt. Gox, a Bitcoin exchange based in Tokyo that was hacked and exposed the records of 18 million transactions (Gandal *et al.*, 2018).

[2] https://coinmarketcap.com/.

[3] https://bbc.com/news/technology-58678907.

[4]https://www.forbes.com/sites/annestevenson-yang/2022/01/12/crypto-vs-chinas-digital-currency-never-the-twain-shall-meet/?sh=b2f709c7555c.

[5] https://www.ecb.europa.eu/paym/digital_euro/html/index.en.html .

[6] For more details see Duarte (2022).

[7] ADF and KPSS tests statistics were also computed for the prices and the exchange rates. The results show that the series are non-stationary for all the cases. Results can be provided upon request.

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European Efficiency or Inefficiency in Economic Growth Through Digital Transformation

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Abstract: The current global changes bring to the fore the importance of the innovation and digital transformation for economic development. Under the previous assumption, an objective evaluation of the economic growth discrepancies, considering the digitalization process, is required. The main goal of the present research is to analyse the economic growth of the European countries, based to the digitalization process, by using an input-output method. Under these circumstances, a Data Envelopment Analysis (DEA) was performed, considering the digitalization dimensions of DESI Index as input and the economic growth (annual %) as output. Based on the proposed model, the results highlighted the bidirectional relationship between economic growth and digitalization. Consistent with the research results, the European countries can be divided in two main categories: the efficient and the inefficient. On one hand, we can find the relatively efficient European states in terms of achieving the economic growth through digitalization (Ireland, Romania, Croatia and Greece). On the other hand, there is a numerous list of the inefficient ones, including important countries like Finland, Germany or France. Obviously, a remarkable aspect related to their situation is that, considering the national available inputs, an output maximization will be possible. According to the proposed model, the efficient countries can serve as peers or optimal benchmarks for solving the issue of relative inefficiency, by adapting and implementing their good practices.

Keywords: digitalization; economic growth; European Union.

JEL classification: O33; O52.

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1. INTRODUCTION

Naturally, all processes undertaken at individual or collective level imply the existence of input elements, based on which the achievement of objectives, well-known as outputs, is expected. Over time, the society and economy have been subjected of challenges in the attempt of continuous evolution, under the influence of numerous internal and external factors.

Aiming to establish a competitive position, global economies undertake considerable efforts to identify key potential influencing factors that can affect their development. Directly related to development, the economic growth undoubtedly represents one of the main goals of the world's states. Consistently, increasing the interest on the inputs that can determine the economic growth becomes a compulsory task.

On the other hand, technological progress has revolutionized from narrow fields of activity to entire industries, beneficially contributing to the development of their related activities. The digital transformation gradually happened over the last decades, becoming a real need during the COVID-19 pandemic, which determined a more alert, even forced in some situations, pace of progress.

Hence, digitalization represents the characteristic phenomenon of the modern world, which unsurprisingly called into question the ability to impact the economic development. The fact that the digital progress has a considerable potential to contribute to the economic evolution has been recognized over the years, the economy itself gaining new directions. Nowadays, a key point of interest has thus been reached, namely the transition to the digital economy.

Efforts to enhance the transition to digitalization are constantly undertaken within all world economies but as respects the impact of related transformations on economic growth, a continuous analysis is required. The existing evidence is difficult to synthesize, and it would be inappropriate to consider it enough to determine a general rule regarding the proportion of the impact of digitalization on the economic growth, while the mutual influence is also recognized. Gaps existing between countries, at almost all levels, do not allow the generalization. Therefore, the efforts should be focused on the national level analysis.

The premises of an economic growth determined, to some extent, by the digital progress, as well as reciprocal, have been demonstrated, some of the aspects related to this phenomenon being subsequently discussed within the current paper. However, considering the fact that not all states perform at the same pace, neither from the point of view of economic development, nor regarding the transition to digital, the issue of comparative analysis among states is raised, aiming to identify strategic measures as benchmarks for implementation.

Focused on the analysis at the EU member states level, the present research aims to provide notable insights related to the ability of efficiently use the digital progress of the considered countries, in order to maximize the economic growth. In this regard, the research will provide both theoretical and empirical demonstration. Theoretically, a review of the specialty literature related to the economic growth and digitalization will be provided and, empirically, a Data Envelopment Analysis model will be applied. Performing the Data Envelopment Analysis model will conduct to identifying the relative efficiency or inefficiency of the European countries in achieving economic growth through digitalization.

Starting from the previously mentioned issues, the paper follows a logical structure, using an appropriate methodology for distinguishing the main debates in the literature related to the selected topics and for conducting the empirical demonstration. Finally, the results will

provide a spotlight on the issue of digitalization for economic growth, consistent with the bidirectional relationship between these important drivers of economic development.

2. THE MUTUAL RELATIONSHIP BETWEEN DIGITALIZATION AND ECONOMIC GROWTH

Well-known as a continuous, constant, and extremely fast process, the digital transformation has set, especially in the last decades, the premises of a new world, characterized by more efficient and sustainable development. Under these circumstances, technology has undoubtedly become one of the basic drivers of economic growth and, consequently, of the prosperous society development.

A decade ago, discussing the dissemination of technology and the economic growth (Quah, 2002) asserted, suggesting the reality that would persist with subsequent related developments, that the new economy is based on non-rival and aspatial knowledge. The researcher was referring to the progressive consumption of goods similar to knowledge, at the expense of physical material, mentioning, among others, the computer software, and services and goods provided and delivered through the Internet. The need of increasing the understanding regarding the exchange and dissemination processes of knowledge products, such as the ones previously mentioned, was thus urged, this being considered more important than solving the paradox of productivity.

In the current context, it is widely accepted that the digitalization of the processes carried out by all actors of society, whether they are individuals, business environment or any other intermediate pillar of the supply and demand duo, can undeniably contribute to the economic growth. In fact, technology is often described as a facilitator of goods and services production, which certainly determines the increase of prosperity, thus impacting the economic growth.

Presenting a demonstrated and subsequently reiterated perspective, the study carried out by Sabbagh *et al.* (2013) highlighted the fact that digitalization has the potential to create new jobs, increase productivity and bring improvements in terms of the life quality at the society level. Because of the new jobs' emergence and the increase in productivity, an improvement in economic growth is naturally expected.

According to McKinsey Global Institute (Bughin *et al.*, 2016), the GDP growth at the European level could be stimulated by 1% per year until 2025 as a result of doubling the digital intensity of the lagging sectors, referring to industries such as education, manufacturing, healthcare and mining. The report also highlights that the impact of digitalization is felt on the European economy, there being a certain correlation between the digital progress intensity and growth of productivity in all key sectors.

Actually, the relative strength of the digital economy has quite recently been characterized as a constant contributing factor to the economic growth, while the digital services and goods were considered main determinants of the GDP growth (Barefoot et al., 2018).

Examining the relationship between digital transformation and three key elements, namely labor productivity, employment and economic development, in developing countries, the study carried out by Aly (2020) led to the finding of a positive relationship between digital transformation and labor productivity, respectively economic development.

Concerning the labor productivity, considered a point of real interest in economic growth, the findings presented by Varlamova and Larionova (2020) are similar to those previously presented in the literature. Thus, it was found that the digital transformation of business processes, correlated with the increase in the share of organizations that use Internet technologies, can determine an increase in the labor productivity.

However, the fact that various existing researches still refer to relationship between digitalization and economic growth at the country level can be easily noticed, the phenomenon being almost impossible to generalize. Thus, disparities in terms of progress within different geographical areas are directly recognized.

Through the comparative analysis of Myovella *et al.* (2020), targeting 74 countries, respectively 33 OECD economies and 41 Sub-Saharan African economies, it was proven that digitalization positively influences economic growth in both groups of states under study. Even though, as a whole, the previously mentioned conclusion of the research has a generalizing note, the authors stating that certain element of digitalization, such as mobile telecommunications or broadband internet, exert a different impact in the two groups of the analyzed countries.

The reciprocal is recognized to the same extent, since, at the current level of technology adoption and implementation, existing findings reveal the influence of economic growth or, at least, of economic development on digital progress. For example, the results of the study by Stavytskyy *et al.* (2019), reveal that a more prosperous society determines the implementation and use of more advanced digital services.

Based on the aforementioned study, reference can be made to the need for increasing employability, followed by the growth in consumption, which includes the consumption of digital services and products. The research focused on the analysis of the impact of consumption index growth by the purchasing power parity and unemployment among the active population on the structural elements of the Digital Economy and Society Index.

According to Yuan *et al.* (2021), the digital transformation within the economy has a crucial importance in terms of economic growth at the state level. At the same time, the results of the research in question highlight the existence of a stable long-term relationship between technological innovation and its multiple determining factors, among which GDP is directly considered and analyzed.

Based on the previously presented findings, but also on many other existing research, the digitalization - economic growth relationship can be characterized as mutual, regardless of whether the process itself is direct or indirect. Figure no. 1 describes the synthesized perspective of the mutual influence between the two key elements considered. Therefore, some main considerations can be easily observed, based on which growth or development as processes are bidirectionally mediated.

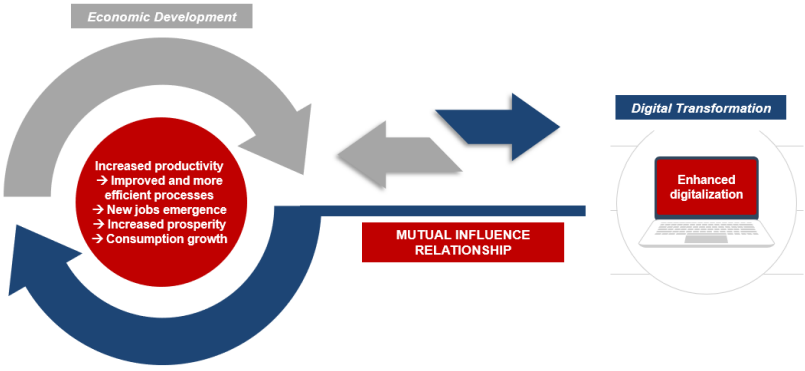

Figure no. 1 – Synthesized Process of the Mutual Relationship Between Digital Transformation and Economic Development

Source: Authors' own sketching

Surely, the previously presented scheme describes in a synthesized manner the relationship between digitalization and economic development, the related sub-processes being much more numerous and extremely difficult to identify. At the same time, referring to the economic development, the figure includes aspects directly related to the economic growth, the two concepts, namely *growth* and *development*, not necessarily having the same meaning in the current reality.

Nevertheless, it can be stated that mutuality characterizes the relationship of influence between the two directions i.e. digital transformation and economic development, but the existing evidence is not enough to determine if a direct proportionality of the impact can be considered. Confidently, decision-makers should take into account the potential benefits of supporting improvements in both areas of interest, a fact already recognized, that has gained real importance at the level of the measures taken for the efficient evolution of global economies and societies.

3. PERSPECTIVES ON THE DIGITAL PROGRESS OF THE EU MEMBER STATES

Technological transformation and the economy, respectively society, are no longer concepts independently handled, but the intense transition to the digital economy and the support of the continuous development of the knowledge-based economy and society are discussed. In fact, improving digitalization in all key sectors of the contemporary society and economy has not remained a subject of interest only for the scientific research field, but represents the phenomenon that underlies the development of numerous government policies and measures.

Currently, most of the objectives set at the world economies level focus, as an important pillar, on digitalization. Thus, many times the achievement of a national goal includes increasing digitalization among the basic directions of action. This situation is also found at the European Union level, which undertakes considerable efforts to enhance the digital progress of the member states.

A well-known tool for measuring the digital progress among the member countries of the European Union is the Digital Economy and Society Index (DESI Index), successfully used for monitoring since 2014. Being a composite index, DESI is currently (following recent updates) focused on four main directions, considered representative of digital evolution, namely: *Human capital*, *Connectivity*, *Integration of digital technology* and *Digital public services*.

With the aim of providing an overall perspective on the digital progress of the EU member states, the DESI Index reports represent a good starting point, more useful for the intended purpose than analyzing the methodology of the index in question. Thus, the last DESI report (European Commission, 2022b), including the results on the areas of interest in terms of digitalization for 2021, highlights the advance for all member states, compared to the previous periods. However, the findings of the DESI Index show gaps in digital skills, a problem constantly encountered over the years, the launch of advanced 5G networks and the digital transformation of SMEs.

In order to provide a better understanding of the digital evolution registered at the EU level, Figure no. 2 illustrates the DESI Index results for each member state, based on the aggregate scores recorded (weighted score - from 0 to 100) in 2021 and 2022.

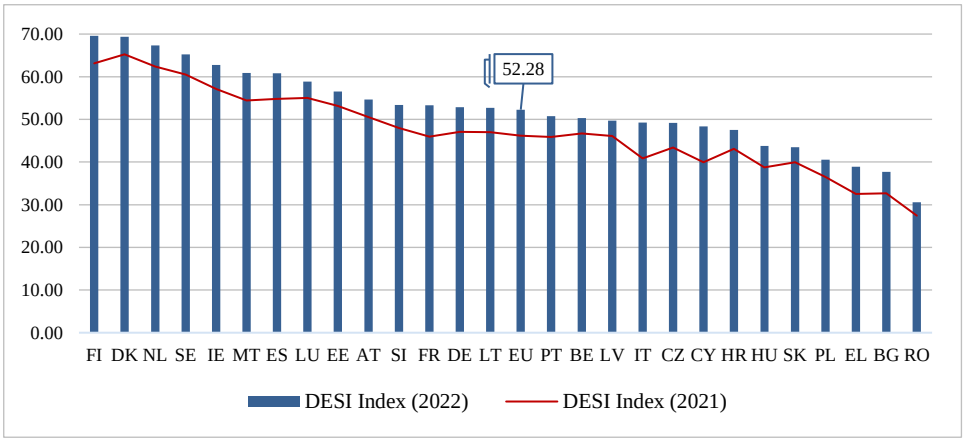

Figure no. 2 – DESI Index by Aggregate Scores 2021 - 2022
Source: authors' own figure - Data provided by European Commission (2022a)

Reiterating the previously mentioned aspects, by following the scores recorded for 2022 (blue columns), compared to those for 2021 (red line), the digital evolution of all countries can be easily observed. Definitely ascertainable, the discrepancies between the countries in terms of digitalization are persistent. However, the weakest digital progress was recorded in Romania, with an increase of only 3.15 in terms of the DESI 2022 aggregated score, compared to the previous year, the growth average at the EU level being 6.08.

There are also countries at the top of the ranking, which have slowed down the progress in terms of digital transformation. For example, in 2022, Estonia registered a higher aggregate score of 3.36 compared to 2021, while the difference between 2021 and 2020 was 4.05 (European Commission, 2022a).

The gaps between countries can be identified from multiple perspectives, whether we are discussing the overall progress, whether we are referring to the components or sub-components included in the DESI Index, or whether we are referring to the speed at which the digital evolution is undertaken at the national level. However, the efforts in the digital transformation within the EU member states are unquestionable, and the forthcoming benefits of the constant progress recorded, from the point of view of economic and society development, denote a promising perspective.

Undoubtedly, considering that the index under analysis focuses on several directions and discussing the digital economy and society, it becomes necessary to take into account all four areas of interest in order to understand the impact of digital transformation on the economic growth.

4. METHODOLOGY

As we mentioned in the previous sections, the main goal of the present research is to illustrate the connection between economic growth and digitalization within the European Union. In order to achieve the stated proposal, both theoretical and empirical approaches were used. The analysis of the specialty literature contributes to a proper understanding of the economic growth in the context of a permanent digitalization and the review of the selected topics conducted us in designing the research method, according to the established goal.

For measuring the efficiency or the inefficiency of European countries in terms of the annual economic growth, by analysing the available resources as regards digitalization, the Data Envelopment Analysis (DEA) will be performed. According to the specialty literature, DEA is non-parametric test, which measure the (in)efficiency of a decision-making unit (DMU) (Charnes *et al.*, 1978, 1981; Charnes *et al.*, 1989). Correspondingly, the available data are distributed in two main categories: inputs and outputs. The obtained results will highlight the relative performance of decision-making units, considering the information related to the degree of input decrease and/or output increase in inactive DMUs (Lábaj *et al.*, 2014), although the units of the parameters are different (Cooper *et al.*, 2011). Within the present study, the following dimensions of the Digital Economy and Society Index constituted the *inputs*: Human Capital, Connectivity, Integration of Digital Technology and Digital Public Services. The *output* is represented by the GDP growth (annual %). Starting from this point, we assume that the annual growth of the GDP can be maximized, using the national available inputs. In the view of the theoretical aspects related both on DEA method and the purposed subject, an output-oriented model will be conducted, presuming Constant Returns to Scale (CRS).

The selected sample is represented by the 27 European countries and the year under analysis is 2021, considering the World Bank data on economic growth and the last report of the European Commission on Digital Economy and Society Index (European Commission, 2022b). Performing Data Analysis Envelopment method was supported by an academic solution, namely Data Envelopment Analysis in R (Benítez *et al.*, 2021).

5. RESULTS AND DISCUSSION

The development of the concept of digital economy brings to the fore the relationship between digitalization and economic growth, which was strongly highlighted in the specialty literature (Dahlman *et al.*, 2016; Pan *et al.*, 2022). Considering the importance of the digitalization process in achieving the economic growth (Cheng *et al.*, 2021) and explaining the discrepancies between the countries, the present research, based on performing a Data Envelopment Analysis, accentuate several cases that must be studied. Forward analysing the empirical results on our selected sample, some theoretical consideration related to Data Envelopment Analysis must be clarified. According to DEA method, a decision-making unit (DMU) is viewed as relatively efficient if the registered value is strictly 1.00. Different values, higher or lower, denote the inefficiency of the analysed DMUs. In order to improve the inefficient state of input-output ratio, the decision-making units must emphasize the practices of the efficient one, which can be seen as peers or optimal benchmarks. Therefore, the efficient units will preserve constant their return to scale (RTS), whereas the inefficient ones will change their returns to scale, specifically increasing or decreasing.

Table no. 1 illustrates the Data Envelopment Analysis results for the selected sample. The first column defines the name of the decision-making units, namely the countries under analysis; the second and the third columns provide the information concerning the efficiency scores; the fourth column specifies the intensities or the weights of a peer DMU. Finally, the last column provides information with regards to the return to scale for each DMU (constant, increasing or decreasing). For the research sample, taking into consideration the output-oriented model, only 4 countries out of 27 are considered efficient in terms of using the digitalization for achieving economic growth. Hence, based on the available resources, merely Ireland, Romania, Greece and Croatia are relatively efficient in improving the economic situation. The previous information can be observed also in Figure no. 3, which highlights with green the optimal benchmarks (peers) and, with red, the inefficient countries.

Table no. 1 – Data Envelopment Analysis – results

DMU	Output oriented efficiency	Efficiency Score	Lambda sum	RTS
Austria	2.44409	40.92%	0.8147	Increasing
Belgium	1.40913	70.97%	0.6472	Increasing
Bulgaria	1.38652	72.12%	0.9118	Increasing
Croatia	1	100.00%	1	Constant
Cyprus	1.63898	61.01%	0.6677	Increasing
Czechia	2.97996	33.56%	0.7284	Increasing
Denmark	2.71633	36.81%	0.9457	Increasing
Estonia	1.17426	85.16%	0.722	Increasing
Finland	3.79443	26.35%	0.9837	Increasing
France	1.49109	67.07%	1.0117	Decreasing
Germany	3.34637	29.88%	0.7188	Increasing
Greece	1	100.00%	1	Constant
Hungary	1.07948	92.64%	1.0187	Decreasing
Ireland	1	100.00%	1	Constant
Italy	1.1959	83.62%	0.5847	Increasing
Latvia	1.89081	52.89%	0.8556	Increasing
Lithuania	1.83307	54.55%	0.6789	Increasing
Luxembourg	1.62948	61.37%	0.9935	Increasing
Malta	1.23768	80.80%	0.8618	Increasing
Netherlands	2.61551	38.23%	1.373	Decreasing
Poland	1.33727	74.78%	0.7987	Increasing
Portugal	2.02011	49.50%	0.7332	Increasing
Romania	1	100.00%	1	Constant
Slovakia	3.00791	33.25%	0.8412	Increasing
Slovenia	1.17945	84.79%	0.7077	Increasing
Spain	2.16924	46.10%	0.8195	Increasing
Sweden	2.75762	36.26%	0.9805	Increasing

Source: authors' own processing based on R results

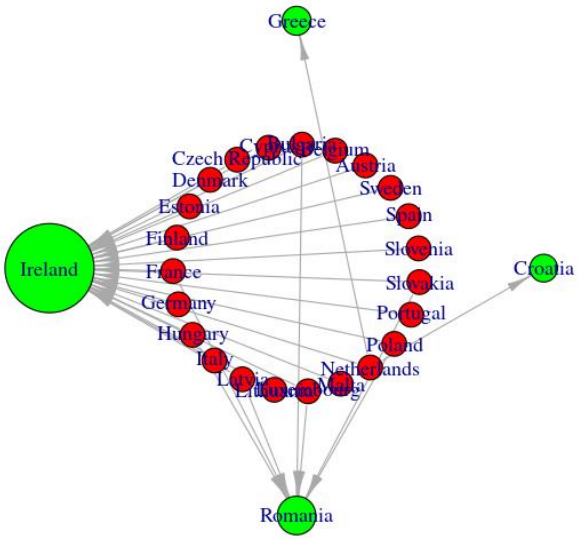

Figure no. 3 – Peer references for each inefficient country
Source: authors' own processing based on R results

At the European level, the issue of economic growth, taking into account the digitalization process divide the countries in two main categories, according to DEA method: the efficient and the inefficient ones. By analysing Table no. 1 and Figure no. 3, the following aspects can be pointed out:

(1) Ireland's results on achieving economic growth through digitalization registered significant progress in the last years (European Commission, 2022d), even though in the last DESI report ranks the fifth at the European level. According to the goal of the national strategy regarding the digitalization, Ireland will become the European leader. Due to its performance related on human capital, connectivity and digitalization of public services, the Irish model can be seen as a peer for all relatively inefficient European countries (see Table no. 2). The changes towards digitalization represent a significant direction for improving the quality of economic activity and, therefore, for economic growth. The Irish optimal benchmark can serve as an important reference for countries like Finland (lambda = 0.9837), Sweden (lambda = 0.9805), Denmark (lambda = 0.9457), but also for Germany (lambda = 0.7188) or France (lambda = 0.588), which are considered the most important economies of the EU.

Table no. 2 – Optimal Lambdas with Benchmarks

DMU	Optimal Lambdas with Benchmarks					
Austria	Ireland	0.8147				
Belgium	Ireland	0.6472				
Bulgaria	Ireland	0.0584	Romania	0.8534		
Cyprus	Ireland	0.6677				
Czechia	Ireland	0.7284				
Denmark	Ireland	0.9457				
Estonia	Ireland	0.7220				
Finland	Ireland	0.9837				
France	Ireland	0.5880	Romania	0.4237		
Germany	Ireland	0.7188				
Hungary	Ireland	0.2177	Romania	0.8010		
Italy	Ireland	0.5847				
Latvia	Ireland	0.4553	Romania	0.4003		
Lithuania	Ireland	0.6789				
Luxembourg	Ireland	0.7082	Romania	0.2853		
Malta	Ireland	0.8618				
Netherlands	Ireland	0.2050	Croatia	0.2932	Greece	0.8748
Poland	Ireland	0.3829	Romania	0.4158		
Portugal	Ireland	0.7332				
Slovakia	Ireland	0.5343	Romania	0.3069		
Slovenia	Ireland	0.7077				
Spain	Ireland	0.8195				
Sweden	Ireland	0.9805				

Source: authors' own processing based on R results

(2) Romania's situation on economic growth, taking into account the available resources in terms of digitalization, ranks the eastern country on the list of the efficient ones. The actual situation of economic growth serves as a reference for seven European countries, no matter the economic situation (see the example of France). According to the existent reports, the situation of digitalization in Romania is still a strong deficiency that places the country on the

last position of the European hierarchy of digitalization (European Commission, 2022e). For example, the problems in respect of the digital skills or the digitalization of public services are still persistent. For some researchers, this generalized situation was explained through the very expensive infrastructure (Aker & Mbiti, 2010). Despite of this, as a result of performing DEA method, it can be stated that Romanian's level of economic growth by using the available resources on digitalization should change the view of the existent perception. In other words, there are significant results in the economic development, in light of the national inputs. In the case of our sample, Romania represents a strong peer or an optimal benchmark for the following countries: Bulgaria (lambda = 0.8534), Hungary (lambda = 0.801) France (lambda = 0.4237), Poland, (lambda = 0.4158), Latvia (lambda = 0.4003), Slovakia (lambda = 0.3069) and Luxembourg (lambda = 0.2853).

(3) Croatia and Greece are also references in terms of attainment the economic growth by digitalization, even if their example can serve as a peer for a narrow group of countries. The performed empirical model showed that the Netherlands can follow the example of good practices implemented by Greece (lambda = 0.8748) and Croatia (lambda = 0.2932).

(4) By analysing the situation of the relatively inefficient countries in terms of economic growth, in the view of the digitalization process, major discrepancies can be identified between the studies that separately address the two topics. It is well known that, for example, Germany or France are the main economic drivers of the European Union but, in terms of achieving the economic growth via digitalization in the selected year, the present research suggests a calculated score of efficiency of 29.88% and 67.07%. Specifically, the digital tools are not properly exploited for improving the economic growth results. A similar observation can be noted in the case of Finland, where the calculated efficiency score is just 26.35%, being the lowest registered value in the purposed model even if, referring to this country, the DESI report states its first place on the digitalization around EU (European Commission, 2022c). Related to this, a possible explanation is strongly connected to the unexploited potential results that the Finish can achieve, by using their intensive digitalized system. Alike, the very low relative efficiency of Germany (29.88%) is mainly explained by the lack of integration of digital technologies, which was described in the specialty literature (Ficarra *et al.*, 2021).

To sum up the previous results, it can be confirmed that the present research highlights that, nowadays, the economic growth can be strongly linked to the digitalization process. The discrepancies in terms of relative efficiency or inefficiency of achieving economic growth through digitalization bring to the fore the importance of a proper exploitation of available inputs. Performing DEA method for a selected sample related on the European Union divided the countries between a small number of relatively efficient (Ireland, Romania, Croatia and Greece) and a large category of inefficient, which includes even if the most important performers in terms of digitalization. However, we must consider the significance of input maximization for improving the present outputs.

6. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

According to the defined goal, the present research aimed to provide a general snapshot of the European countries in the matter of the relative efficiency or inefficiency in achieving economic growth through digitalization. In this regard, an empirical demonstration was performed, using Data Envelopment Analysis (DEA). The proposed model (output-oriented, with constant returns to scale), assumed as inputs the digital dimensions of DESI Index

(*Human Capital*, *Connectivity*, *Integration of Digital Technology* and *Digital Public Services*) and as output the *annual economic growth*.

The results obtained illustrated that, in the case of the selected sample, only four countries out of 27 can be considered relatively efficient, namely Ireland, Romania, Croatia and Greece. In their situation, a maximization of the output (annual economic growth) can be emphasized using the national available inputs (in this case, these four digitalization dimensions of DESI Index). Considering the specialty literature, the four mentioned European countries can be seen as peers or optimal benchmarks for the inefficient ones, which must adapt their activities in order to enhance the efficiency level. In contrast, for the applied model, the most inefficient countries are Finland (26.35%), Germany (29.88%) and Slovakia (33.25%). The examples like Finland and Germany showcase that, in general, the economic growth and the digitalization cannot be separated. The economic development, without a strong integration of digital technologies, results in a relative inefficiency and vice-versa.

Concluding, the limitations of the present study are certainly admitted, the research being focused only on the European level, by reference to a single year. Additionally, a recognized limit is related to the performed model, that can be criticized for not considering others different variables, which can affect the previous results. Due to these, a further development of the research is assumed, with the aim of expanding the time span under analysis and the group of analysed countries.

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The Impact of Environmental Effects of Sustainable Development on Direct Investments

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Abstract: On the background of the exponential decrease of natural resources and the continuous and accentuated degradation of the quality of the environment, ensuring the sustainability of economic and social processes has become a reality of everyday life. However, the primary focus is on the degradation of the quality of the environment, which has the main effect of global warming. The idea of sustainable development is based on 3 fundamental pillars, namely the economic, the social and last but not least the environmental. In contemporary society, direct investment is often seen as a vital source for development and even sustainable development. Thus, the desire for development must go hand in hand with sustainable development, implicitly with the quality of the surrounding environment. At the level of the European Union, it is important that all member countries implement common measures on sustainable development. This is the generous context in which the paper aims to analyse the impact of environmental effects in the volume of direct investments. We will analyse the countries of European country in the period 2004-2020, and we will use the Stata program. Thus, following the running of the multiple regression equation, we found that in attracting direct investments in European country in the period 2004-2020, the environmental effects have a positive influence.

Keywords: environmental effects; sustainable development; direct investments; European countries.

JEL classification: Q01; O11; G28.

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1. INTRODUCTION

From a historical point of view, the concept of sustainable development appears for the first time in 1987 during the World Conference on Environment and Development. During this conference, was published the report named "Our common future" (Voica *et al.*, 2015). In this report, the definition of the term sustainable development was given for the first time as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

This term is composed of 3 dimensions, namely the economic, the environmental and the social. Worldwide, the United Nations is the leader that catalyzes international efforts to establish a balance between the 3 dimensions.

Globally, there is talk about the importance and role of direct investment in the economy. Thus, the specialists discuss one of the key issues, namely the one that refers to the relationship between direct investments and economic growth. All the economies of the European states are aiming for an increase in the level of direct investments. This statement is supported by the hypothesis that investment is the driver of long-term economic growth (Herman, 2011).

Currently, we are witnessing a new trend in the field of investment, namely increasing interest in green growth and sustainable development. Thus, the question of the impact of direct investment on green growth, the environment and ultimately on sustainable development has become imperative.

2. LITERATURE REWIEW

Baliamoune-Lutz (2004) highlight the potential for FDI to contribute to political stability through efficient allocation of corporate resources. And it is considered that direct investments have a positive effect on economic growth (Johnson, 2006; Elkomy *et al.*, 2016)

A study (Lee, 2013) find that clean energy use strongly leads to economic growth while it is in negative relation to an increase in CO2 emissions. The finding implies that clean energy use has played a critical role in boosting economic growth while it has reduced a large portion of CO2 emissions. The finding also implies that clean energy use may have been accentuated because technological advancement accompanied by FDI may have led to a rapid improvement in the use of clean energy and the development of clean energy resources, and thus resulted in reducing CO2 emissions.

Another study (Sarkodie & Strezov, 2019) reveals a strong positive effect of energy consumption on CO2 emissions and a weak effect on non-CO2 GHG emissions. This is because China, India, Indonesia, Iran and South Africa have industrial economies and are largely dependent on fossil fuel energy technologies for energy-intensive foreign direct investment inflows and carbon-intensive industries for to boost its economic development.

In recent years we have all witnessed the growing concerns of states regarding climate change, but also the ways in which it will determine economic activities and human development. Developed countries that have a more sophisticated financing system than developing countries have better competitive advantages that attract a larger volume of direct investment (Aust *et al.*, 2020).

However, an important and frequently raised issue regarding direct investment is the negative potential on the environment. However, the results of a study (Demena & Afesorgbor, 2019) demonstrate that the basic effect of FDI on environmental emissions is

close to zero. And accounting for heterogeneity across studies, direct investment is found to significantly reduce environmental emissions. The results remain robust after disaggregating the effect for countries at different levels of development as well as for different pollutants.

The findings of a study (Nong *et al.*, 2021) shows that developing countries, which experience relatively low production costs due to cheap labour, capital, and natural resources, suffer relatively high emission costs from a uniform carbon tax rate of US $15.

It is noted that the studies presented above do not present what are the conditions and components that could determine a consistent positive relationship between direct investment and sustainable development. Thus, the present study focuses on a pillar of sustainable development, namely the environmental one.

Related to the Research Hypotheses we want to demonstrate that there is a relation between identified variables: direct investment and indicators that measures de environmental effects of the sustainable development. In this case, the null hypothesis is that:

H0*: There is an influence of the level of environmental effects on direct investment,* meaning that the coefficient of the variable (direct investment, especially) is statistically significant (p-value is above 0.1, at 10% level).

3. DATA AND METHODOLOGY

The study on the impact of the environmental effects of sustainable development on direct investment, in the period 2004-2020, extracted from the total population represented by the states of the world only European countries, numbering 27 (Austria, Belgium, Bulgaria, Switzerland, Czechia, Germany, Denmark, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Iceland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia). The sample was limited to this number depending on the availability of data collected from the EUROSTAT database (Balance of payment statistics, 2022).

3.1 Data description

The identified variables, their description, but also the sources of other studies performed that considered the variables identified in our study are presented in Table no. 1.

Table no. 1 - Variables definition

Variable symbol	Variable name type	Description	Units
Country	*Country*	The sample includes 27 countries.	
YEAR	*Year*	The time is 2004-2020.	
DI	*Direct investments, Flows*-dependent variable	This is a category of investment whereby an investor establishes a lasting interest in an enterprise located in an economy that differs from that investor's resident economy.	% of GDP

Variable symbol	Variable name type	Description	Units
GAS	*Greenhouse gas emissions per capita*-independent variable	This indicator measures all national emissions, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and the so-called F-gases (hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride (NF3) and sulfur hexafluoride (SF6)).	%
ENERGY	*Share of renewable energy in gross final energy consumption*-independent variable	This indicator measures the share of renewable energy consumption in gross final energy consumption according to the Renewable Energy Directive.	%
TAX	*Share of environmental taxes in total tax revenues*-independent variable	This indicator measures the share of environmental taxes in total revenues from taxes and social contributions.	%

Source: own processing

The summary of descriptive statistics is presented in Table no. 2.

Table no. 2 – Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Country	459	14	7.797379	1	27
year	459	2012	4.904325	2004	2020
DI	459	23.15699	113.418	-836.7	980
GAS	459	10.1537	4.097159	4.8	30.8
ENERGY	459	17.76677	11.54811	0.102	60.124
TAX	459	7.451699	1.70568	3.62	12.32

Source: own processing

The dataset has 459 observations, with a time lengths of 17 years, between 2004 and 2020. The unit panel is referring to 27 countries from European Union. The dependent interest variable DI has an average mean of 23.15699, a minimum of -836.7, a maximum of 980, and a standard deviation of 113.418. The independent interest variable is GAS, which has an average mean of 10.1537, a minimum of 4.8, a maximum of 30.8, and a standard deviation of 4.097159. The other variables are used as control variables. The variable ENERGY has an average mean of 17.76677, a minimum of 0.102, a maximum of 60.124, and a standard deviation of 11.54811. The variable TAX has an average mean of 7.451699, a minimum of 3.62, a maximum of 12.32, and a standard deviation of 1.70568.

3.2 Methodology

The data analysis methods used refer to the estimation of the regression equations. We use cross-data panel regression and before we begin to estimate the equations, we must test the independent variable for unit root and see if some of the variables are better estimated as level 1 or level 2 difference.

In this study we will use 4 unit root tests, respectively: Levin-Lin-Chu, Im-Pesaran-Shin and the Breitung and Hadri Lagrange multiplier stationarity test regarding the dependent variable direct investments.

The assumptions established for the tests considered are:

- for Levin-Lin-Chu is H0: Panels contain unit roots
- for Im-Pesaran-Shin is H0: All panels contain roots of unity
- for Breitung is H0: Panels contain roots of unity
- for the Hadri Lagrange multiplier stationarity test is **H0**: All panels are stationary.

Levin *et al.* (2002) tested the null hypothesis using

$$\Delta q_{it} = \alpha_{mi} d_{mt} + \delta q_{i,t-1} + \sum_{k=1}^{p} y_k \Delta q_{i,t-k} + \varepsilon_{i,t'} \quad (1)$$

Where d_{mt} denotes the deterministic parts, and $\varepsilon_{i,t}$ is assumed to be independently distributed across i and t, with $i = 1, \dots, N$ and $t = 1, \dots, T$. Once the normalized bias and the corresponding pseudo t-ratio of pooled OLS estimation of δ in (1) are appropriately normalized, convergence to a standard normal limit distribution is achieved as $N \to \infty, T \to \infty$ so that $\sqrt{N}/T \to \infty$.

Im *et al.* (2003) test is built on the estimation of (1), but changing δ with δ_i. The null hypothesis is rejected if there is a subset (N1) of stationary individuals. The first test proposed is the standardized group-mean Lagrange Multiplier (LM) bar test statistic.

$$\psi_{\overline{LM}} = \frac{\sqrt{\overline{N}}\left[\overline{LM} - N^{-1}\sum_{i=1}^{N} E(LM_i)\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(LM_i)}} \quad (2)$$

with $\overline{LM} = N^{-1}\sum_{i=1}^{N} LM_i$, where LM_i denotes the individual LM tests for testing $\delta_i = 0$ in (1), and $E(LM_i)$ *and* $Var(LM_i)$ are obtained with the help of Monte Carlo simulation. The following test is the standardized group mean, t bar test statistic. This one has a similar expression of (2), with bringing up that it replaces $\overline{LM}$ and LM_i with $\bar{t}$ and t_i.

We outline $\bar{t} = N^{-1}\sum_{i=1}^{N} t_i$, where t_i denotes the individual pseudo t-ratio for testing $\delta_i = 0$ in (1), and $E(t_i)$ and $Var(t_i)$ are calculated using Monte Carlo simulation.

Breitung and Das (2005) propose a test based on robust standard errors. It has been shown that under the null hypothesis that

$$\mathrm{E}\left(\Delta y_{it}^{*} \tilde{y}_{i,t-1}\right) = s_t\left[(t-1)\sigma_i^2 - \frac{(t-1)\sigma_i^2}{T-t}(T-t\right] = 0 \quad (3)$$

where $\sigma_i^2 = E(\varepsilon_{it}^2)$ (Breitung, 2000). Hence, the OLS estimator of ϕ in the regression

$$\Delta y_{it}^{*} = \phi \tilde{y}_{i,t-1} + u_{it}^{*} \quad (4)$$

can be shown to have a standard normal limiting distribution.

Hadri (2000) proposes a residual-based Lagrange multiplier (LM) test for a null that the individual observed series are stationary around a deterministic level or around a deterministic trend against the alternative of a unit root in panel data.

In the study, he relaxes the assumption on the errors y_{it} being $i.i.d\ N(0, \sigma_\varepsilon^2)$ over t to accommodate serial dependence cases. Also, he defined the consistent estimator of σ^2 as

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N} \lim_{n\to\infty} T^{-1}(S_{iT}^2) \quad (5)$$

To estimate the regression equations, we used ordinary least squares panel data linear regression of the form:

$$y_{it} = f(X_{ij}, \beta) + \delta_i + \gamma_t + \varepsilon_{it} \quad (6)$$

Our specific case involves a linear conditional mean specification, so we obtain:

$$y_{it} = \alpha + X'_{it}\beta + \delta_i + \gamma_t + \varepsilon_{it} \quad (7)$$

where Y_{it} is the dependent variable, X_{it} is a k-vector of repressors and εit are the error terms for $i - 1, 2, \dots, M$ cross-sectional units observed for dated periods $t - 1, 2, \dots, T$. The α parameter represents the overall constant in the model while δ_i and y_t represent cross-section or period specific effects.

4. RESULTS

The correlation matrix in Table no. 3 suggests a direct relationship between the variables: direct investments and Greenhouse gas emissions per capita, respectively between direct investments and Share of environmental taxes in total tax revenues. We found that the highest correlation is established between Greenhouse gas emissions per capita and direct investments (0.3816), so the series will be interchanged using them as control (variables). In Figure no. 1A from Annexes, it can be seen in more detail the relationships that are established between the variables considered in this study.

Table no. 3 – The correlation matrix

	DI	GAS	ENERGY	TAX
DI	1.0000			
GAS	0.3816	1.0000		
ENERGY	-0.2328	-0.4180	1.0000	
TAX	0.0511	-0.0928	-0.0641	1.0000

Source: own processing

The results for unit root Levin-Lin-Chu, Im-Pesaran-Shin, Breitung, and Hadri Lagrange multiplier stationarity test regarding the dependent variable, direct investments, are presented in Table no. 4.

Table no. 4 - The unit root tests for environmental effects

Variables and tests	Results			
Variable name:	DI			
Tests	Levin-Lin-Chu	Im-Pesaran-Shin	Breitung	Hadri
Tests in levels	0.0011***	0.0007***	0.0025***	0.0001***
Tests in first difference	-	-	-	-
Tests in second difference	-	-	-	-
Variable name:	GAS			
Tests	Levin-Lin-Chu	Im-Pesaran-Shin	Breitung	Hadri
Tests in levels	0.0000***	-0.4064***	1.0000***	0.0000***
Tests in first difference	-	0.0000***	0.0000***	-
Tests in second difference	-	-	-	-
Variable name:	ENERGY			
Tests	Levin-Lin-Chu	Im-Pesaran-Shin	Breitung	Hadri
Tests in levels	0.9987***	1.0000***	1.0000***	0.0000***
Tests in first difference	0.3324***	0.0024***	0.0000***	-
Tests in second difference	0.0006***	-	-	-
Variable name:	TAX			
Tests	Levin-Lin-Chu	Im-Pesaran-Shin	Breitung	Hadri
Tests in levels	0.0313***	0.5345***	0.9978***	0.0000***
Tests in first difference	-	0.0000***	0.0000***	-
Tests in second difference	-	-	-	-

Source: own processing

As we can see from Table no. 4, direct investment is stationary at level with a statistical significance of 5% for all tests.

Greenhouse gas emissions is stationary at level though the tests Levin-Lin-Chu, and Hadri with a statistical significance of 5%, and though the tests Im-Persan-Shin, and Breitung that data became stationary at first difference with a statistical significance of 5%.

Share of renewable energy in gross final energy consumption is stationary at level though the tests Levin-Lin-Chu, and Hadri with a statistical significance of 5%, %, and though the tests Im-Persan-Shin, and Breitung that data became stationary at first difference with a statistical significance of 5%.

Share of environmental taxes in total tax revenues is stationary at level though the tests Levin-Lin-Chu, and Hadri with a statistical significance of 5%, and though the tests Im-Persan-Shin, and Breitung that data became stationary at first difference with a statistical significance of 5%.

In all the cases the null hypothesis is rejected by all the test and the statistical significance is lower than 5%.

After obtaining stationary data, we estimate the regression equations to see the influence of the environmental effects on direct investments.

We propose the next regression equation to illustrate the environmental effects:

$$DI = \beta_1 + \beta_2 * GAS + \beta_3 * ENERGY + \beta_4 * TAX + \varepsilon \quad (8)$$

To estimate this equation, we used the Panel Least Squares method with an adjusted sample from 2004 to 2020. The results of the estimation are presented in Table no. 5.

Table no. 5 – The regression results for the environmental effect

Sources	**SS**	**df**	**MS**		**Numer of obs**	**=**	**43**
					F(3, 427)	**=**	**26.7**
Model	918173.11	3	306057.703		Prob>F	=	0.000
					R-squared	=	0.158
Residual	4883099	427	11435.8303		Adj R-squared	=	0.152
Total	5801272.64	430	13491.3317		Root MSE	=	106.9
DI	Coef.	Std. Err.	t	p>|t|	95% Conf.	Interval	
GAS	10.08839	1.397254	7.22	0.000***	7.342039	12.8347	
ENERGY	-0.8004706	0.4988824	-1.60	0.094***	-1.781042	0.180100	
TAX	5.425173	3.077353	1.76	0.079***	-0.6234727	11.4738	
_cons	-104.3884	32.71542	-3.19	0.002***	-168.6917	-40.0850	

Source: own processing

As we can see from the null value of Prob(F-statistic) the model is viable, also the standard deviation of the dependent variable is higher than standard error of the regression, but from the value of R2 we conclude that 15.80% of the variation of DI is explained by the independent variables included in the model. We see from Table no. 5 that all independent variables have a statistical significance of 10% or lower.

The final regression equation for the environmental effect is:

$$DI = 104.3884 + 10.08839 * GAS + (-0.8004706) * ENERGY + 5.425173 * TAX \quad (9)$$

The share of renewable energy has a negative impact on the DI, while the rest of the independent variable has a positive effect.

We checked with the White test whether the errors were not correlated with each other. The test results showed a sig = 0.0000 less than 5%, so we reject the null hypothesis and accept the second hypothesis, namely that there is heteroscedasticity.

5. CONCLUSIONS

The results showed us that an important influence on direct investment is made by environmental effect of sustainable development.

The results of this study show that the environmental effects have a positive influence on the direct investments in the 27 European countries. Thus, environmental indicators have a positive influence on direct investment, explaining 15.80% of the evolution.

It can be seen that the environmental effect is becoming more and more important in the context of climate change, but also of ecological investment projects in business. And in the case of the objectives of reducing greenhouse gas emissions, direct investments ease the financing burden on the shoulders of European states.

In general, direct investment is targeted at green investments that generate increased clean energy production and clean technology innovation.

Currently, in the context of the European energy crisis, the development of renewable energy has become one of the most important fields of our time. Thus, reducing costs and increasing the efficiency of renewable sources generates an increasing flow of direct investment in this field.

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ANNEX

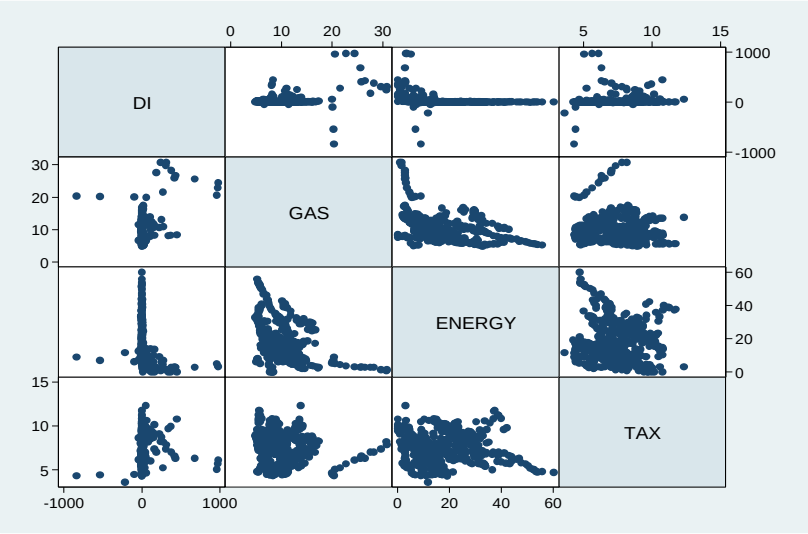

Figure no. 1A – The relationship between variables
Source: own processing

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The Impact of Business Intelligence and Analytics Adoption on Decision Making Effectiveness and Managerial Work Performance

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Abstract: Business Intelligence and Analytics systems have the capability to enable organizations to better comprehend their business and to increase the quality of managerial decisions, and consequently improve their performance. Recently, organizations have embraced the idea that data becomes a core asset, and this belief also changes the culture of the organization; data and analytics now determine a data-driven culture, which makes way for more effective data-driven decisions. To the best of our knowledge, there are few studies that investigate the effects of BI&A adoption on individual decision-making effectiveness and managerial work performance. This paper aims to contribute to bridging this gap by providing a research model that examines the relationship between BI&A adoption and manager's decision-making effectiveness and then his individual work performance. The research model also theorizes that a data-driven culture promotes the BI&A adoption in the organization. Using specific control variables, we also expect to observe differences between different departments and managerial positions, which will provide practical implications for companies that work on BI&A adoption.

Keywords: Business Intelligence and Analytics; data-driven culture; decision-making effectiveness; individual work performance.

JEL classification: M15; D81; L86.

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1. INTRODUCTION

Data-driven culture is increasingly embraced by organizations that become aware of the benefits of this approach. An insight from Assur and Rowshankish (2022), suggestively entitled "The data-driven enterprise of 2025," affirmed that "the data-driven culture fosters continuous performance improvement to create truly differentiated customer and employee experiences," given the multitude of cutting-edge new technology that constantly become available.

In recent times, Business Intelligence and Analytics (BI&A) has developed as a representative field in Decision Support Systems research and attracted significant interest in academia. In the current dynamic environment and economic uncertainty, Chen *et al.* (2012) insinuated that they will successfully transform the organizational decision-making process. Having in mind the importance of decision making in managers' work, Sharda *et al.* (2015, p. 615) emphasize the significant role of analytics systems that will transform their job because they are able to "change the manner in which many decisions are made." The same authors (2015, p. 616) consider that "analytics technologies tend to reduce the time required to complete tasks in the decision-making process and eliminate some of the nonproductive waiting time by providing knowledge and information." Given the Big Data challenge that companies have to face, accurate and pertinent decisions are only possible with BI&A that offer the tools to analyze large volumes of data (Trkman *et al.*, 2010).

Studies on the effects of using BI&A systems have shown that their usage enhance organizational performance. Some authors have attested a direct relationship with operational performance (e.g., Anderson-Lehman & Watson, 2004; Trkman *et al.*, 2010; B. Chae *et al.*, 2014; Appelbaum *et al.*, 2017), others explain that BI&A contributes to business performance by creating value (e.g., Sharma *et al.*, 2010; Wixom *et al.*, 2013; e.g., Seddon *et al.*, 2017). As regards individual perception, traditionally (starting with DeLone & McLean, 1992) there are studies that analyze 'user satisfaction about the information system' as a construct that affects individual performance (i.e., decision effectiveness, problems detection, or individual work productivity). However, few papers analyze the impact of BI&A on individual work performance; for example, there is evidence of higher individual work performance determined by the use of BI (Hou, 2012). Our paper aims to contribute at filling this research gap, by analyzing the effects of BI&A adoption on managerial work performance. The targeted individuals are managers at different organizational levels that work in different departments.

While there is evidence that BI&A adoption has effects on organizational performance, we want to demonstrate that the decision-making process itself is positively affected. Furthermore, we want to validate that there is a positive relationship between a data-driven culture in the organization and BI&A adoption. Therefore, we formulate the following research questions:

RQ1. Does the data-driven culture promote the adoption of BI&A in an organization?

RQ2. To what extent the adoption of BI&A influences the effectiveness of decision-making and thus the managerial work performance?

2. LITERATURE REVIEW

2.1 Data-driven culture

The data-driven organizations are the ones that have managers that realize the benefits of trusting on data insights to take intelligent business actions. According to the results of a McKinsey Global Institute study cited in Bokman *et al.* (2014), the data-driven organizations "are 23 times more likely to acquire customers, six times as likely to retain customers, and 19 times as likely to be profitable as a result." The worldwide phenomenon of ongoing data growth and the more and more digitalized reality generated a new tendency in organizational management known as 'data-oriented' or 'data-driven' approach, described as a "strategic process of leveraging insights from data" to improve performance and gain competitive advantage (De Saulles, 2019). With this new line of action, managers are able to use "evidence-based data" when making their decisions (De Saulles, 2019).

Kiron *et al.* (2013) gave one of the first definitions of data-oriented culture as "a pattern of behavior and practices by a group of people who share a belief that having, understanding and using certain kinds of data and information plays a crucial role in the success of the organizations." Holsapple *et al.* (2014) acknowledged this definition and enhance it by indicating that it should be "consistent with the principles of analytical decision making."

Tushman *et al.* (2017) emphasizes that "analytics using complex data sets are playing an important role in effectively managing organizational change" and so organizational management is becoming increasingly data-driven. More recently, Duan *et al.* (2020) and Chatterjee *et al.* (2021) extensively discuss the data-driven culture evolution and organizational impact in the last decade. Their research also validates the idea that together with Business Analytics, the data-driven culture in organizations has the capability to enhance innovation, which subsequently results in higher organizational performance.

2.2 Business Intelligence and Analytics (BI&A)

Business Intelligence (BI) and Business Analytics (BA) are both well-established areas and prominent topics for IS researchers and practitioners (Chen *et al.*, 2012). BA is considered an evolution of BI, a system that offers "advanced techniques for the analysis and reporting of data" (Someh *et al.*, 2019). As reported by Brynjolfsson and McAfee (2017), BA is seen as "the next big thing" in the business community, while BA tools are expected to augment or substitute for humans in the decision-making process.

BA is adding extra functions to the BI tools that are designed for reporting, analyzing, and presenting. Davenport and Harris (2007) introduce BA the as “representing the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and fact-based management to drive decisions and actions”. Business Analytics has four objectives (Yin & Fernandez, 2020). First of all, BA reduces the time spent with decision-making, thus optimizing decision-making processes in real time (Sharma *et al.*, 2014; Hindle & Vidgen, 2018). At the same time, BA increases the objectivity of decisions. As revealed in previous research, the use of BA has a positive influence on customer marketing (Schläfke *et al.*, 2012) and quality of services and product is improved (Troilo *et al.*, 2016). Last but not least, the use of BA helps understand the external environment (Calof *et al.*, 2015).

Cosic *et al.* (2012) considers BA a company asset that includes "people, processes, and technologies involved in data gathering, analysis, and transformation to support managerial decisions." As Seddon *et al.* (2017) also acknowledged, BA is about using data "to make sounder, more evidence-based decision making."

Descriptive analytics provides answers to questions such as "What happened?", "Why did it happen?", but also "What is happening now?" mostly in a streaming context. Predictive analytics determines "What will happen?" and "Why will it happen?" in the future, prescriptive analytics will provide solutions to questions such as "What should I do?" and "Why should I do?". In this respect, BA is useful for companies that plan to change their business model or seek to adapt to a new business environment. Advanced data processing algorithms such as complex statistics, data mining, machine learning are used to suggest and verify changes made to products and services in order to better match customer requirements (Djerdjouri & Mehailia, 2017).

To predict the effects of a changed business model a substantial amount of high-quality data is required and that is made available in a data-driven environment. In the Big Data and AI age, BI&A evolves to "data-driven discovery and highly proactive and creative decision making" (F. Wang *et al.*, 2022) offering the company the opportunity to spawn new competitive advantage.

BI&A had received extensive attention in literature but not many papers offered empirical evidence on BI&A effectiveness and value realization for the manager. This paper explores the relationships between BI&A adoption, decision making effectiveness, and individual work performance.

2.3 Decision making based on BI&A

Decision making is an essential managerial task which is crucial because it shapes the course of a company. Traditionally, managers use to rely on their intuition, as a "form of reasoning that is based on years of experience and learning, and on facts, patterns, concepts, procedures, and abstractions stored in one's head" (Matzler *et al.*, 2007). Today they have to rely more on gathering of facts, figures, data, and evidence and replace the intuitive decision making with the fact-based decision making. Companies accumulate immense amount of data from diverse sources but to make use of it in decision making, they need to deploy data analytics solutions (Madhala *et al.*, 2021).

In order to avoid situations like data redundancy or information overload, or incomplete information that result in mediocre outcomes, managers need the right amount of data in the suitable form. This need stimulated companies to adopt BI&A systems, aiming to optimize the decision through the "pervasiveness availability of data with quality and in a timely fashion".

The decision-making process based on BI&A tools utilizes insights that are generated by the analysis of data from multiple sources. Insights give rise to "the discovery of creative options through immersion in data" (Frisk *et al.*, 2014) and support the data-driven decisions approach (Passlick *et al.*, 2020). Traditional BI reporting systems often cannot keep up with this need and self-service BI appeared as a more flexible environment for the manager's demands, accomplishing decentralized decision making across all departments. Furthermore, the dynamic business environment and the intense competition in the last decade amplified the necessity for a fast and effective decision-making process. Business Analytics came up with the promise to create value from the huge volumes of available data.

An increased number of companies tried to benefit from the BA promise and invested in related technologies and infrastructure. Nowadays, the idea of improving the decision-making process demonstrates new opportunities due to the achieved capacity of storing and analyzing data in real-time that have expanded the data analytics capabilities (Madhala *et al.*, 2021).

3. RESEARCH METHODOLOGY

3.1 Research model and hypotheses

The proposed model is based on the previous research on impact of BI&A use on decision making and organizational performance.

According to Madhala *et al.* (2021), the categories of effects of BI&A use that are analyzed in literature are "performance, innovation, strategy, and decision-making process." Business performance constitutes the mainly researched result; literature investigated the effects of BI&A adoption on organizational performance and suggested that it results in improved effectiveness (innovation of products and services, quality, or customers' satisfaction) and efficiency (B. Chae *et al.*, 2014; Battleson *et al.*, 2016; Gupta & George, 2016; Alexander & Lyytinen, 2019; Jha *et al.*, 2020). Meanwhile, other authors (Seddon *et al.*, 2017; Ghasemaghaei, 2019) assert that there is still ambiguity on the subject of the impact of adopting of BI&A on performance, so the subject can benefit from further investigation.

To the best of our knowledge, the individual work performance is an outcome that is seldom analyzed, and our research aim to contribute in this research direction. Moreover, the proposed model includes also the decision-making process effectiveness. The complete research model is pictured in Figure no. 1.

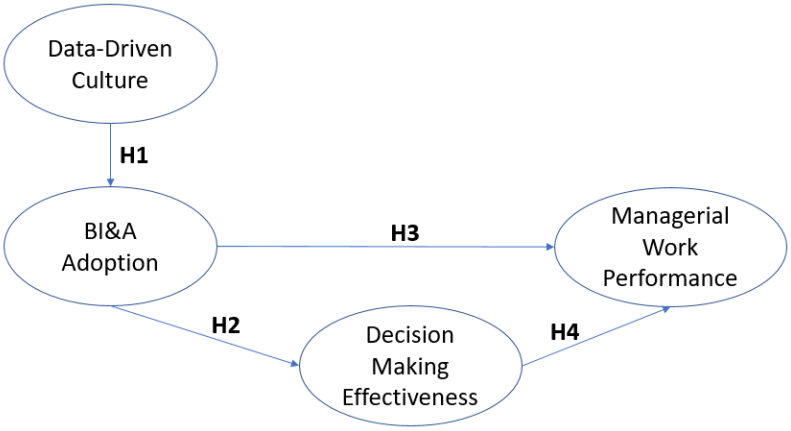

Figure no. 1 – Research Model

Our first assumption aims for determining the correlation between data-driven culture and BI&A adoption. Given the enormous volume of data created and made available to the companies, it is important for them to transform their organizational culture into a data-driven one. While other researchers consider that BA adoption determines a data-driven culture

(Chatterjee *et al.*, 2021), our intention is to test if BI&A adoption is positively influenced by a data-driven culture.

Kiron *et al.* (2013) suggested that companies need to develop "data-oriented management systems" as a proper response to the increasing volumes of data. As explained in Chatterjee *et al.* (2021), data-driven culture boosted after 2016, along with the incredible growing of connected devices and innovative data technology. In their research about the challenges tackled by managers striving for their organizations to become more data-driven with the aim of creating value, Vidgen *et al.* (2017) also enumerated "building a corporate data culture" among other data-related assignments like, "managing data quality" or "building data skills." Many organizations today recognize data as a new class of business assets and this postulation is also reflected in their investments in specific technology, like BI&A. As stated in Tavera Romero *et al.* (2021), to accomplish the BI potential, a change in culture is necessary. In the same vein, Duan *et al.* (2020) emphasized the importance of not regarding BA as "just a technical development", but also considering it strongly related to the organizational culture. In this respect, Wedel and Kannan (2016) asserted that a data-driven culture encourages BA adoption and determines the maximization of the BA potential.

Taking into consideration the fact that data and BI&A solutions increasingly become user-friendly and cost-efficient, we reason that a data-driven culture is encouraging for BI&A adoption in the organization and we articulate the first hypothesis:

***H1**: Data-driven culture is positively related to BI&A adoption.*

In 2004, (Gibson *et al.*) asserted that BI delivers substantial business value by enhancing the effectiveness of the decision-making process, being the "principal provider of decision support". Decision making effectiveness is also considered an important indicator of the BI system success (Y. Wang & Byrd, 2017).

Having in mind the differentiation between dependence and infusion of a system's use described by Sundaram *et al.* (2007), in case of the BI&A systems we don't observe the system-dependence because the manager's decision does not necessarily depend on the BI&A system use – many managers still base their decisions on intuition or 'gut'. Based on Sundaram *et al.* (2007), Trieu *et al.* (2018) explained the 'BI infusion', which happens when managers fully use the BI system for enhancing their work performance. In addition, the importance of data for the management environment is unanimously recognized, data-driven decisions are leading to beneficial actions for the organization (Sharma *et al.*, 2014; Hindle & Vidgen, 2018). BI&A is expected to deliver "the right decision support to the right people and digital processes at the right time" (Laursen & Thorlund, 2010). Basing their decisions on BI use, managers may be able to replace intuitive decision making with "fact-based decision making" (Davenport, 2006). Recent studies examined the effects of BI&A adoption on decision making. For example, Ghasemaghaei *et al.* (2018) determined that Business Analytics capabilities can significantly improve the decision-making quality. Kitchens *et al.* (2018) and Tan *et al.* (2016) discovered the BI&A contribution for optimizing decision making in the e-commerce domain.

In this vein, we posit that BI&A adoption enhances the manager's decision-making effectiveness and formulate as follows:

***H2**: BI&A adoption is positively related to decision making effectiveness.*

Complex business models and processes require a series of innovative approaches to increase managerial performance. Exploiting the full potential of internal and external data by using BI&A tools leads to increased efficiency of operations and business performance (Oliveira *et al.*, 2012; B. K. Chae & Olson, 2013).

Many papers in BI&A literature as well as business reports validated the theory that BI&A solutions are beneficial for companies because they contribute to their performance (Anderson-Lehman & Watson, 2004; Davenport & Harris, 2007; Davenport *et al.*, 2010; Shanks & Bekmamedova, 2012; Wixom *et al.*, 2013; Someh *et al.*, 2019). According to Shanks and Bekmamedova (2012), Business Analytics "provides value to the organization when it is embedded in it." As regards individual work performance, based on the frequency and duration of the IS usage, Hou (2012) discovered that "higher levels of BI system usage lead to higher levels of individual performance." It is reasonable to assume that BI&A use helps managers to accomplish their tasks more effectively and enhanced their work performance and we articulate the next hypothesis:

H3*: BI&A adoption is positively related to managerial work performance.*

According to Sharma *et al.* (2014), the 'first-order effects' of BI&A adoption are likely to affect the decision-making process and consequently, the improved decision-making process will positively influence the organizational performance. In the same line of thought, Trkman *et al.* (2010) explained that analytical tools enhance the decision-making process and as a result the business performance increases. Data-driven decision-making has a positive effect on firm performance, in other words, companies that rely on data and facts for decision-making enhance their productivity (Brynjolfsson & McAfee, 2017).

"Make decision quicker", "Shorten the time frame for decision making", or "Spend less time in meetings" are listed as benefits of computer-aided decision making (Leidner & Elam, 1993) and it is only reasonable to assume that an effective decision-making process has a positive impact on managerial work performance. Therefore, we hypothesize:

H4*: Decision making effectiveness is positively related to managerial work performance.*

3.2 Research Methods

Starting from these research questions, we developed a research model with four variables: Data-Driven Culture (DDC), Business Intelligence & Analytics adoption (BIAA), Decision Making Effectiveness (DME) and Managerial Work Performance (MWP). Measurement items have been already identified in previous studies: Sanders and Courtney (1985); Leidner and Elam (1993); Koopmans *et al.* (2012); Cao and Duan (2014); Chatterjee *et al.* (2021). All the items will be measured on a five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree).

A pilot test will be conducted in a local IT company involving at least 10 managers at different levels and departments. The population will be selected from 40 medium and large size companies from at least four national development regions, the questionnaire being distributed to at least 10 managers from each organization. Firm size and industry (for the company), as well as managerial position and department (for the manager) will be taken as control variables.

Data will be analyzed with PLS-PM that provides the opportunity to assess the measurement of the constructs and test hypotheses on all the relationships among the constructs at the same time, in the same analysis. According to Benitez *et al.* (2020), Partial Least Squares path modeling (PLS-PM) has been "the predominant estimator for structural equation models" in the IS area.

We will test the adequacy of the model proposed regarding the reliability of data, convergent and discriminant validity. In order to validate the proposed model, further processing is necessary, and the following steps are required:

- key parameters estimation, namely the path coefficients and R2 value of the IWM latent endogenous variable (Individual Work Performance construct); the path coefficients express how strong is the effect of one variable on another variable;
- reliability and validity measurement, being essential to determine if the latent variables are reliable and valid of and the correlations among the latent constructs (DDC, BIAA, DME, IWM);
- measurement of the structural model; typical assessment standards consist of collinearity test, the coefficient of determination, the predictive relevance, and "the statistical significance and relevance of path coefficients" (Fricker *et al.*, 2012).

4. EXPECTED CONTRIBUTION

The proposed research is assumed to generate some theoretical and practical contributions. First, the research will contribute to fill the gap in the literature by investigating the relationship between BI&A adoption and decision making effectiveness and the individual work performance.

Next, our research model theorize that data-driven culture has a major positive effect on BI&A adoption because we are observing a strong belief that Big Data triggers an inevitable change in the organizational culture that is more than simply investing in the company's analytics capacity.

Third, we expect to discover differences in the adoption of BI&A tools between different managerial levels and departments and in relation to the company size and industry. These dissimilarities promise to reveal significant insights that may be useful for the BI&A adoption strategy.

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The Empirical Study of the Impact of Firm- and Country-level Factors on Debt Financing Decisions of ICT Firms

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Abstract: The capital structure has been extensively analysed in the empirical literature. Despite of the great contribution of the technological industry to the global economy, little research has been conducted regarding corporate finance of ICT firms. Moreover, the previous literature barely considers the effect of macroeconomic variables on financial decisions, focusing much more on internal determinants, such as cash flow, firm's size or growth opportunities. The objective of this work is to reduce this gap by disentangling the reasons behind the financial decisions of technological firms. The sample included 1,510 public ICT firms from 23 countries over the period 2004 – 2019 (17,342 observations). The variables used in this study are obtained from S&P Capital IQ, World Development Indicators, Main Science and Technology Indicators from OECD, and FMI dataset. The two-step system generalized method of moments (GMM) was used as methodology. Consistent with the extant literature, more profitable and liquid ICT firms and those with an increased non-debt tax shields are less leveraged. However, the companies which present higher risk, measured as volatility of EBIT, increase their use of debt financing. Contrary to the findings of many other studies, the analysis of a firm's size and tangible assets shows non-conclusive results. Regarding macroeconomic determinants, only economic growth and foreign direct investment inflows were found to generate a positive effect on financial decisions of ICT firms. The findings of this work can be used to design and develop policies, measures, and facilitate mechanisms for optimal management of the financing decisions of ICT firms.

Keywords: financial decisions; capital structure; corporate finance; external and internal determinants; ICT firms.

JEL classification: G30; G32.

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1. INTRODUCTION

Financing decisions are those faced by the firm at a given moment and include the best combinations of sources to finance investment and other needs. These decisions require the firm to determine the financial structure in which the optimal ratio of debt to equity must be defined since it influences firm value, future growth and profit generation (Hackbarth & Mauer, 2011). Early approaches to capital structure focused on determining possible relationships between the level of debt linked to the cost of capital and the value of the firm in perfect markets. Later, when considering the reality of imperfect markets, this theoretical proposal gave rise to other models that analyse firm value through the level of debt taking into account the tax effect, distress costs, agency conflict and information asymmetry. There are several theoretical models that have been constructed in response to the search for an explanation of a firm's optimal capital structure decisions to ensure greater value for the firm. The main theories of capital structure comprise the trade-off theory and pecking order theory. In addition, there are a number of models associated with them that relate to other factors by establishing an optimal capital structure for companies.

These bases are applied in the assessment of the financing decision behaviour of companies in different sectors, since there are a number of factors that condition these decisions in one way or another. In this sense, it is interesting to analyse the capital structure of companies belonging to the sector of information and communication technologies, ICT, since it is peculiar in many ways and differs from the rest of the sectors. Firstly, the ICT sector is extremely critical for the personal and professional development of individuals and companies of other sectors enabling all of them to connect, interact, transact in the digitised environment and also use technologies to accelerate the pace of innovative creations in various fields. This gives rise to the emergence of different sub-sectors focused on the creation of technological infrastructure, network components, applications, system components and the Internet (Sekmen & Gokirmak, 2018), as well as Big Data and the Internet of Things that enable the effective collection, management and analysis of large volumes of data received from multiple sensors (Ahmed *et al.*, 2017).

Officially, according to the definition reached by OECD member countries in 1998 and revised in 2006 (OECD, 2009), the ICT sector aims to carry out and enable the processing and communication of information by electronic means as well as to transmit and present it visually. Within the ICT sector, two main groups can be distinguished: manufacturing and services (Psychoyios & Dotsis, 2018). Products in the manufacturing subsector fulfil the function of information processing and communication including transmission and display, such as, for example, the manufacture of office machinery, computer and telecommunication equipment, computers, electronic products, electronic components, semiconductors and cables (Holm & Østergaard, 2015). As for the services subsector, this includes services around IT equipment, computers and components such as their sale, installation, maintenance and repair as well as the design, development and licensing of software, online applications, hosting and internet services, data analysis, processing and storage, telecommunication and consulting services, or auditing, among others (Ciesielska, 2017).

Secondly, we should recall that we are currently immersed in the fourth industrial revolution, called Industry 4.0, which is about the increased use of modern technologies and wider access to advanced knowledge and active cooperation that serves to drive industrial development (Nahtigal, 2014). Nowadays, the influence of new technologies on the economy

at large is undeniable. In essence, they have radically transformed the way in which data is generated, processed and used in all domains and have created digital technologies with new functionalities that have led to the redesign of traditional business strategies and processes (Bharadwaj *et al.*, 2013). It is the harnessing of these technologies together with innovation that enables successful digital transformation, i.e., generating new digital capabilities and creating new ways of managing resources and business (Condea *et al.*, 2017). As stated by one of the latest reports of OECD (2017) on digital economy, "the ICT sector remains a key driver of innovation, accounting for the largest share of OECD business expenditure on research and development" (2017, p. 1).

The relevance of technologies is currently reflected in the impact generated by digital initiatives from various sectors for companies expressed in cumulative values from 2016 to 2025 and also for the society. In this regard, it is worth noting that in some sectors, such as consumption, automotive, logistics, electricity and aviation, the cumulative value is much higher for society than for the industry itself. In other sectors, e.g., telecommunications, oil and gas, media, mining and chemicals, the contribution is more relevant for business. In addition, increased support for technologies helps to reduce harmful gas emissions significantly. Such is the example of the electricity, oil and gas and logistics sectors. In terms of jobs, the impact of technologies is not always positive, only in some sectors, such as telecommunications, electricity and logistics (see Table no. 1).

Table no. 1 – Potential impact of digital initiatives per sector

Sector	Accumulated value 2016-2015, in billions of USD		Reduction of CO2 emissions, in million tons	Jobs, in thousands
	for society	for firms		
Consumption	5,439	4,877	223	3,249
Automotive	3,414	667	540	Not available
Logistics	2,393	1,546	9,878	2,217
Electricity	1,741	1,360	15,849	3,158
Telecommunications	873	1,280	289	1,100
Aviation	705	405	250	**-780**
Oil and gas	637	945	1,284	**-57**
Media	274	1,037	**-151**	Not available
Mining	106	321	608	**-330**
Chemical	2	308	60	**-670**

Sources: own elaboration based on WEF report Digital Transformation of Industries

Thirdly, considering the multiple applications of technologies in economic fields, new sectors of the digital economy are emerging, such as e-business, e-commerce, digital manufacturing, precision agriculture, algorithmic economy, sharing economy, collaborative economy, fintech, tourismtech and insurtech, among others. Fourthly, the speed at which technologies develop is another prominent feature of the ICT sector, leading to the continuous improvement of technologies and rapid creation of new ones. For example, as reflected in the 2019 Digital Economy Report of the United Nations (UNCTAD, 2019), global Internet Protocol traffic has increased from 2002 to 2017 from 100 to 46,600 gigabytes per second and the forecast for 2022 puts it at 150,700 gigabytes per second. In 2018 there were more objects connected to the internet than people: 8.6 billion versus 5.7 billion broadband subscriptions. And by 2022, Internet of Things connections are expected to exceed 22 billion, driven mainly

from the United States and China. Another example is 5G, a new fifth-generation mobile technology network, capable of processing huge volumes of data much more effectively and connecting many more devices than current networks. Already by 2025, it is estimated that 5G will account for almost half of all mobile technologies in North America and a third in Europe. Finally, traffic generated by cloud technologies, which solve the problem of data storage and transform current business models, grew by 116% in just three years, reaching 13 zettabytes of total volume in 2019, and is expected to grow to almost 20 zettabytes by 2022.

The ICT sector is therefore characterised as disruptive and innovative on a global scale because new technologies offer innovative solutions to other sectors with a value proposition. For example, Legner *et al.* (2017) argue that the increased use of digital technologies increases business opportunities at all levels. Ferreira *et al.* (2019) suggest that higher performance and, consequently, higher competitiveness is achieved by companies that actively rely on digital processes. Stanley *et al.* (2015) explain that technologies contribute to a country's productive and economic growth, as well as to the creation of new employment opportunities on a permanent rather than sporadic basis. Pradhan *et al.* (2015) and Nureev and Valerievich (2018) add that, thanks to technologies, significant cost reductions are achieved, generating new forms of wealth in other sectors. All of this reshapes traditional business models, contributing to the creation of a new, more dynamic, changing and demanding environment that affects other sectors and markets (Seo, 2017).

Given the specific characteristics of the ICT sector described above, it is possible to think that technological companies need to manage financing issues in a different way than the rest in order to cope with the particular needs of product development. So, it is likely that decision making on financing issues is influenced by other factors, less known or even unknown. Therefore, the main objective of this study is to deepen the analysis of the impact generated by the firm-level as well as macroeconomic variables on the debt financing of ICT firms, trying to find and assess eventual differences of this impact between debt measured at book and market values.

The rest of the paper is structured as follows: Section 2 contains the literature review on the antecedents of capital structure theories and proposals and their application to the ICT sector; Section 3 explains the details of the sample composition, database used and the methodology applies and also presents the econometric model; Section 4 includes the highlights of the empirical results; Section 5 offers discussion on the obtained results and main conclusions of the study suggesting the future research lines.

2. LITERATURE REVIEW AND HYPOTHESIS

2.1 Classical theories of financing decisions

Trade-off theory, suggested by S. Myers (1984), is one of the most important theories of capital structure. It is derived from Modigliani and Miller (1958) theorem which postulates that, in perfect markets, the value of the firm does not depend on the capital structure or financing decisions. It is assumed that firms have wide access to debt and equity and that the market in which they operate is perfect. Therefore, any combination of debt or equity is good. This theory suggests that the optimal capital structure is achieved when there is a trade-off between the marginal value of the benefits associated with debt and the costs associated with debt issuance (Cekrezi, 2013).

Trade-off theory has two major advantages regarding the use of debt: (1) tax savings through expenses which are deductible; and (2) reduction of agency conflict arising from control between shareholders (principals) and directors, or managers (agents) who have different interests and objectives (Jensen & Meckling, 1976; Jensen, 1986). On the one hand, profitable firms, in general, take on more debt because their expected profits are usually high (Fama & French, 2002; Benito, 2003; Heider & Ljungqvist, 2015). On the other hand, managers do not always act in accordance with shareholders' interests, but try to satisfy their own ones (Boshkoska, 2015). Managers tend to use free cash flow to make suboptimal investments, but debt limits it because it forces the firm to pay excess cash flow through interest. In this regard, some works has found that more profitable firms tend to use more debt in order to monitor managers' use of cash flow and reduce agency costs (Castro *et al.*, 2016; Zeitun *et al.*, 2017).

However, it should be noted that a large debt level increases the likelihood of financial distress, the most serious of which is bankruptcy (Mueller, 2012). Therefore, debt is one of the financial factors that increase the risk level of the firm (Ughetto, 2008; Ozdagli, 2012; Sun *et al.*, 2016). In this regard, some papers have found that large and profitable firms tend to have high levels of debt because they are less likely to default, so their financial imbalance costs are expected to be low (Rajan & Zingales, 1995; Benito, 2003).

In addition to the version of the trade-off explained so far, called static, there is another one, called dynamic. The dynamic trade-off takes into account the fact that firms need to be able to adjust their level of indebtedness according to their internal characteristics, such as cash flow volatility, return on assets, interest and bankruptcy cost (Fischer *et al.*, 1989; Yinusa, 2017). This means that firms will make adjustments to the capital structure when these limits are altered (Goldstein *et al.*, 2001; Strebulaev, 2007). In summary, the basis of the trade-off theory is the optimal debt ratio (static model) and the necessary adjustments within optimal limits which are not fixed to reach this target (dynamic model).

The pecking order theory, developed by S. Myers (1984) and S. Myers and Majluf (1984), offers a different explanation of the financing decision than the trade-off theory, focusing mainly on the existence of informational asymmetries and costs associated with the source of financing. The pecking order does not consider the existence of the optimal capital structure but rather the costs of adverse selection between the firm and creditors. That is, these costs are what determines financing decisions (Frank & Goyal, 2003; Whited, 2006; Mueller, 2012; Naranjo *et al.*, 2022). The pecking order theory states that the firm first uses internal financing as the cheapest source of financing, then external financing through debt, with a higher cost, and finally equity issuance, which is the most expensive option (Benito, 2003; Zeitun *et al.*, 2017).

Firms choose not to borrow when the interest on debt is high (Hogan & Hutson, 2005; Paul *et al.*, 2007). If internal funds are not sufficient, the firm will resort to debt financing (Castro *et al.*, 2015). The issuance of equity, as the last alternative of financing, involves higher costs than the previous sources of financing. This is due to the high risk it entails for an external investor, so that the demanded return on equity is also high. According to S. Myers and Majluf (1984), a company chooses to issue equity only if it does not have sufficient funds to cover its investments and if these investments are really profitable. Cotei and Farhat (2009) explain that it also happens when firms have exhausted their borrowing capacity and are unable to present more collateral. However, equity issuance, unlike financing through internal funds or debt, implies a loss of control over the firm as it involves active participation by equity investors in important business decisions (Kaplan & Strömberg, 2001). This situation

could affect the long-term performance of the firm because it implies the transfer of control from the owners of the firm to new shareholders, whereby the owners will try to avoid loss of control (Cressy & Olofsson, 1997).

2.2 Other theories of capital structure

The classical theories mentioned above have certain limitations. One of them is that they do not provide a general explanation of capital structure behaviour (S. C. Myers, 2001), as they do not consider other factors such as the tangible and intangible nature of assets, growth opportunities, the type of products or services the firms sells, the size, the industry in which it operates, and the volatility of revenues and profitability, among others. Therefore, these theories need some improvement by considering many other factors to provide a more unified framework, as noted by Hennessy and Whited (2005), Sánchez-Vidal and Martín-Ugedo (2005), Leary and Roberts (2007) and Strebulaev (2007). The financing decisions of certain companies are difficult to explain within classical capital structure theories as they are more in line with alternative models, such as the financial growth cycle theory, the market timing model and the managerial entrenchment theory, which are described below.

The financial life cycle theory advocates the idea that a firm, over the course of its life, adopts different capital structures which are optimal according to the stage of the firm's development (A. N. Berger & Udell, 1998; Butzbach & Sarno, 2019). This theory adopts a dynamic perspective on capital structure and considers that life cycles determine a firm's financial need, the selection of a financing source and the cost of capital (La Rocca *et al.*, 2011). Generally, newly created companies in their initial stage of activity resort to internal sources of financing, such as contributions from the founders themselves and their family circles. This type of company is the most opaque in terms of the information it offers to the outside world and the assets it tends to have, which are more intangible, which makes access to external financing more difficult (Huyghebaert, 2001). Despite the difficulties in accessing finance, young firms seem to prefer debt to equity. But what conditions the financing decision is not the firm's preference but the freedom of access to one or another type of financing. As firms grow, they become larger and more experienced and have better access to external sources of finance because they have more assets that can serve as collateral for debt and less informational asymmetries (Mueller, 2012; Hogan *et al.*, 2017).

The market timing model does not assume the existence of an optimal capital structure, but rather that the financial structure depends on the historical financing decisions that were taken depending on the more or less favourable conditions for the company. Market timing analyses the decision of firms to issue equity based on market behaviour, taking into account the variation over time in the cost of capital relative to the cost of other forms of financing in imperfect markets. According to the idea proposed by S. Myers (1984), subsequently studied by other authors such as Lucas and McDonald (1990) or Graham and Harvey (2001), and finally popularised by Baker and Wurgler (2002), companies tend to synchronise with the market and issue shares when they perceive that its behaviour is favourable. This occurs when equity issuance costs are low and the firm's market value is higher than its book value (Alti, 2006; Smulders & Renneboog, 2014).

However, it has to be kept in mind that in order to issue equity at a given moment, firms have to assess whether market conditions are attractive, otherwise equity will not be issued (Frank & Goyal, 2009). It is further noted that firms may prefer to issue equity even when they do not really have a need for funds or when they could have used internal funds or even debt, if market conditions are favourable (Fama & French, 2005). This decision affects the capital structure which, according to Baker and Wurgler (2002) and Mahajan and Tartaroglu (2008), is understood as the cumulative outcome of attempts to predict on the past market movements. In contrast to the Modigliani and Miller theorem, the market timing model considers that the costs of debt and equity vary independently, so that firms have the opportunity to switch between one source of financing and another to minimise the associated costs. If the costs of deviation from the optimal capital structure target are low compared to the costs of issuing equity, the variation in past market values can have a long-lasting effect on the capital structure. However, Leary and Roberts (2005) add to the market timing model the adjustment costs that arise when firms are forced to rebalance the capital structure.

The managerial entrenchment theory takes into account the behaviour of managers through their decisions on capital structure. This model considers capital structure as a central element that allows managers to balance the expansion of their empire-building and to maintain control over their empire, i.e. to retain and entrench their position in the face of internal and external control of any kind (Zwiebel, 1996). Managerial entrenchment is based on agency theory which states that managers do not always choose the capital structure with the optimal level of debt. Entrenched managers can hedge against internal and external pressures generated by corporate governance mechanisms. This behaviour causes debt levels to change as a function of the degree of entrenchment: when managers are not under pressure from shareholders or performance rewards, the firm's indebtedness is lower (Morellec *et al.*, 2008). Debt levels, however, increase when managerial entrenchment in the firm is reduced through the introduction of disciplinary measures, such as takeover bids, managerial replacement or board expansion that incorporates controlling shareholders.

In this regard, there are several studies that analyse the consequences of managerial entrenchment on capital structure. For example, Faleye (2007) and Ruan *et al.* (2011) find that the higher degree of entrenchment significantly affects the market value of the firm. P. G. Berger *et al.* (1997), in their analysis of 434 large US industrial firms, find that a high degree of managerial entrenchment in the firm leads to low indebtedness, and vice versa. Brailsford *et al.* (2002), Kayhan (2003) and Morellec *et al.* (2008), through their respective empirical studies, confirm the same result: entrenched managers choose less debt and rebalance the capital structure less frequently than shareholders would like to. P. G. Berger *et al.* (1997) explain that this result is in line with other studies showing that in a firm with a small board of directors managers face more active monitoring and are therefore less entrenched in the firm, leading to an increase in the level of debt.

2.3 Financing decisions in ICT companies

Although there is a considerable literature on the implication of different market imperfections on the financing decision, there is relatively little research on the behaviour of ICT firms in this field. The existing literature points out certain trends concerning the choice of financing sources by technological companies.

In this regard, the first source of financing is internal funds, followed by equity issuance and, finally, debt. The extensive use of internal funds is explained by the need to manage innovation projects, which are more frequent in the ICT sector than in any other one (Magri, 2009; Revest & Sapio, 2012). However, internal funding may be insufficient and may condition the growth and development of companies. The second financing option is equity issuance, considered as the most preferred by innovative companies (Robb & Robinson, 2014). The reasons why equity issuance is more attractive than debt for tech firms, according to Carpenter and Petersen (2002), are the lack of obligation to provide collateral through tangible assets and a lower exposure of firms to financial imbalances. In addition, a possible loss of ownership control, relevant in many sectors, does not seem so critical for tech firms (Hogan *et al.*, 2017). External financing through debt seems to be the least convincing option for ICT firms. In fact, some studies show that these companies have lower debt levels than the firms of other sectors (N. Chen & Kou, 2009; Calcagnini *et al.*, 2011). This behaviour is mainly explained by higher information asymmetry of ICT companies, high levels of uncertainty and volatility and little tangible assets, which makes debt more expensive and difficult for technological firms to access (Coleman & Robb, 2012).

2.4 Main hypothesis of the study

In order to better understand what determines the capital structure of companies of the ICT sector, an empirical study is proposed with the main hypothesis based on the fact that the internal characteristics of ICT companies influence their financing decisions. In addition, the macroeconomic conditions of the country have an impact on the level of indebtedness of these companies.

One of the variables that can have the greatest influence on a company's capital structure is its profitability. Some studies suggest that the effect of this variable on indebtedness is positive. This is because a profitable firm would have to pay a higher tax rate on profit, so that, according to the trade-off theory, an increase in debt would provide a tax saving (Benito, 2003). However, it is also observed that profitable firms borrow less. Taking into account the dynamic trade-off theory, the adjustments costs predict a negative relation between debt and profitability, but in this case, debt is measured at market value (Hennessy & Whited, 2005; Strebulaev, 2007). Likewise, following the pecking order theory, a profitable firm has a greater availability of internal funds that it will use first (S. Myers, 1984; Frank & Goyal, 2009). In this regard, Rajan and Zingales (1995), in an empirical analysis of the determinants of capital structure in listed companies worldwide, find that profitability and debt are inversely related in most countries. The same negative effect is obtained by Booth *et al.* (2001), through their analysis of the capital structure of firms in ten developing countries, and by other authors in their respective studies on the capital structure of different types of firms located in different countries and regions (e.g., J. J. Chen, 2004; Deesomsak *et al.*, 2004; Antoniou *et al.*, 2008; Sbeiti, 2010; Ebrahim *et al.*, 2014; Belkhir *et al.*, 2016). Therefore, the following hypothesis is proposed.

H*$_1$: The profitability of an ICT company negatively influences its level of debt.*

Another factor that influences a company's debt is the non-debt tax shield, NDTS. The elements included in the NDTS generate certain expenses that the company can use to reduce tax payments. Thus, the non-debt tax benefits arise, which could act as a substitute for the tax benefits derived from debt financing (De Miguel & Pindado, 2001; Schallheim & Wells,

2006). According to the trade-off theory, when NDTS increases, the fiscal savings from borrowing become less attractive, so that the observed relationship between NDTS and debt is negative (De Miguel & Pindado, 2001; Deesomsak *et al.*, 2004; Graham & Tucker, 2006; Ghosh *et al.*, 2011). This allows us to generate a second hypothesis.

***H*$_2$**: *The non-debt-derived tax shield of an ICT firm negatively impacts its level of indebtedness.*

Liquidity, as an indicator of the firm's ability to repay debt (Kedzior *et al.*, 2020), is another factor which conditions the financing alternative used by firms. According to the trade-off theory, firms with higher liquidity ratios are expected to use more debt because they have the ability to meet their payment obligations (Morellec, 2001; Zeitun *et al.*, 2017). In this sense, it is observed that firms with higher liquidity decide to take on riskier projects to finance through debt, which is relatively easy to access due to their high level of solvency (Ramli *et al.*, 2019). However, it is also noted that the more liquid firms tend to follow the pecking order approach: they first resort to internal financing and then to external one. Even, as Lipson and Mortal (2009) show, debt may be the last financing option in these firms, because, after internal funds, they prefer equity issuance and, finally, debt. Thus, the relationship between liquidity and debt is inverse. These results are also reflected in a number of studies authored by Deesomsak *et al.* (2004), Udomsirikul *et al.* (2011), Pindadoa *et al.* (2012) and Zeitun *et al.* (2017). Therefore, the third hypothesis is as follows.

***H*$_3$**: *The level of liquidity of an ICT company has a negative effect on its debt level.*

Tangible assets act as collateral for debt, so a higher proportion of tangible assets reduces the risk that lenders may face when lending capital to firms (Rajan & Zingales, 1995). Firms with much tangible assets have lower costs associated with debt (Deesomsak *et al.*, 2004) and, as a consequence, improve their access to debt financing. On the other hand, companies with little tangible assets find it more difficult to use debt and are forced to resort to equity issuance if the level of internal funds is insufficient (Scott, 1977). As a result, the observed relationship between the value of tangible assets and the level of indebtedness is positive. This effect is particularly noticeable for a long-term debt (J. J. Chen, 2004) and in bank-oriented economies (Antoniou *et al.*, 2008).

As Falato *et al.* (2022) explain in their study of US companies, technological transformation in any company increases intangible assets and this leads to a reduction in debt and a greater reliance on cash flow. The same applies to ICT firms, in fact,, they tend to have low levels of debt and limited fixed assets, with large proportion of intangible assets (Aoun, 2012). These assets, due to their low residual value and a high level of uncertainty, are not usually accepted as collateral for debt (Brierley, 2001; Carpenter & Petersen, 2002). So, these firms are less leveraged (Rajan & Zingales, 1995). As revealed by other studies, firms dedicated to software development usually have little assets, which makes them less secure and less attractive to borrowers (Talberg *et al.*, 2008). The fourth hypothesis, therefore, says the following.

***H*$_4$**: *Fixed assets of an ICT company generate a negative impact on its debt use*.

The risk of the firm, perceived through the variation of results, such as operating profit, generates an important effect on the capital structure of a firm. A number of empirical studies show that firms with high operating profit volatility have a high level of risk and, therefore,

have low debt ratios (Bathala *et al.*, 1994; Homaifar *et al.*, 1994; Ozkan, 2001; Psillaki & Daskalakis, 2009). This is also the finding presented by Dierker *et al.* (2019) who measured risk mainly through stock return volatility and asset volatility and found that the riskier companies tend to issue equity rather than debt and that this behaviour is aligned with the dynamic trade-off theory. Lenders understand that risky companies have greater financial problems (financing costs) and would, therefore, have difficulty in meeting their liability to repay the debt (Aoun, 2012; Sohn *et al.*, 2013). So, the formulation of the fifth hypothesis is as follows.

***H*$_5$**: *The risk of an ICT company influences negatively its debt level*.

The market value of a company is another internal variable that influences the level of indebtedness of a company. According to the market timing theory, a higher market value reduces the debt ratio used by a company, as explained by Baker and Wurgler (2002). The authors show that low-debt companies issue equity when their market value is high. In contrast, the issuance of equity at a time when the firm's value is low corresponds to a high level of debt.

Some empirical studies suggest that the market value is one of the factors that cause firms to deviate from their optimal level of indebtedness. In this sense, authors such as Hovakimian (2006), Kayhan and Titman (2007), and Frank and Goyal (2009) show that the high market value of the company apparently reduces its level of debt. This result is more noticeable in the short term than in the long term. According to the above mentioned studies, high market value could be related to high investment opportunities, which would correspond to a low level of debt. On the other hand, successful companies tend to change the focus of their business as their optimal capital structure changes, so it would be the issuance of equity rather than debt that would provide the most significant financial support for this change. However, it is important to take into account other factors too, so the market timing model is not the only one that would explain the relationship between a company's value and its debt levels. With all these considerations, we can come to the formulation of the sixth hypothesis.

***H*$_6$**: *The value of an ICT company generates a negative effect on its debt*.

Firm size is another important factor that determines the selection of the source of financing (Revest & Sapio, 2010). Size is directly related to the firm's debt capacity (Beck & Demirgüç-Kunt, 2006; Psillaki & Daskalakis, 2009). Larger firms are more diversified, have lower information asymmetry, probability of bankruptcy and supervision costs, and therefore have less risk and barriers to access to debt financing (Chittenden *et al.*, 1996; González & González, 2008). All this allows large companies to benefit from a greater borrowing capacity. On the other hand, small and medium-sized firms are more opaque, which not only restrict access to debt, but also generate a large difference between the cost of internal and external financing (Brierley, 2001). Another disadvantage for small firms, in general, is the high bankruptcy costs that hinder access to debt (S. Myers, 1984). Therefore, these companies manage their financing needs mainly through their internal funds, as documented by numerous authors in their respective empirical studies (Giudici & Paleari, 2000; Colombo & Grilli, 2007; Scellato & Ughetto, 2010).

In addition to this focus, other approaches should be taken into consideration with inconsistent or negative relationship between size and debt. Firstly, in large firms the costs of issuing capital are lower than in smaller firms, so that, contrary to what the pecking order theory postulates, they will tend to finance themselves through equity (Zeitun *et al.*, 2017).

Therefore, the relationship between size and debt in this case would not be so clear. Secondly, some studies show the negative effect generated by size on debt, which, a priori, is not in line with what is marked by theories on capital structure. Large and mature firms have more capacity to generate and retain profits and, therefore, have less need to resort to external financing than younger firms, as explained by La Rocca *et al.* (2011). Kara and Erdur (2015) add that large firms accumulate the profits generated over years and, because of this, the use of debt becomes unnecessary.

Regarding technological firms, small-sized but with great potential for development, especially those in the high-tech sector, in their initial stage turn to the private stock market rather than to banks for financing. This type of company is associated with a high level of risk, requires intensive external financing, and has little tangible assets and low levels of debt (Carpenter & Petersen, 2002). In addition, the opacity of information and high presence of intangible assets in these firms create adverse selection problems by hiding their weaknesses and emphasizing their strengths (Hogan & Hutson, 2005). In contrast, large and profitable tech firms generally follow the pecking order theory (Castro *et al.*, 2015). This is because, although banks seem prone to grant them credit, they prefer to use internal funds first to finance their investments (López-Gracia & Sogorb-Mira, 2008; Mihalca & Antal, 2009). All this seems to correspond to the results of the empirical study carried out by Aoun (2012) in which he compares the capital structure of firms of the ICT sector and other sectors. So, his suggestions is that size does not seem to be determinant of the level of debt in technological companies.

***H7**: The size of an ICT company generates an inconsistent effect on its debt level.*

Among the macroeconomic variables that may influence the financing decisions of ICT companies, there is a country's economic growth. Numerous studies have analysed this relationship showing different results. However, the analyses that show and explain the positive impact of economic growth on the indebtedness of companies in various sectors stand out. This is the case of Köksal *et al.* (2013), who analyse economic growth in terms of the availability of growth opportunities in the market. The authors find a positive relationship between the economic growth and corporate debt especially in small firms because they mostly use debt to cover their working capital needs. Brown *et al.* (2009) and Hsu *et al.* (2014) also find a positive relationship between economic growth and debt, focusing on financing through innovation. Christopoulos and Tsionas (2004) confirm the same results, but they take into account other variables such as investment and inflation in the country. Another possible explanation for the positive results is that during the country's economic downturn the supply of loans is reduced and, thus, the borrowing capacity of firms is also reduced. In addition to being scarce, external financing becomes more expensive as the risk level of firms rises, idea supported by a number of authors, e.g. Ivashina and Scharfstein (2010), Akbar *et al.* (2013), B. Harrison and Widjaja (2014), Vithessonthi and Tongurai (2015) and Zeitun *et al.* (2017). Therefore, the country's economic growth and corporate debt seem to be aligned.

***H8**: The economic growth of a country influences positively the ICT company's debt.*

Inward foreign direct investment (FDI) offers numerous advantages to the host country, leading to higher economic growth and improving factors of production as well as capital accumulation (Lee & Tcha, 2004). In addition, it facilitates the access of firms in that country to external financing through credit, according to Mišun and Tomšík (2002), A. E. Harrison

and McMillan (2003) and R. T. Harrison *et al.* (2004), as it provides an additional source of capital, especially in countries with less developed credit markets with significant difficulties in accessing debt financing. Also, the presence of more capital in the country, as one of the factors helping to create a favourable macroeconomic environment, leads to higher borrowing by firms, allowing them to adjust the capital structure towards the optimal level more quickly (Korajczyk & Levy, 2003). However, it should be noted that if foreign firms, mainly multinationals, decide to finance themselves in the credit markets of the countries where they set up, they may make it more difficult for local firms to access debt capital, as explained in their respective studies by Johnson (2006) and Forte and Moura (2013). However, Johnson points out that the relationship can be reversed if the presence of foreign firms serves as a stimulus to increase local production in different sectors and generate demand for intermediate products.

***H*$_9$**: *The inflows of foreign direct investment impact positively on the ICT company's debt.*

Taxes are considered to be one of the relevant factors affecting the capital structure of their firms. Due to the deductibility of interest through taxes, tax systems in many countries favour the use of debt (Shyam-Sunder & Myers, 1999; Gordon & Lee, 2001). Therefore, according to the trade-off theory, higher taxes are expected to favour corporate borrowing, i.e. the higher the tax rate on profit, the higher the use of debt (Modigliani & Miller, 1963; A. N. Berger & Udell, 1998; Graham *et al.*, 1998; Benito, 2003; Graham, 2003; Brounen *et al.*, 2006; De Mooij, 2011; Belkhir *et al.*, 2016). However, this positive effect is not observed in all types of firms. For example, SME-type firms have to take into account the restrictions they face in accessing external finance. Therefore, they cannot make the same adjustment to their debt as larger firms, especially those in capital-intensive sectors (aus dem Moore, 2014). It is also observed that a high tax rate causes many firms to adopt an aggressive fiscal policy, using non-debt tax shields as much as possible (Lin *et al.*, 2014; Richardson *et al.*, 2014). These considerations look more adjusted to the reality and help to formulate the final tenth hypothesis as follows.

***H*$_{10}$**: *The corporate tax impact generates a negative effect on the corporate debt of ICT companies.*

3. EMPIRICAL STUDY

3.1 Sample Composition

The empirical test of the above stated hypotheses is carried out for a sample of listed technological companies from 23 OECD countries between 2004 and 2019. The selection of these countries allows us to examine the impact of macroeconomic variables on the investment decision of listed companies worldwide. The corporate, accounting and financial information is obtained from the S&P Capital IQ database, which contains historical data on numerous listed companies. Macroeconomic information for each country is drawn from the World Bank's World Development Indicators database and the OECD's Main Science and Technology Indicators (MSTI) and International Monetary Fund statistics. The sample includes those companies and those countries that provide complete data for the indicated

period. Table no. 2 shows the number of firms and observations per country, while Table no. 3 includes the time distribution of the sample.

Table no. 2 – Sample composition: number of companies and observations per country

Country	no. of observations	no. of companies
Australia	295	32
Austria	81	6
Belgium	77	7
Canada	418	37
Denmark	83	7
Finland	221	16
France	818	68
Germany	786	64
Israel	637	53
Italy	244	22
Japan	3,837	314
Korea, Rep.	3,380	303
Luxembourg	54	5
Mexico	59	5
Netherlands	124	9
New Zealand	59	7
Norway	124	11
Poland	298	34
Spain	70	7
Sweden	450	42
Switzerland	243	18
United Kingdom	597	64
United States	4,387	379
Total	**17,342**	**1,510**

Source: own elaboration

Table no. 3 – Sample composition: distribution of observations per year.

Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
no. of observations	631	702	788	871	949	1,050	1,098	1,134
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
no. of observations	1,206	1,229	1,273	1,293	1,323	1,300	1,275	1,220

Source: own elaboration

Following Aoun and Hwang (2008), the sample of ICT companies used in this study includes the sub-sectors corresponding to the following SIC Standard Industrial Classification codes: (manufacturers) 3357, 3571, 3572, 3575, 3577 - 3579, 3651, 3661, 3663, 3671, 3672, 3674 - 3679, 3699, 3823, 3825, 3826; (communications) 4812, 4813, 4822, 4832, 4833, 4841, 4899; (wholesalers and retailers) 5045; (services) 7371 - 7379. All sectors have been grouped into two large clusters called ICT Manufacturing Sector and ICT Service Sector, which are highly interdependent (Miozzo & Soete, 2001; Guerrieri & Meliciani, 2005). Table no. 4 shows the distribution of the observations into these main groups.

Table no. 4 – Distribution of the sample by subsectors

ICT sector: subsectors		no. of observations	companies	
subsector description	**sic code**		**number**	**% over the total number of the sample**
ICT Manufacturing Sector				
Drawing and insulation of non-ferrous wire	3357	378	28	1.9%
Electronic computers	3571	73	6	0.4%
Computer storage devices	3572	97	8	0.5%
Computer terminals	3575	18	2	0.1%
Computer communications equipment	3576	348	30	2.0%
Computer peripheral equipment, NEC	3577	500	40	2.6%
Calculating and accounting machines	3578	230	19	1.3%
Office machines, NEC	3579	187	15	1.0%
Home audio and video equipment	3651	447	38	2.5%
Telephone and telegraphic apparatus	3661	326	26	1.7%
Radio and television communication and transmission equipment	3663	1,264	112	7.4%
Printed circuit boards	3672	575	42	2.8%
Semiconductors and related devices	3674	1,856	174	11.5%
Electronic coils, transformers and other inductors	3677	73	5	0.3%
Electronic connectors	3678	161	11	0.7%
Electronic components, NEC	3679	933	78	5.2%
Automatic industrial process controls	3823	512	41	2.7%
Instruments for measuring and testing electrical power and electrical signals	3825	344	26	1.7%
Laboratory analytical instruments	3826	365	26	1.7%
Measuring and control apparatus	3829	405	33	2.2%
Total ICT Manufacturing Sector		**8,762**	**760**	**50.3%**
ICT Service Sector				
Radiotelephone communications	4812	478	35	2.3%
Telephone communication, except by radiotelephones	4813	410	34	2.3%
Radio broadcasting stations	4832	148	14	0.9%
Television broadcasting stations	4833	500	45	3.0%
Cable television and other pay-television services	4841	212	18	1.2%
Other communication services	4899	580	61	4.0%
Wholesale-Computers and peripheral equipment and software	5045	367	34	2.3%
Computer programming services	7371	116	11	0.7%
Computer programming and software	7372	3,184	301	19.9%
Computer integrated systems design	7373	1,708	147	9.7%
Data processing and computing centres	7374	547	50	3.3%
Total ICT Service Sector		**8,250**	**750**	**49.7%**
Totals		**17,342**	**1,510**	**100.0%**

Source: own elaboration

The sample is well balanced, with 50.3% of ICT manufacturing firms and 49.7% of ICT service firms. We can highlight the presence of 174 companies (11.5% of the total sample)

dedicated to the manufacture and sale of semiconductors and related devices in the ICT manufacturing subsector. In the ICT services subsector, which is characterised by being innovative and fast-growing, the companies involved in computer and software programming and the design of integrated computer systems stand out: 301 companies with 19.9% and 147 companies with 9.7% of the total sample, respectively.

3.2 Econometric model

Based on the different theories regarding business financing decision discussed in previous sections, and taking into account the specificities of the ICT sector, an econometric model is proposed that attempts to explain the level of indebtedness of technology companies based on company-specific, sector-specific and country-specific variables in terms of the economic conditions of the country in which they are located. The model builds on others proposed in the work of Deesomsak *et al.* (2004) and Aoun (2012) and integrates the interaction with both firm-specific and country-specific variables. As a result, equation (1) is obtained:

$$(LEV)_{it} = ß_0 + ß_1(LEV)_{it-1} + ß_2 ROA_{it} + ß_3 NTDS_{it} + ß_4 LIQ_{it} + ß_5 TANG_{it} + ß_6 RISK_{it} + ß_7 MV\_PERF_{it} + ß_8 SIZE_{it} + ß_9 GDP\_GRTH_{jt} + ß_{10} FDI_{jt} + ß_{11} TAX_{jt} + \sum_j \gamma_j CONTRY_{jit} + \sum_k \lambda_k YEAR_{kit} + \sum_m \varphi_m SECTOR_{mit} + \varepsilon_{it} \quad (1)$$

where $ß_0$ is the constant term of the equation, $ß_1$ is the coefficient of the lagged dependent variable of debt (*LEV*), $ß_2$ to $ß_{11}$ are the coefficients of the independent variables which impact on the level of debt we are analysing, ε_{it} is the error term. The corresponding dummies are also introduced to take into account the effects generated by the countries and years we use for the sample, as well as the groups of technological sectors previously identified. The variables included in our model are as described below.

Dependent variable:

- LEV: measures the level of indebtedness of a firm and is calculated as the ratio of the book value of total debt to total assets (Aivazian *et al.*, 2005; Gaud *et al.*, 2005; Delcoure, 2007; Ramalho & Silva, 2009; Serrasqueiro, 2011).

In this analysis, besides the book value of total debt, an additional analysis is carried out on debt calculated through the market values of debt. Therefore, an additional variable is included, which is described below:

- LEV_MV: is the ratio of the market value of total debt over the sum of the market value of total debt and market value of equity. The book and market values of debt are different due to the inclusion of quoted prices of the company's shares in the estimation of the market value of debt. The book value of debt provides backward-looking measurements and, therefore, does not coincide with the market value of debt and can lead firms to make financing decisions that are not entirely accurate (Welch, 2004). According to Campello (2006), debt estimated in terms of market values reflects the assessment of performance in the near future. Aoun (2012) explains that, although the book value of debt is a relevant measure of the obligations of a firm that acquired the debt, the market value of debt seems to be a determinant of the real value of that firm.

Control variables:

- ROA: represents the profitability of the firm and is calculated as operating profit (EBITDA) divided by total assets of the firm (De Miguel & Pindado, 2001; Bauer, 2004; Delcoure, 2007; Ramalho & Silva, 2009; Degryse *et al.*, 2010).
- NTDS: is the non-debt tax shield corresponding to the ratio of the sum of depreciation, depletion and amortisation to total assets (Ozkan, 2001; Bauer, 2004; Delcoure, 2007; Ramalho & Silva, 2009; Degryse *et al.*, 2010).
- LIQ: corresponds to the firm's ability to meet its obligations and is calculated as the ratio of current assets to current liabilities (Ozkan, 2001; Deesomsak *et al.*, 2004; Eriotis *et al.*, 2007).
- TANG: refers to the firm's fixed assets and corresponds to the ratio of total fixed assets to total assets of the firm (Cuñat-Martínez, 2007; Bastos & Pindado, 2013; Garcia-Appendini & Montoriol-Garriga, 2013).
- RISK: calculated as the difference between the variation of earnings before interest and taxes expressed in percentage and the ratio of its average value.
- MV_PERF: is the firm's performance at market value. It represents the return on the market value of the firm and is calculated as the difference between the logarithm of the market value of equity and the lagged variable of the market value of equity.
- SIZE: corresponds to the logarithm of total assets (Cuñat-Martínez, 2007; Kestens *et al.*, 2012; Sanfilippo-Azofra *et al.*, 2016).

Country variables:

- GDP_GRTH: this is the economic growth rate of the country. It is measured as the change in the logarithm of GDP between the periods t and t-1.
- FDI: measured as the ratio of inward FDI flows to the GDP of the host country.
- TAX: is the average corporate tax rate applied on the profit (EBT) of a company in a country.

The descriptive statistics of the variables used in this study and correlations to identify the potential collinearity problems are presented below (Table no. 5 and Table no. 6).

Table no. 5 – Descriptive statistics

variable	mean	deviation	min	max
ROA	.0706	.1554	-2.2875	.6899
NTDS	.0462	.0417	.0001	.6826
LIQ	2.3539	2.4969	.1350	73.3730
TANG	.1764	.1688	2.7100	.9182
RISK	4.0770	33.2906	1.5100	2007.7490
MV_PERF	.0487	.5856	-4.5714	4.2095
SIZE	12.3848	2.0489	7.1880	19.2761
GDP_GRTH	1.5786	2.4822	-8.2690	7.2017
FDI	.0132	.0202	-.0587	.2386
TAX	28.7406	5.5638	15.0000	37.9960

Source: own elaboration

Table no. 6 – Correlations

	ROA	NTDS	LIQ	TANG	RISK	MV_PERF	SIZE	GDP_GRTH	FDI	TAX
ROA	1									
NTDS	0.0378	1								
LIQ	-0.0383	-0.1191	1							
TANG	0.0922	0.3141	-0.1088	1						
RISK	-0.0497	-0.0013	-0.0155	-0.0313	1					
MV_PERF	0.1690	-0.0304	0.0008	-0.0052	-0.0137	1				
SIZE	0.2714	0.0487	-0.0851	0.1262	-0.0570	0.0042	1			
GDP_GRTH	0.0355	-0.0101	0.0018	0.1093	0.0160	0.0931	-0.0661	1		
FDI	0.0397	0.0678	-0.0679	-0.0900	-0.0101	0.0108	-0.0356	0.0341	1	
TAX	-0.0332	0.0130	0.0531	-0.1672	-0.0010	-0.0177	0.2635	-0.1465	0.0653	1

Source: own elaboration

The model proposed in equation (1) is estimated through the System-GMM dynamic panel data methodology, Generalised Method of Moments, which allows the use of lags (Arellano & Bover, 1995; Blundell & Bond, 1998). The GMM estimator generates coefficients that are consistent and efficient in the presence of the endogenous independent variables. The GMM method controls for endogeneity, which is very appropriate for the model proposed.

In the estimation of the model the macroeconomic indicators - economic growth of the country, FDI inflows and profit taxes - are considered as exogenous variables, while firm-specific variables are considered endogenous. The estimation strategy for the endogenous variables applied in our analysis employs between the second and fourth lags as instruments.

4. RESULTS

4.1 The model with book value of debt

The results of the analysis of total debt in the sample companies - model (a) and model (b) - are presented below (Table no. 7). Both models include control variables and country variables and analyse the impact of these variables on the book value of total debt. Model (a) does not include the subsector dummy and model (b) does include it.

In model (a) ROA has a significant and negative associated coefficient. It means that the higher the profitability the lower the debt of an ICT firm. Therefore, hypothesis H_1 is supported. NTDS is shown with a negative and significant coefficient, which means that ICT firms use less debt when they have high NTDS. This result provides evidence for the hypothesis H_2. The coefficient of LIQ is negative and significant, showing an inverse relationship between liquidity and debt. Therefore, hypothesis H_3 would be supported. The variable RISK has a positive and significant associated coefficient, so that ICT firms with higher variability of operating profits take on more debt. This result would therefore support hypothesis H_5. The coefficient associated to GDP_GRTH is positive and significant, which means that ICT firms increase their leverage when the country's economic growth is higher. Therefore, the result of our analysis would support hypothesis H_7.

Model (b), which serves as a robustness check of the model under analysis, includes an additional dummy variable to control for the specific effect of the two subsectors into which the sample has been divided. To this end, a value of 1 is assigned to the companies belonging to the group of ICT manufacturing subsectors and 0 to the rest of the companies of the ICT service subsector. In this sense, the aim is to capture whether there is any difference in financing

behaviour between these two subsectors. The results of this analysis are similar to those of model (a). Again, the variables ROA, NTDS, LIQ, RISK and GDP_GRTH are shown to be significant and with the same associated signs. There is one new significant variable, which is FDI, with a significant and positive associated coefficient. This means that technological firms increase their debt when there is an increase in the inflows of foreign direct investment into the country. Consequently, hypothesis H_8 would be supported by this model. Likewise, the sector dummy comes out significant too. This means that there would appear to be differences in investment behaviour between the ICT manufacturing and services subsectors.

Table no. 7 – Results of the analysis: model (a) without subsector dummies and model (b) with subsector dummies

	MODEL (A)	MODEL (B)
LEV_{t-1}	.6885 (9.04)***	.6910 (8.95)***
ROA	-.0564 (-2.05)**	-.0653 (-2.25)**
NTDS	-.6801 (-1.80)*	-.6595 (-1.68)*
LIQ	-.0138 (-3.40)***	-.0131 (-3.13)**
TANG	.0337 (0.40)	-.0011 (-0.01)
RISK	.0003 (2.28)**	.0003 (2.16)**
MV_PERF	-.0008 (-0.06)	-.0008 (-0.06)
SIZE	-.0005 (-0.09)	.0009 (0.14)
GDP_GRTH	.0059 (1.88)*	.0052 (1.69)*
FDI	.0013 (1.51)	.0016 (1.65)*
TAX	.0006 (0.58)	-.0000 (-0.02)
Constant	.1851 (2.06)**	.1614 (1.46)
Country dummies	Yes	Yes
Subsector dummies	No	Yes -.0038 (-1.73)*
Year dummies	Yes	Yes
AR2	0.109	0.147
Hansen	0.255	0.274

Note: For each variable its coefficient and T-student is shown in brackets; *** indicates a significance level of 1%, ** indicates a significance level of 5%, * indicates a significance level of 10%. AR2 is the second order serial correlation statistic distributed as an N(0,1) under the null hypothesis of non-serial correlation. Hansen is the over-identification test, distributed as a chi-square under the null hypothesis of no relationship between the instruments and the error term.

Source: own elaboration

In both models, the variables TANG, MV_PERF, SIZE and TAX show no significant associated coefficient, which means that the results are inconclusive. Therefore, the hypothesis H_4, H_6 and H_{10} are not likely to succeed. However, the hypothesis H_7, which says that the ICT firm's size generates an inconsistent effect on its debt, is well justified.

4.2 The model with market value of debt

The models presented below analyse the effects generated by the independent intra-firm and macroeconomic variables on the market value of the total debt of ICT firms. Table no. 8 shows the results of these analyses in models (c) and (d). Model (c) does not include the subsector dummy and model (d) does include it.

Table no. 8 – Results of the analysis: model (c) without subsector dummies and model (d) with subsector dummies

	MODEL (C)	MODEL (D)
LEV_MV_{t-1}	.8265 (19.84)***	.8325 (20.54)***
ROA	.0078 (0.39)	.0083 (0.42)
NTDS	-.4968 (-1.98)**	-.5168 (-2.01)*
LIQ	-.0076 (-2.65)**	-.0076 (-2.76)**
TANG	.0180 (0.24)	.0005 (0.01)
RISK	.0001 (1.70)*	.0001 (1.74)*
MV_PERF	-.1497 (-10.99)***	-.1483 (-11.01)***
SIZE	.0007 (0.18)	.0009 (0.23)
GDP_GRTH	.0019 (0.71)	.0020 (0.78)
FDI	.0004 (0.59)	.0005 (0.69)
TAX	-.0003 (-0.42)	-.0003 (-0.40)
Constant	.0733 (1.16)	.0754 (1.20)
Country dummies	Yes	Yes
Subsector dummies	No	Yes -.0017 (-1.30)
Year dummies	Yes	Yes
AR2	0.101	0.136
Hansen	0.188	0.214

Note: For each variable its coefficient and T-student is shown in brackets; *** indicates a significance level of 1%, ** indicates a significance level of 5%, * indicates a significance level of 10%. AR2 is the second order serial correlation statistic distributed as an N (0,1) under the null hypothesis of non-serial correlation. Hansen is the over-identification test, distributed as a chi-square under the null hypothesis of no relationship between the instruments and the error term.

Source: own elaboration

The variable LIQ, once again, has a negative and significant coefficient. This means that the higher the liquidity, the lower the level of market value of debt in ICT firms. So, hypothesis H_3 would be supported. The variable RISK has a positive and significant coefficient which means that technological companies take on more debt when they show greater variability in operating profits. This result, therefore, would support hypothesis H_5. The variable MV_PERF is shown to have a significant and negative coefficient, so that the higher the market return of the ICT firm, the lower its level of debt measured at market level. Therefore, the result of this analysis would support hypothesis H_6. The variables ROA, TANG, SIZE, GDP_GRTH, FDI and TAX in this model present a non-significant coefficient. Therefore, these results are inconclusive with respect to market value of debt. As stated previously for the models (a) and (b), the non-conclusive results for SIZE do support the hypothesis H_7.

Model (d) serves to check the robustness of model (c) and, as done in the analysis of the previous models, includes a dummy variable to control for the specific effect of the two subsectors present in the sample. Model (d) presents very similar findings to those of model (c) with significant coefficients for the same variables.

5. DISCUSSION AND CONCLUSIONS

This research has studied the influence that the internal factors characteristic of the company and the macroeconomic factors characteristic of the country generate on the level of indebtedness of companies in the information and communication technologies sector. The

study used a sample of 1,510 listed companies from 23 OECD countries between 2004 and 2019. The proposed model was estimated using the Generalised Method of Moments System-GMM dynamic panel data methodology. Regarding the internal firm characteristics, the following variables have been analysed: profitability, the non-debt tax shield, liquidity, tangible assets, risk understood as the volatility of operating profits, performance of the firm's market value and firm size. The main hypothesis of this paper is that the internal characteristics of technological companies influence their debt financing decisions. In addition, the macroeconomic conditions of the country were considered since they also generate an impact on the level of debt of ICT companies.

According to the results obtained from the four models presented, it can be derived that the level of indebtedness of ICT companies depends to a large extent on the firm-level factors. More profitable technological companies take on less debt measured at book value. This result is supported by the pecking order theory that suggests that firms use internal funding as their first choice (S. Myers, 1984). Profitable ICT firms follow the same pattern showing lower levels of debt (Booth *et al.*, 2001; Frank & Goyal, 2009). Similarly, the market performance value of these companies also impacts debt negatively, but in this case debt measured at market value. This evidence corresponds to the idea proposed by Baker and Wurgler (2002) in their market timing model, which establishes an inverse relationship between the market value of the company and debt. For both variables the results are conclusive in the respective models and in those including the subsector dummy.

Besides that, ICT firms with much non-debt tax shield, NTDS, and liquidity tend to be less leveraged. Regarding NTDS, the result is in line with the trade-off theory, according to which the observed relationship between NTDS and debt is negative (Ghosh *et al.*, 2011). Concerning liquidity, the results correspond the pecking order proposal (Deesomsak *et al.*, 2004). They point out that technological firms, as in other sectors, reduce the level of debt when they have abundant cash flow, which they use to finance outstanding investments and projects (Ozkan, 2001; J. J. Chen, 2004; Degryse *et al.*, 2010).

It is also observed that when the ICT sampled companies have higher levels of risk associated with the variability of operating profits, they exhibit high levels of debt. These results are repeated in the basic models and in those incorporating the sector dummy, so that in this sense the results would be similar for both the manufacturing and services subsectors. The same relationship is also stated for debt at book and market value. The risk may be related to variations in growth and higher business opportunities of the firms, as suggested by Huynh and Petrunia (2010). So, this situation possibly requires more financing, for which the companies resort to debt to make new investments (Brown & Petersen, 2015).

However, fixed assets and the size of the ICT companies do not seem to be determinants of the level of their debt, since the results are inconclusive in all the models. This may correspond to the specific characteristics of the ICT sector. Firstly, technological companies have fewer tangible assets than intangible ones. But even if they have large tangible assets, their level of debt remains low because it is generally not the first source of finance they use (Castro *et al.*, 2015). As suggested by Hogan and Hutson (2005), equity issuance is probably the most commonly used type of financing in this case. Secondly, small and large ICT companies do not seem to use debt as a first financing option. Small firms find it very difficult to access debt, as explained by a number of authors (López-Gracia & Aybar-Arias, 2000; A. N. Berger & Udell, 2002; Carpenter & Petersen, 2002). Large firms, on the other hand, seem to follow the pecking

order theory, choosing internal funds as their first financing option (López-Gracia & Sogorb-Mira, 2008; Mihalca & Antal, 2009).

Additionally, external factors seem to have certain impact on the decisions of ICT firms to take on debt. On the one hand, the country's economic growth favours greater indebtedness in these companies, but only applied to book value of debt. This result is in line with the proposals of various studies previously mentioned (Christopoulos & Tsionas, 2004; Brown *et al.*, 2009; Köksal *et al.*, 2013; Hsu *et al.*, 2014). On the other hand, a greater presence of capital from foreign direct investment in the country contributes to an increase in debt in technological companies. This result is in line with the observations of other studies which suggest that inward FDI capital improves the access of host-country firms to external financing through credit (A. E. Harrison & McMillan, 2003; R. T. Harrison *et al.*, 2004) and that with increased availability of capital in the country the corporate debt of firms also increases (Korajczyk & Levy, 2003). This result is validated in the model that analyses book value of debt with the incorporation of the sector dummy, so that there might be some differences between ICT firms in the manufacturing and services subsectors regarding their decision to use debt financing.

Finally, corporate income taxes do not seem to be a determinant of the level of debt, both at book and market value. This result may suggest that technological companies could follow the same pattern as SMEs, as explained by aus dem Moore (2014) or that probably they could use more non-debt tax shields, whenever as possible, to reduce the tax base, as suggested by Lin *et al.* (2014) and Richardson *et al.* (2014).

The findings of this paper contribute to the existing literature by providing empirical results on the particular behaviour of ICT firms in terms of decisions to use debt financing. The study provides evidence of the impact of some factors, both at company and country level, jointly on the level of corporate debt. It is interesting to note that the variables impacting debt levels are different when analysing debt measured at book and market values. The research also offers evidence that helps to explain that firm size, the variable widely used in many studies as a determinant of the financing decision, is irrelevant for technological companies. Probably, future research should be developed to analyse this behaviour in detail distinguishing between firms in the manufacturing and service subsectors, as the presented models suggest that the patterns of financing decisions might be different. This work can also contribute to the design and development of policies, measures and mechanisms for optimal management of the financing decisions of companies in the ICT sector.

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Effects of Economic Freedom on Subjective Well-Being

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Abstract: Are people more likely to be satisfied with their lives if they had freedom from regulations, if they had the ability to trade freely internationally? In light of the demographic aging phenomenon we are facing, the present study analyzes the relationship between economic freedom and life satisfaction among European older adults. In order to do so, we are using data from the European Health, Ageing, and Retirement Survey and Economic Freedom of the World. By using the ordered logit regression method, we estimated different models to identify how sub-indicators of economic freedom affect the subjective well-being. According to the findings, the quality of the institutions that define the legal system and establish rules for the protection of private property and sound monetary policy have a positive effect on subjective well-being. On the other hand, openness to international trade has a negative effect and government and regulation doesn't show any significance.

Keywords: subjective well-being; economic freedom; SHARE; ologit; life satisfaction.

JEL classification: I31; J14; P14; P16.

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1. INTRODUCTION

Increasing life expectancy is associated with an increase in the number of older adults in the population, and, as a result, they face changes in their social networks, economic conditions, health-related issues, and demographic characteristics. As the aging phenomenon becomes more evident in our society, many studies have been conducted in order to understand the factors that influence the subjective well-being of elderly people, such as family relationships, activities of daily living, health and so on. Among these factors, an area of research that is still in its developmental stages is the relationship between economic freedom and subjective well-being.

Based on the vast body of literature, it appears that improved economic freedom is associated with better economic outcomes, such as a higher per capita income and a faster economic growth rate. Then, wouldn't a better level of economic freedom also contribute to higher levels of well-being or happiness as a result?

There is evidence that can be used to answer this question. Esposto and Zaleski (1999), have found that an increase in economic freedom is associated with an increase in human well-being. Based on the findings of Ovaska and Takashima (2006), it was concluded that the level of economic freedom is positively related to the level of health. As they note, these are important findings, particularly at the individual and aggregate levels, due to the fact that health is one of the strongest predictors of well-being.

In view of this, the main objective of this paper is to examine the economic freedom—elderly's subjective well-being relationship at a disaggregated level. A person's economic freedom can be defined as their right to control the use of their own labor and property in the course of their life. A well-known assessment of economic freedom is the one produced by the Fraser Institute, namely the Economic Freedom of the World Index (EFW).

It has been argued by De Haan and Sturm (2006) that the five sub-indices of the Economic Freedom of the World offer many advantages over the summary-based index. There have also been several studies that have examined the importance of these components in explaining subjective well-being yield mixed results (Compen *et al.*, 2012; Nikolaev, 2013). Therefore, it is important to pay attention to each of the individual components, rather than the aggregate index of economic freedom, as it is possible for each of them to have a different effect on the European older adults' subjective well-being.

By decomposing the EFW index into its five primary categories, we discover that subjective well-being is not determined by the size of the government, but rather by the quality of the institutions that define the legal system, establish rules for private property protection, and sound monetary policy. Openness to international trade, on the other hand, is found to affect subjective well-being negatively and regulation doesn't have any effect on it.

The paper is structured as follows. Section 2 provides an overview of previous empirical research on the relationship between subjective well-being measures and economic freedom and other variables. Our empirical methodology and data sources are presented in Section 3. Section 4 presents the results of the empirical analysis, followed by conclusions in Section 5.

2. LITERATURE REVIEW

Even though the concept is very complex and numerous definitions have been provided, in its essence economic freedom stands for "personal choice, voluntary exchange, freedom to

enter markets and compete, and security of the person and privately owned property" (Gwartney *et al.*, 2022, p. v.).

Following the liberal tradition of Adam Smith, David Ricardo, John Stuart Mill, Ludwig von Mises, Friedrich August von Hayek, Milton Friedman etc., a significant body of theoretical and empirical literature developed over the past several decades has established the fact that economic freedom is related to growth and progress. One of the first aspects underlined by the latest Economic Freedom of the World Report (Gwartney *et al.*, 2022, p. VII) states that "Nations that are economically free out-perform non-free nations in indicators of well-being".

Furthermore, the literature includes a large number of studies that explore the relationship between economic freedom and subjective well-being, and most of these studies found that individuals in countries where the institutions are consistent with the principles of economic freedom are likely to report higher levels of subjective well-being (Bjørnskov *et al.*, 2010; Gehring, 2013).

In their overview of the literature using the Fraser Institute's Economic Freedom Index, Hall and Lawson (2014) show that over two-thirds of 198 studies found a positive impact of economic freedom on growth, better living standards, more happiness and only less than 4% found a negative influence, economic freedom being susceptible to increase income inequality. Using the index of economic freedom from Heritage Foundation, the study of Spruk and Kešeljević (2016) found that higher levels of economic freedom are associated with higher level of subjective well-being.

However, the relationship between economic freedom and subjective well-being is much too complex to be analyzed only by using aggregate indicators and, consequently, numerous studies address the issue of the relationship between components of economic freedom and/or components of subjective well-being, pointing out to the same positive effects (Benz & Frey, 2008; Arikan, 2011; Che *et al.*, 2017; Le Roux & Roma, 2018; Graafland, 2020).

The more recent study of Lawson (2022) increases the sample examined by Hall and Lawson (2014) with 523 papers, to a total of 721, using the Economic Freedom Index and/or its components and shows that 50.6% of them show a positive outcome of economic freedom, 4.6% conclude on a negative outcome while 44.8% of the papers fell into the mixed/null/uncertain category (Lawson, 2022).

Thus, economic freedom and/or its components, as an expression of a country's good institutions, have become significant explanatory variables for subjective well-being. Dawson (2003) considers that the freedom-welfare relationship is conditioned by the level of democracy in the country analysed.

Bjørnskov et al. (2010), noted that when there are changes in freedom and quality of institutions, happiness/well-being is affected across countries, with a difference appearing between the development levels of nations. Thus if economic freedom improves a person's financial situation and easy economic conditions are associated with increased levels of well-being, it shows that the relationship between the two may be implicit.

In accordance with the research of Rode et al. (2013), economic freedom and political freedom contribute to people's happiness through two channels. One of the channels is based on free markets and democracy, both of which result in economic growth, lower unemployment, and therefore an increase in the level of happiness in society overall. Secondly, risk aversion and the ability to make your own decisions are two of the things that make people happy and make them feel satisfied.

Based on data for 122 countries, Graafland and Compen (2012) have estimated the relationship between different sub-indicators of economic freedom and life satisfaction. Their results suggest that life satisfaction has a positive relationship with the protection of property rights as well as the quality of the legal system. Furthermore, it was found that freedom of trade is able to foster life satisfaction, but only for countries that are poor. In spite of this, once the model is controlled for income per capita, the relationship between economic freedom and life satisfaction becomes negative. Moreover, it has been shown that life satisfaction is negatively related to government size and sound money when income is held constant. A robust positive relationship is only found with the legal system.

Rode (2013), examines the idea of causality regarding subjective well-being, by examining whether good institutions, such as democratic systems and economic freedoms, are related to increased subjective well-being. He finds that in countries with lower incomes, economic freedom has a strong association with life satisfaction, and that electoral democracy is one of the major determinants of life satisfaction based on aggregated cross-country data from the WVS. Likewise, Rode demonstrates that by decomposing the EFW index, citizens in poor countries derive procedural utility through access to sound money and freedom to trade in the stock market.

Also, Gehring (2013), examines the effect of different dimensions of the EFW index on subjective well-being. His findings show that legal security and property rights, sound money, and regulation are key predictors of subjective well-being. It is important to note that the overall effect is not affected by socio-demographic factors such as gender, age, political orientation or social class but rather by the level of economic development. Compared to richer countries, the poorer ones benefit more from economic freedom.

The study of Ovaska and Takashima (2006), which used cross-sectional data from 68 countries to examine the effects of economic freedom on happiness and life satisfaction, found that economic freedom had a significant positive impact on happiness and life satisfaction in 3 out of 4 estimated relationships, but lost significance after controlling for the effects of religion and age.

Veenhoven (2000), in an analysis of 44 countries, found that there was a significant correlation between economic freedom and life satisfaction. It is important to note that this relationship remains statistically significant if it is controlled for differences in per-capita income. Therefore, Veenhoven (2000) concludes that economic freedom affects life satisfaction in a different way than trough economic growth.

According to Spruk and Kešeljević (2016), countries with better economic institutions, a greater degree of economic freedom, captured by an environment that is conducive to property rights, international trade, and a monetary system with more limited government authority are much more likely to experience greater subjective well-being.

Economic freedom has the potential to affect life satisfaction in many ways, including through increased entrepreneurial activity, as indicated by Benz and Frey (2003), because entrepreneurs are more satisfied, and entrepreneurship is stimulated by economic freedom. There is evidence from research conducted by Bjørnskov and Foss (2008) that countries that have higher levels of 'sound money' also tend to have higher levels of entrepreneurship.

3. DATA AND METHODOLOGY

According to the proposed objective of the study, the biggest part of our used data will be retrieved from the survey conducted by SHARE-ERIC - Survey of Health, Ageing and Retirement in Europe – European Research Infrastructure Consortium (Börsch-Supan *et al.*, 2013). SHARE is the largest pan-European panel study, collected every 2 years, which includes data on socio-economic, lifestyle and health-related information for people aged 50 that have the residence in the European Union's countries and Switzerland.

The analysed dataset is build by combining wave 8 of SHARE (Börsch-Supan, 2021) and Economic Freedom of the World index. Our sample consists 41490 respondents that have been questioned about several aspects of their life, in the first period of 2020, just before the burst of the Coronavirus pandemic. The used method for collecting the survey data from the respondents was Computer-Assisted Personal Interviewing (CAPI), method that offers many attractive benefits over paper-and-pencil interviewing.

A description of all variables used in this study is given in Annex, while a more detailed description of some of the main variables will be provided below.

- **Subjective well-being**

In terms of subjective well-being (SWB) as well as its components, there are a number of measures available. In spite of this, most of the national data come from large social surveys which include only brief measures. The most commonly used measures are single items that assess life satisfaction and happiness. Subjective well-being is defined as „a person's cognitive and affective evaluations of his or her life" (Diener *et al.*, 2002). Consequently, life satisfaction items measure the cognitive aspect of SWB, and they correlate more strongly with positive affect than with the absence of negative affect. On the other hand, happiness measures are associated more specifically with positive affect, rather than negative affect. The SHARE survey measures subjective well-being by asking individuals whether they feel satisfied with their lives in general. They are required to rate their life satisfaction on a scale of 0 (completely dissatisfied) to 10 (completely satisfied).

- **Economic Freedom**

As a measure of the level of economic freedom in a country, we refer to the 2012 Economic Freedom of the World index by Gwartney *et al.* (2012) which measures „the degree to which the policies and institutions of countries are supportive of economic freedom" (Gwartney *et al.*, 2021). According to the index, economic freedom is assessed in the following five major areas: (1) Size of Government; (2) Legal Structure and Security of Property Rights; (3) Sound Money; (4) Freedom to Trade Internationally; (5) Regulation of Credit, Labor, and Business. The five sub-indices of economic freedom will be briefly described to aid in understanding the concept of economic freedom.

A detailed explanation of the first sub-index, Size of Government can be found in the 2021 Annual Report Economic Freedom of the World: „As government spending, taxation, and the size of government-controlled enterprises increase, government decision-making is substituted for individual choice and economic freedom is reduced" (Gwartney *et al.*, 2021). The second sub-index, Legal System and Property Rights, quantifies the quality and integrity of the legal system and the protection of property rights. This element can be interpreted as an attempt to quantify the rule of law. The third component of economic freedom relates to

how much citizens can rely upon a strong currency, since a strong currency is essential for the conduct of business: "Inflation erodes the value of rightfully earned wages and savings" (Gwartney *et al.*, 2021). Sound money is thus essential to protect property rights. When inflation is not only high but also volatile, it becomes difficult for individuals to plan for the future and thus use economic freedom effectively" (Gwartney *et al.*, 2021). The fourth sub-index, Freedom to Trade Internationally refers to the exchange of goods and services across national boundaries. The ability to trade freely with people in other countries is an important component of economic freedom. The economic freedom of a country is diminished when governments impose restrictions that limit the ability of its citizens to engage in voluntary exchanges with people in other countries. The fifth sub-index, Regulation, „ measures how regulations that restrict entry into markets and interfere with the freedom to engage in voluntary exchange reduce economic freedom" (Gwartney *et al.*, 2021).

Components and subcomponents are rated on a scale from 0 to 10, reflecting the distribution of the underlying data. The mean of the subcomponent ratings is used to determine the component rating for each component. Afterwards, the component ratings for each of the five domains have been averaged in order to obtain ratings for each of these domains. A summary rating for each country is derived by averaging the ratings for the five domains. Lastly, the World Economic Freedom Index is calculated on a scale of 0 (least free) to 10 (most free).

- **Control variables**

Our analysis takes into account a wide range of individual-level characteristics that have found that they have the ability to influence subjective well-being. These variables include categorical variables such as marital status, gender, living area, employment status, marital status, as well as discrete variables such as age, years of education, social network satisfaction. All microeconomic controls are derived from the Survey of Health, Ageing and Retirement in Europe. A full description of these variables is given in Table in the Annex.

Based on the fact that the dependent variable is ordinal, we had to take into consideration more models (logit, probit, ordere probit, multiple linear) in estimating subjective well-being. After a large number of estimations with various models, we settled into using ordered logistic regression (ordered logit) to predict the model since the elderlys life satisfaction is discrete and defined on a finite ordinal scale. In our model, the observed ordinal variable, Y can take 11 values (i.e. SWB ∈ (0,..,10)). Y is a function of an unmeasured variable, Y*. The value of this continuous latent variable Y* determines what the observed ordinal variable Y equals depending on 10 thresholds (or cut-off terms) c1 to c10.

As a result, the following model has been developed:

$$\begin{Bmatrix} Y_i = 0 \; if \; Y_i^* \leq c_1 \\ Y_i = 1 \; if \; c_1 < \; Y_i^* \leq c_2 \\ Y_i = 2 \; if c_2 < \; Y_i^* \leq c_3 \\ \vdots \\ Y_i = 7 \; if c_7 < \; Y_i^* \leq c_8 \\ \vdots \\ Y_i = 10 \; if Y_i^* \; > \; c_{10} \end{Bmatrix}$$

where $Y_i^* = \sum_{j-1}^{J} X_{ji}\beta_j + \varepsilon_i$, X_j represent the explanatory variables and ε_i is the error term. Taking into consideration the cut-off terms, a particular value of Y can be predicted:

$$\Pr(Y=0) = \frac{1}{1+\exp(c1-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

$$\Pr(Y=1) = \frac{1}{1+\exp(c2-\sum_{j-1}^{J} X_{ij}\beta_j)} - \frac{1}{1+\exp(c1-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

$$\Pr(Y=2) = \frac{1}{1+\exp(c3-\sum_{j-1}^{J} X_{ij}\beta_j)} - \frac{1}{1+\exp(c2-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

$$\vdots$$

$$\Pr(Y=5) = \frac{1}{1+\exp(c5-\sum_{j-1}^{J} X_{ij}\beta_j)} - \frac{1}{1+\exp(c4-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

$$\Pr(Y=6) = \frac{1}{1+\exp(c6-\sum_{j-1}^{J} X_{ij}\beta_j)} - \frac{1}{1+\exp(c5-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

$$\vdots$$

$$\Pr(Y=10) = 1 - \frac{1}{1+\exp(c10-\sum_{j-1}^{J} X_{ij}\beta_j)}$$

4. RESULTS

The Survey of Health, Ageing and Retirement in Europe provides a measure of subjective well-being. First, SHARE asks individuals how satisfied they with their life are. They can answer on a scale from 0 (very dissatisfied) to 10 (very satisfied). Figure no. 1 shows that the distribution of the responses is concentrated in the top of the scale (values of 7, 8, 9 and 10) with an average value of 7.81. It indicates that European older adults feel rather satisfied with their life.

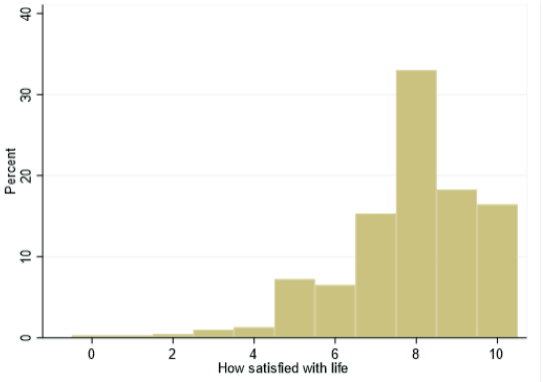

Figure no. 1 – Distribution of subjective well-being (SHARE, wave 8)

The skewed distribution of subjective well-being created a series of problems in estimations. For example, when the logit model was used, we created two grouped the 11 categories into 2 categories, but the results were not robust. Through many series of estimations, we opted for the estimation using an ologit type model, and the results are presented in Table no. 1.

According to the results, what matters is not the size of the government, but the quality of the institutions in the government. Life satisfaction has been found to increase when there is a better legal system and protection of private property as well as sound monetary policies. There is a risk associated with every trade agreement if property rights are not protected. Mutually beneficial agreements cannot be concluded because, in the absence of an enforcement mechanism, contracting parties cannot make binding commitments to each other (Goldsmith, 1997). In his research, Gehring (2013) shows that Legal Security & Property Rights dimension is significant for subjective well-being only in the case of older people since they have a higher aversion to a possible loss caused by an instable institutional environment.

Sound money, which is particularly associated with lower and less volatile inflation, is found to have a positive effect on the SWB of older adults. As previously shown in the literature, the sound money area is positively associated with the degree of control that individuals perceive they have over their lives (Nikolaev & Bennett, 2016). Furthermore, this perception was found to be the strongest predictor of life satisfaction (Verme, 2009). Thus, the perception of control mediates the positive relationship between sound money and subjective well-being.

Promotion of international trade negatively impacts life satisfaction. To stay in business, a country needs to compete with other countries, which may result in more working hours. It is important to note that excessive workloads can have a negative impact on the life satisfaction of older adults. This is because they may adversely affect both their health and, in terms of the time, they have to pursue activities that contribute to a higher level of well-being. Furthermore, if there is a high degree of freedom of trade, it may create a high level of competition in the market, which can result in stress and uncertainty, feelings that people would like to avoid if possible. Besides, at psychological level, older people might feel emotionally closer to traditional products and familiar companies (the ones already existing on the market) which may come across difficulties due to harsh international competition (Gehring, 2013). Regulation fails to show any significance.

These results are supported in the existing literature which analyses the relationship between the components of economic freedom and subjective well-being. When considering, for example, income inequality as a channel through which economic freedom affects life satisfaction, the study of Graafland and Lous (2018) on OECD countries shows that income inequality has a significant negative impact on life satisfaction. More precisely, trade openess increases income inequality (Cornia, 2004; World Bank, 2006) thus, decreasing life satisfaction while sound money, since it reduces inflation, decreases income inequality and increases life satisfaction.

Table no. 1 – Ordered logit estimation results

Variable	β	Robust SE	p-value
Age	-0.079***	0.0114	0.000
Age square	0.0006***	0.00007	0.000
Gender (ref. Woman)			
Male	0.0960***	0.0194	0.000
Marital status (ref. Married, living with spouse)			
Registered partnership	-0.2432***	0.0726	0.001
Married, not living with spouse	-0.3392***	0.0926	0.000
Never married	-0.2528***	0.0435	0.000
Divorced	-0.3120***	0.0336	0.000
Widowed	-0.3442***	0.0292	0.000
Employment status (ref. Retired)			

Variable	β	Robust SE	p-value
Employed or self-employed	0.0619**	0.0290	0.033
Unemployed	-0.5050***	0.0718	0.000
Permanently sick	-0.3265***	0.0708	0.000
Homemaker	0.0938**	0.0385	0.015
Other	0.1618**	0.0809	0.046
Living area (ref. Rural)			
Urban	0.0553***	0.0194	0.004
Years of education	-0.009***	0.0023	0.000
Social network satisfaction	0.3516***	0.0087	0.000
Social support-Given help to others (how many)	0.0486***	0.0130	0.000
Social support-Received help from other	-0.0606***	0.0148	0.000
Done voluntary or charity work (ref. No)			
Yes	0.1157***	0.0229	0.000
No. of chronic disease	-0.0703***	0.0067	0.000
IADL	-0.0391***	0.0122	0.001
ADL	-0.1053***	0.0197	0.000
Depression scale EURO-D	-0.2408***	0.0051	0.000
Isolation (ref. Often)			
Sometimes	0.3658***	0.0524	0.000
Rarely	0.6522***	0.0529	0.000
Never	1.0797***	0.0533	0.000
Consume of Fruits (ref. Everyday)			
3-6 times a week	-0.1156***	0.0236	0.000
Twice a week	-0.1517***	0.0472	0.001
Once a week	-0.1432*	0.0765	0.061
Less than once a week	-0.3580***	0.1034	0.001
Consume of Meat (ref. Everyday)			
3-6 times a week	0.0952***	0.0214	0.000
Twice a week	0.0677**	0.0296	0.022
Once a week	0.0819*	0.0449	0.068
Less than once a week	-0.1224*	0.0703	0.082
Consume of Dairy products (ref. Everyday)			
3-6 times a week	-0.0488**	0.0232	0.036
Twice a week	-0.1270***	0.0334	0.000
Once a week	-0.0985**	0.0484	0.042
Less than once a week	0.1156**	0.0530	0.029
Able to make ends meet (Ref. With great difficulty)			
With some difficulty	0.4139***	0.0368	0.000
Fairly easily	0.8193***	0.0383	0.000
Easily	1.1839***	0.0404	0.000
Number of children	0.0706***	0.0077	0.000
Regulation	-0.0320	0.0252	0.204
Freedom Trade	-0.0558*	0.0325	0.086
Sound Money	0.1571***	0.0349	0.000
Legal System	0.1336***	0.0173	0.000
Size of Government	0.0093	0.0118	0.431
Observations	41490		
Pseudo – R^2	0.1078		
Wald chi2	13179.64***		0.000

Note: ***p<0.001; **p<0.05; *p<0.1

Additionally, most of the other control variables in the model are also consistent with previous findings in the literature on subjective well-being as well. It is, therefore, not surprising that a high level of personal income, being married, employed, living in an urban area, having a high level of satisfaction with one's social network, helping others, volunteering, doing charitable work, the number of children and having a low level of depression are all related to high levels of life satisfaction.

On the other hand, divorce, unemployment, poor health, are associated with lower levels of life satisfaction. An interesting result is the relation between the number of school years and life satisfaction. People with a higher educational level have lower chances of reporting greater well-being. There is a possibility that this may be due to the fact that, as education levels increase among older adults, life satisfaction perception may change due to higher educational objectives which, if not achieved, can lead to a decrease in subjective well-being. Clark and Oswald (1994) have also found that the level of education is negatively related to the level of life satisfaction as well. According to their argument, people with a high level of education see a greater decrease in their subjective well-being due to unemployment than people with a low level of education. Educational expectations that are unrealistic may adversely affect subjective well-being.

In order to test the proposed model for robustness, we followed 3 different paths, for which we did not enter the estimation results due to the lack of space. The first way we checked the robustness was with the help of an ordered probit model. Another option was the estimation of a multiple linear model in which the dependent variable is the conditional average of SWB at the national level, and the third option was bootstrap estimation. All three variants confirmed that the results obtained by us are robust.

5. CONCLUSIONS

This paper empirically addresses the question of whether economic freedom affects life satisfaction. Our findings contribute to the existing literature by covering more recent data and examining the relationship between economic freedom and life satisfaction of older adults as a part of a larger study of the determinants of their well-being. As we face the demographic phenomenon of aging, it is imperative that we understand the determinants of their well-being.

According to our findings, the legal system and right to property as well as sound money, positively influence subjective well-being. As a result, this points to the importance of policies that can improve the quality of the legal system, and must establish rules to protect private property, and sound monetary policy, all of which have been proven to be associated with improved subjective well-being for older adults.

These results are even more important in the case of Central and Eastern European countries with low and relatively low levels of subjective well-being for which explanations can also be found at the institutional level. After more than three decades of transformations and a significant number of years of EU membership, some of these countries still face a highly unstable economic environment and serious institutional issues affecting population's well-being. Thus, our research results confirm the need to improve the institutional setting, especially in terms of stability, predictability and protection of property.

In contrast, we have found that the freedom to trade internationally is negatively correlated with subjective well-being, contrary to our expectations. There may be an explanation for this by the fact that market competition leads to increased levels of stress due to the necessity for continuous improvement. As Graafland (2020) explains, market competition may adversely affect the virtues and thereby negatively impact life satisfaction.

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ANNEX

List of variables

Variable	Min	Max	Description and measurement
Life satisfaction	0	10	On a scale from 0 to 10 where 0 means completely dissatisfied and 10 means completely satisfied, how satisfied are you with your life?
Size of Government	0	10	Size of Government
Legal System and Property Rights	0	10	Legal System and Property Rights
Sound Money	0	10	Sound Money
Regulation	0	10	Regulation
Freedom to Trade Internationally	0	10	Freedom to Trade Internationally
Age	32	103	Number of years lived at the time of the interview
Gender	0	1	Woman=0, Men=1
Marital status	1	6	Marital status of the respondent at the time of the interview: 1. Married and living with a spouse; 2. Registered partnership; 3. Married and living separately from the spouse; 4. Never married; 5. Divorced; 6. Widowed
Education	0	25	Number of years of education
Living area	1	5	In which type of area is the building located? 1. A big city; 2. The suburbs or outskirts of a big city; 3. A large town; 4. A small town; 5. A rural area or village
Employment status	1	3	Current job situation: 1. Retired; 2. Employed or self-employed (including working for family business); 3. Other inactive
Social network satisfaction	0	10	Satisfaction with personal network (0-completely dissatisfied-10 completely satisfied)
Social support-Received help from other	0	3	Received help from others like: personal care, practical household help; help with paperwork, such as filling out forms, settling financial or legal matters
Social support-Given help to others (how many)	0	3	Given help to others (how many) like: personal care; practical household help; help with paper work, such as filling out forms, settling financial or legal matters
Done voluntary or charity work	0	1	Done voluntary or charity work
Self-rated overall health	1	5	Would you say your health is: 1. Excellent; 2. Very good; 3. Good; 4. Fair; 5. Poor
ADL-Functional capacity	0	6	Limitations with activities of daily living
IADL-Functional capacity	0	9	Limitations with instrumental activities of daily living
Depression scale EURO-D	0	12	Depression scale EURO-D: 0-not depressed- 12-Very depressed
Isolation	1	4	Feeling left out of things: 1. Often; 2. Sometimes; 3. Rarely; 4. Never
Able to make ends meet	1	4	Household able to make ends meet: 1. With great difficulty; 2. With some difficulty; 3. Fairly easily; 4. Easily
Dairy products	1	5	How often serving of dairy products: 1. Everyday; 2. 3-6 times a week; 3. Twice a week; 4. Once a week; 5. Less than once a week
Meat	1	5	How often a day do you eat meat, fish or poultry: 1. Everyday; 2. 3-6 times a week; 3. Twice a week; 4. Once a week; 5. Less than once a week
Fruits	1	5	How often a week do you consume a serving of fruits or vegetables: 1. Everyday; 2. 3-6 times a week; 3. Twice a week; 4. Once a week; 5. Less than once a week
Number of children	0	17	Number of children stated by the respondent

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Financial Performance - Organizational Sustainability Relationship. Literature Review

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Abstract: Organizational sustainability efforts focus on three main areas: people, profit, and the environment (Elkington, 1998). With an increasing emphasis on sustainable development, economic entities are concerned with achieving long-term performance, the capacity to create value and to meet the needs of interest groups (investors, employees, customers, communities, local development), but also on the development, promotion and implementation of concrete actions for environmental protection. This study aims to identify the current stage of the relationship between sustainable development and financial performance, in order to identify key elements, trends and research gaps. Based on these considerations, we performed a quantitative analysis of a sample of 62 articles from 3 databases (ScienceDirect, Scopus and Web of Science), which we subsequently studied qualitatively.

Keywords: organizational sustainability; financial performance; sustainable development.

JEL classification: M14.

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1. INTRODUCTION

Given the current context of economic development, for an organization to be considered successful is not enough if it manages to achieve its financial objectives – it must adapt as much as possible to the social and environmental context in which it operates. According to Cooper and Edgett (2008) "we cannot drive what we cannot measure". In this regard, organizations that claim to implement sustainable actions or claim to be sustainable should have a system for measuring their own financial performance. Organizations are pressured by both internal and external factors to improve their performance in organizational sustainability. Investors, shareholders, policy makers are pressuring organizations to take sustainability performance more seriously.

Organizations have an important role to play in maintaining sustainable development. At present, organizations in collaboration with society and the environment in which they operate can contribute to increase overall performance and business sustainability, to maintain and develop their capacity to continue to operate efficiently. These must be done to meet the needs of the current generation, but without compromising the ability of future generations to meet their own needs.

Performance evaluation of organizations is the research objective of many scientific papers. However, the theorists' views have evolved, becoming more and more controversial. For example, neoclassical economic view indicates that profit maximization is the fundamental goal of organizations; instead, financial theory considers that the purpose of the organization must be to maximize financial value or create value for investors. We consider that the most important criterion for evaluating the performance of the organization is the criterion of sustainability, which implies the organization ability to make a long-term profit and, implicitly, allows a sustainable survival by reducing risks in a very complex and dynamic environment.

Sustainability has become a managerial behavior that plays an important role in contemporary organizational strategy. By using sustainability in a more dynamic manner and integrated with management strategies, the organization responds more easily to changes in the business environment (Amui *et al.*, 2017).

Sustainability defined as "that type of development that meets the needs of the present without compromising the capacity of future generations and satisfies their own" (WCED, 1987, p. 16) becomes a very important problem within the entities. This definition refers to a cleaner environment that uses resources efficiently, and a more inclusive society, with common benefits of increased prosperity. In the last two decades, the concept of sustainability has become much debated around the world. By contrast, in literature, due to the emphasis on economic growth in sustainable development, the Brundtland Report has been criticized (Robinson, 2004; Siew, 2015).

The International Institute for Sustainable Development (IISD) defines sustainability as the process of "adopting business strategies and activities that meet the needs of entities and stakeholders, protecting and sustaining the future" (IISD, 2001, p. 1).

Székely and Knirsch (2005) demonstrate that sustainability means economic support and development, prestige and reputation of the entity, maintaining and strengthening customer relationships, increasing the quality of products and services, adopting and encouraging practical jobs, carrying out philanthropic actions for the population from disadvantaged backgrounds. Van Marrewijk (2003) explains sustainability as the totality of the practices

undertaken by entities to include social and environmental actions in economic decisions and to improve investor relations.

Sustainability has become a managerial behavior that plays an important role in contemporary organizational strategy. By using sustainability in a more dynamic and integrated manner with management strategies, the entity responds more easily to changes in the business environment (Amui *et al.*, 2017).

Although there are many definitions of sustainability, there is a generally accepted view in the literature that, in order to assess how sustainable actions can be integrated into an entity, this should be measured.

Poor management of sustainability can have a negative impact on the image and reputation of the entity, which in turn adversely affects the value of the shares and the entity in the market. Sustainable development involves a process of change in which the use of resources, investment management, technology development and changes in institutions are harmonized with both future and current needs of society. Sustainable development is achieved by improving the integration of three interdependent dimensions of development: economic, social and environmental. Although it has become a concept and an idea widely used, sustainable development seeks to combine growing concerns about a range of environmental issues with socio-economic issues.

Against the background of globalization, the principles that govern the business environment have changed. Increasing profitability rates is still considered the cornerstone of any successful entity, but meeting market requirements is not enough. Since the launch of the Brundtland Report (WCED, 1987), managers have understood that, in order to be competitive, they need to analyze not only economic but also social and environmental issues. These circumstances have facilitated the creation of a new type of entity, called a sustainable organization, meant to be profitable and to develop the socio-ecological system in which it operates. A new type of knowledge-based entity later emerged (Drucker, 1988). In this economic entity, knowledge is the key to gaining competitive advantage. Currently, a sustainable knowledge-based entity is proposed that adapts in a timely manner to the dynamic and uncertain character of the economic environment (Leon, 2013).

Organizational sustainability can be considered a multidimensional phenomenon that focuses on consolidating results, generating knowledge, maintaining capacity, establishing relationships with business and production partners in terms of business and production and efficiency. This phenomenon must be implemented by achieving a balance between the economic, environmental and social dimensions (Rodríguez-Olalla & Avilés-Palacios, 2017).

Lozano (2018) explains organizational sustainability as follows: "The entity's contributions to equilibrium sustainability include the economic, environmental and social dimensions of today, as well as the relationships between and during these dimensions (short, medium and long term). This contribution involves the ongoing incorporation and integration of sustainability issues into the entity's system (business operations and production, strategy and management, administration, organizational systems, service provision, evaluation and reporting, and development). The components of the system and the development processes transform the inputs (materials and resources with economic, environmental and social value) into results (products, services and waste with economic, environmental and social value). This process leads to the achievement of the entity's objectives, depending on the efficiency and effectiveness of resources. The entity is affected by its material and human resources, by

its infrastructure, by its supply chain (upstream and downstream), and by investor relations" (Lozano, 2018, p. 16).

Norton *et al.* (2014) deals with organizational sustainability based on employees' perceptions of the entity's ecological work climate. They conducted a study on 168 employees, demonstrating that perceptions of the ecological work climate create a positive relationship between employees 'views on the presence of a sustainability policy and their employees' reports on environmental behavior. This research deals with organizational sustainability from a psychological point of view.

Burritt *et al.* (2019) considers that organizational sustainability consists in the use of tools that support management based on optimal decisions to achieve a green economy, called environmental management accounting. This theory is demonstrated by conducting five business case studies in Indonesia, the Philippines and Vietnam. The analyzed cases demonstrate the usefulness of promoting more environmentally friendly production processes through a multitude of environmental management accounting tools, rejecting the idea that management cost accounting would be sufficient for sustainable sustainability.

We find the same opinion in Qian *et al.* (2018). It is considered that, unlike traditional accounting, environmental management accounting highlights the importance of tracking, managing and reporting full, total or actual costs and analyzing the environmental impact of the business. Traditional accounting focuses mainly on profitability and ignores other important factors that can affect the business, such as climate change, the use of non-renewable resources and environmental issues, as well as environmental issues. Using data collected from 114 large entities in the US, Germany, Australia and Japan, Qian *et al.* (2018) have shown that many companies apply environmental management accounting, and this is having a positive effect on carbon emissions.

In the vision of Malik *et al.* (2021), organizational sustainability is considered as a practical path of sustainable accounting, which leads to the transformation of organizational accounting approaches into sustainability. This route develops and evaluates the inputs and outputs data of the entities, combining the existing financial accounting with the national public information on the supply chain. This study summarizes the results of an application that integrates financial information on sales and acquisitions with older economic data, in order to reveal the impact of organizational procurement decisions on entities. The integration of the entity's organizational financial accounts with national accounts reveals aspects of the entity's interaction with the macroeconomic economy. This interaction refers to goods and services purchased by entities in other sectors of the economy and goods and services sold to other economic sectors. The secret of conducting sustainable procurement assessments proposed in research is to integrate the procurement data of an entity with environmental indicators (eg., emission rate, energy and water consumption) and social indicators (eg., modern employment, employment).

At national and international level, there is a range of accounting information that provides information on the direct and indirect impact of the supply chain on the environment, on health. The accounting profession needs to take greater responsibility for organizational sustainability, facilitating and promoting the testing and adoption of related methodologies and tools to enable entities to measure and report on their performance.

Modern ideologies based on short-term economic gains and scientific traditions focused on reductionist cause-and-effect relationships fail to analyze and address the dynamic and complex relationships between economic, environmental and social aspects and perspective.

The concept of organizational sustainability has emerged to help understand and reduce the degradation of the environment, the economic and social environment. However, this concept is still unknown or misunderstood by many individuals and entities around the world. Thus, we believe that it is necessary to facilitate a better awareness and understanding of this concept in economic entities.

2. METHODOLOGY

In order to identify current trends in the national and international literature regarding the analysis of the relationship between financial performance and organizational sustainability, we propose a research both quantitative and qualitative of some articles extracted from three main scientific databases: ScienceDirect, Scopus and Web of Science.

By querying these databases using the search term the structure composed of *organizational sustainability* and *financial performance*, 315 papers in ScienceDirect, 15 papers in Scopus and 21 papers in Web of Science were initially identified. Finally, 62 scientific articles were selected to perform an analysis and develop a systematic knowledge base, which were processed using VOSviewer software (van Eck & Waltman, 2011). This software allows the visualization of the terms and concepts discussed and approached in the literature on organizational sustainability and financial performance.

3. ANALYSIS OF THE RELATIONSHIP FINANCIAL PERFORMANCE - ORGANIZATIONAL SUSTAINABILITY

Starting from the fact that the objective of the research is to establish the current state of knowledge regarding organizational sustainability and financial performance, we chose as a search expression the following composite structure: "organizational sustainability" and "financial performance". Thus, we identified 45 articles in the ScienceDirect database, 13 articles in the Scopus database and 4 articles in the Web of Science (Table no. 1).

Table no. 1 – The number of items resulting from the selected databases

Selection criteria		Number of selected items
Database	ScienceDirect	45
	Scopus	13
	Web of Science	4
Total		**62**

In percentage shares, the majority share is held by ScienceDirect with 72.58%, followed by Scopus (20.97%), Web of Science (6.45%).

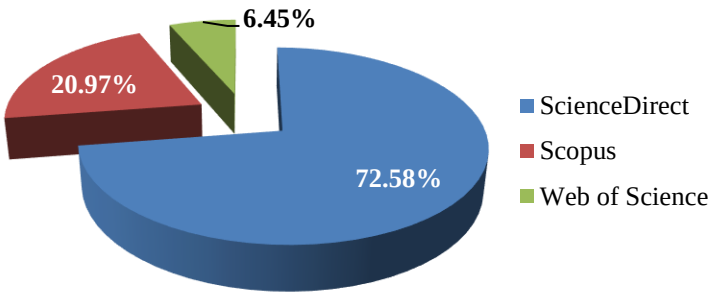

Figure no. 1 – The sample of articles represented on databases

With the help of VOSviewer software, we obtain a map that allows the visualization of the terms and concepts discussed and approached in the literature, of the articles from the three databases (Figure no. 2).

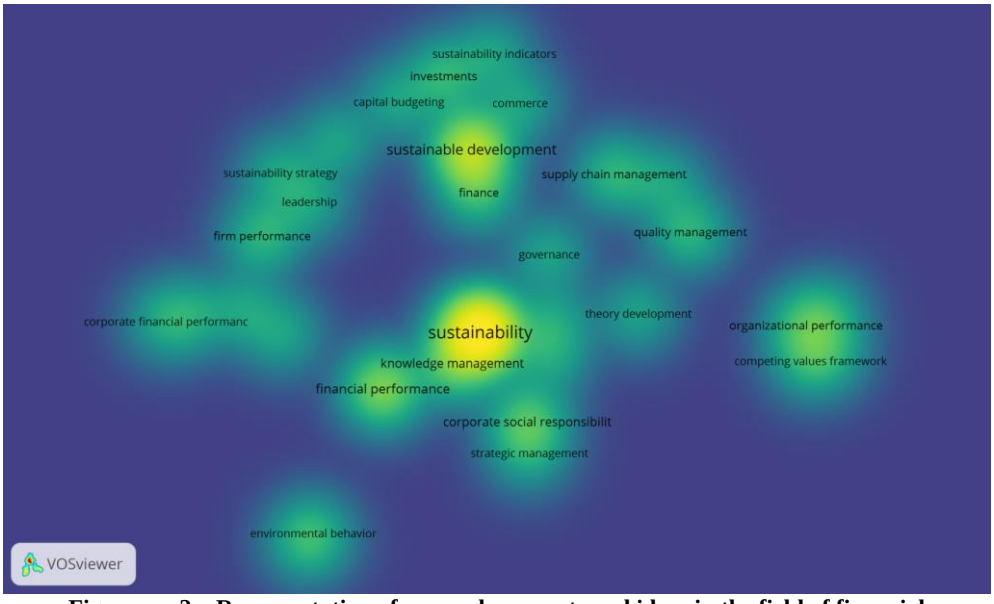

Figure no. 2 – Representation of research concepts and ideas in the field of financial performance and organizational sustainability

We notice that topics such as those related to sustainability, sustainable development, financial performance, social-corporate responsibility, sustainability indicators, organizational performance, knowledge management, etc. are topics of interest among researchers in the field of financial performance and organizational sustainability, so far.

Through quantitative analysis we identified the number and nature of papers published in 1997-2022 on the two concepts discussed ("organizational sustainability" and "financial performance"). Thus, we manage to research the journals in which these studies were published, which was the period in which these topics were of interest to researchers in the

field, which were the topics discussed, theories applied and research methods. In Table no. 2 are centralized the journals in which the researched articles were published, sorted in descending order according to the number of articles.

Table no. 2 – Identified journals and related articles

Journal name	Number of items	Year
Journal of Cleaner Production	20	2016-2022
Sustainability	6	2016-2021
International Journal of Production Economics	3	2020-2022
Human Resource Management Review	2	2020
Industrial Marketing Management	2	2010-2020
Journal of Environmental Management	2	2016-2018
Management Accounting Research	2	2013-2022
Organizational Dynamics	2	2012-2022
Journal of Managerial Psychology	1	2016
13th International Scientific-Technical Conference on Actual Problems of Electronic Instrument Engineering, APEIE 2016	1	2016
Accounting Forum	1	2005
Accounting, Organizations and Society	1	2010
Ambiente Contábil	1	2021
Computers in Industry	1	2020
Engineering Management Journal	1	2013
Environment Behaviour Proceedings Journal	1	2016
Environmental Engineering and Management Journal	1	2017
IIE Annual Conference and Expo 2008	1	2008
Information and Computer Security	1	2020
International Journal of Production Research	1	2019
Journal of Accounting and Organizational Change	1	2012
Journal of Business Research	1	2020
Journal of Multinational Financial	1	2017
Procedia - Social and Behavioral Sciences	1	2012
Procedia Engineering	1	2017
Procedia Technology	1	2012
Sustainable Production and Consumption	1	2019
Technological Forecasting & Social Change	1	2019
Technology in Society	1	2021
The Asian Journal of Shipping and Logistics	1	2019
Thunderbird International Business Review	1	2013

Analyzing the period in which these articles were published, we notice that in the period 2016-2022 most works were published (Figure no. 3).

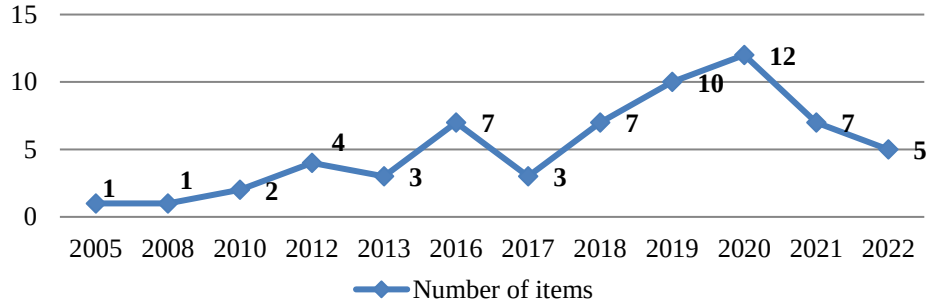

Figure no. 3 – Distribution of analyzed articles by years

In this research field we identify various well-known authors and reference works. Using the VOSviewer software tool, we obtained a map of researchers who have made a significant contribution to shaping the conceptual framework and empirical study of the relationship between organizational sustainability and financial performance (Figure no. 4).

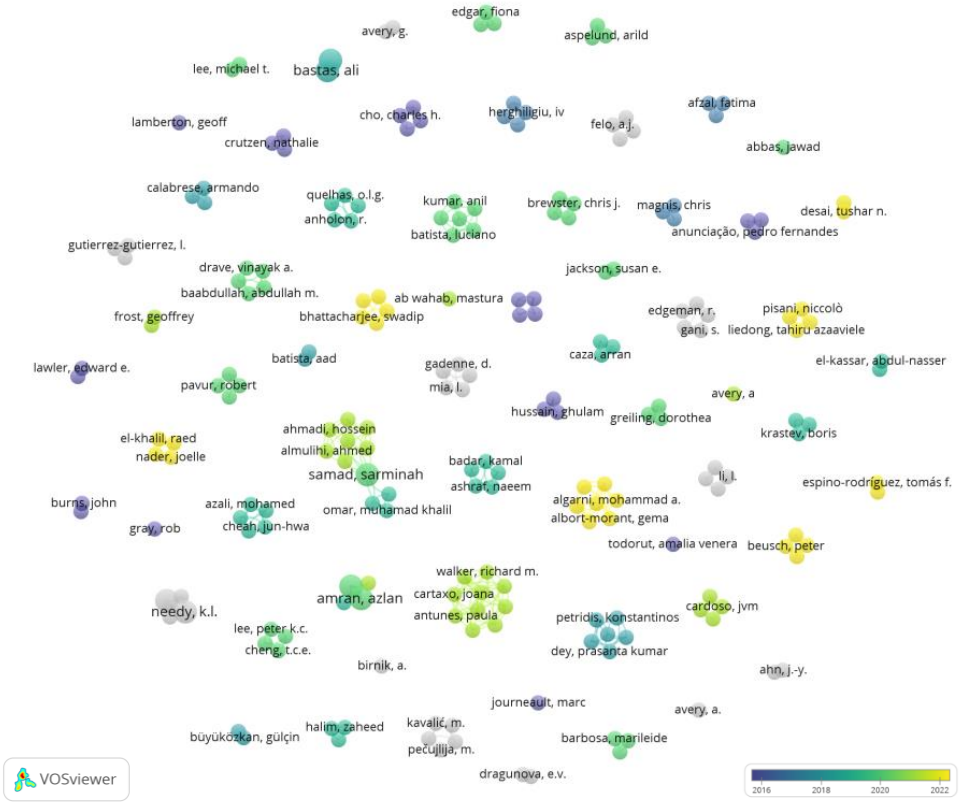

Figure no. 4 – Map of representative researchers

Figure no. 5 allows identifying the most cited researchers within the field with the most citations used in research: Gray (2010) - 589; El-Kassar and Singh (2019) - 253; Sharma *et al.* (2010) - 198; Maas *et al.* (2016) - 149; Contrafatto and Burns (2013) - 82; Büyüközkan and Karabulut (2018) - 81.

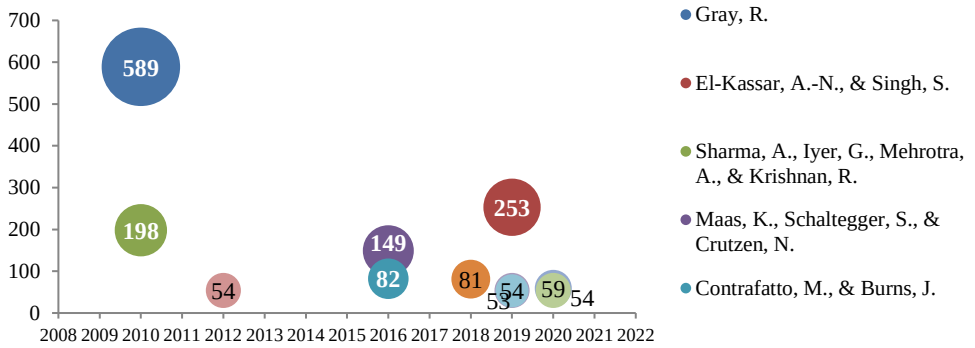

Figure no. 5 – Distribution of researchers according to the citations obtained

We notice that 25.81% of the analyzed scientific papers have a higher frequency, respectively over 35 citations, compared to the rest of the papers, which represent 74.19% and fall below the average (Figure no. 6).

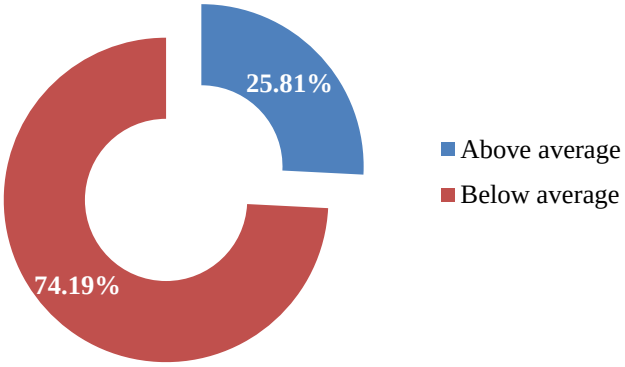

Figure no. 6 – Citations of articles under analysis

Regarding the type of papers included in the research, presented in Figure no. 7, we note that most are Journal Article (96.77%), followed by Conference Proceedings (1.61%) and Proceedings (1.61%).

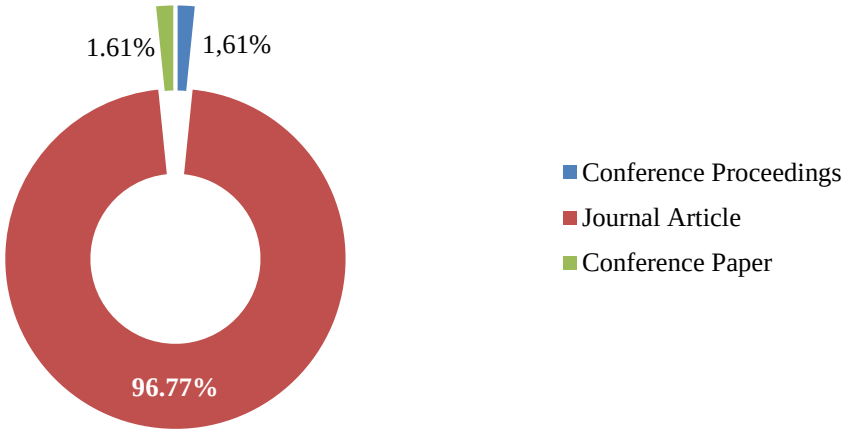

Figure no. 7 – Distribution of works according to the type of article

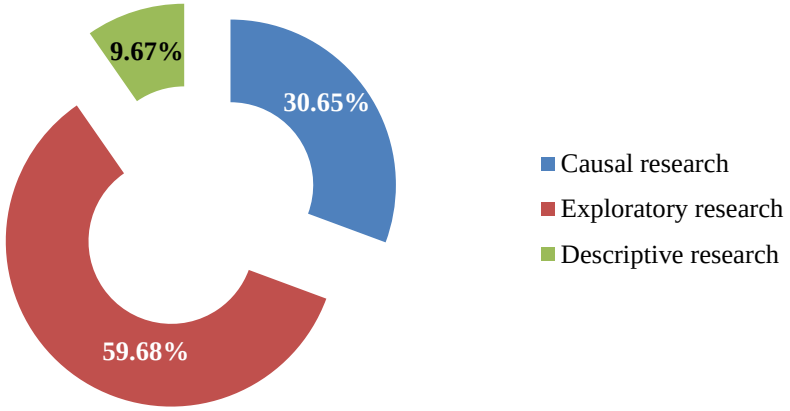

Figure no. 8 – Distribution of articles according to the type of research

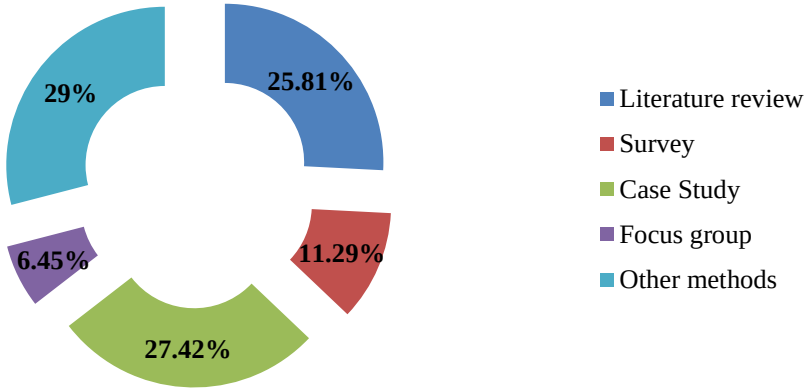

Figure no. 9 – Distribution of articles according to the research method

A final classification of the articles (shown in Figures no. 8 and no. 9) was made according to the research method used by the researchers. Three types of research were considered: exploratory research, descriptive research and causal research. The most used research methods in the analysis were: Case Studies (27.42% of selected articles), Literature Review (25.81% of selected articles), Survey (11.29% of selected articles) and Focus group (6.5% of the studied articles).

Following the qualitative analysis of the articles within the proposed sample for analysis, a number of research directions were identified, which are presented graphically in Figure no. 10.

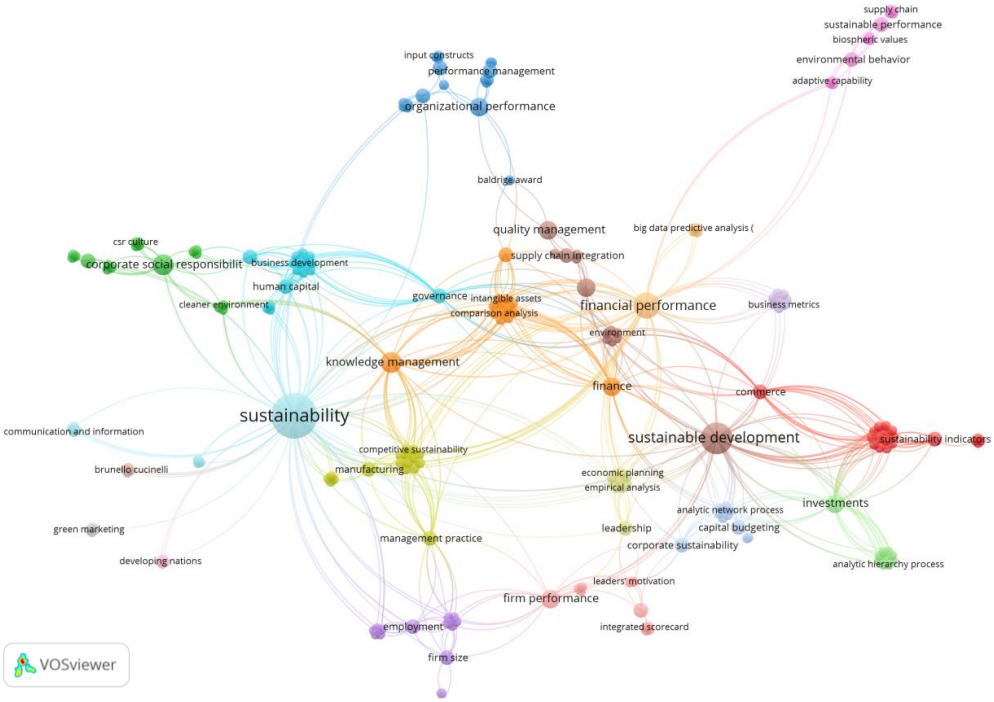

Figure no. 10 - Map of terms and concepts associated with financial performance

Starting from Figure no. 10, we identify as a research direction in the study of the literature, the one related to the investigation of the way in which sustainability, sustainable development and social-corporate responsibility influence the financial performance of organizations.

Sustainability has become a topic of interest for both academics and practitioners for more than 10 years (Turan *et al.*, 2008; Turan & Needy, 2013; Merriman *et al.*, 2016; Yusoff *et al.*, 2019; Stahl *et al.*, 2020) . Sustainability can be defined as the actions of building and maintaining long-term investor satisfaction (Turan *et al.*, 2008). Sustainability is an ambiguous concept, which can be analyzed from different perspectives and dimensions, with an emphasis on the topics of biology, ecology and economics. Thus, in the literature we identify concerns regarding the implementation of organizational sustainability in entities (as we systematized in Table no. 3).

Table no. 3 – Sustainability analysis in the literature

Domain	Subdomains	No. of items	Researcher
Corporate sustainability	- evaluation of organizational culture in the context of corporate sustainability; - analysis of the relationship quality management - corporate sustainability; - analysis of human resources management on corporate sustainability; - analysis of the relationship between sustainable corporate performance and financial performance;	4	(Dyck *et al.*, 2019; Abbas, 2020; Stahl *et al.*, 2020; Algarni *et al.*, 2022)
Integrated sustainability	- description of integrated sustainability models; - analysis of the relationship between sustainability reporting and accounting information; - methods of incorporating sustainability into quality management and the supply chain in organizations; - methods of incorporating sustainability into entities; - integrating sustainability control management into the integrated sustainability strategy;	6	(Maas *et al.*, 2016; Pavlopoulos *et al.*, 2017; Bastas & Liyanage, 2018; Hussain *et al.*, 2018; Bastas & Liyanage, 2019; Barbosa *et al.*, 2020; Beusch *et al.*, 2022)
Sustainable accounting	- analysis of sustainable accounting in terms of environmental performance indicators, social and economic; - the role of management accounting in sustainability; - analysis of the relationship between sustainability reporting and accounting information; - analysis of the relationship sustainable accounting - sustainable development;	8	(Lamberton, 2005; Gray, 2010; Contrafatto & Burns, 2013; Pavlopoulos *et al.*, 2017; Büyüközkan & Karabulut, 2018; Traxler *et al.*, 2020; Frost & Rooney, 2021; Beusch *et al.*, 2022)
Sustainable development	- analysis of the relationship sustainable accounting - sustainable development; - analysis of the relationship between sustainable development and financial performance; - creating strategic tools to support the sustainability strategy; - analysis of the relationship between corporate social responsibility and sustainable financial development; - analysis of the impact of human resources management on sustainable development; - analysis of the relationship between knowledge management and sustainable development; - analysis of the relationship between structural and relational green capital and business sustainability;	18	(Gray, 2010; Esteves *et al.*, 2012; Lawler & Worley, 2012; Journeault, 2016; Afzal *et al.*, 2017; Istrate *et al.*, 2017; Batista & Francisco, 2018; Wang *et al.*, 2018; Cheah *et al.*, 2019; El-Kassar & Singh, 2019; Lueg *et al.*, 2019; Yusoff *et al.*, 2019; Ren & Jackson, 2020; Traxler *et al.*, 2020; Yang *et al.*, 2020; Ab Wahab, 2021; Kavalić *et al.*, 2021; Nader *et al.*, 2022)

Domain	Subdomains	No. of items	Researcher
Social-corporate responsibility	- analysis of the implications of social-corporate responsibilities in leadership and culture on financial performance; - promoting the theory of ecological modernization; - analysis of human resources management on corporate sustainability; - analysis of the relationship knowledge management - social responsibility; - analysis of the relationship between corporate social responsibility and sustainable financial development;	6	(Sharma *et al.*, 2010; Lin *et al.*, 2019; Martins *et al.*, 2019; Phillips *et al.*, 2019; Stahl *et al.*, 2020; Yang *et al.*, 2020)
Sustainable performance	- the assessment of sustainability performance is based on sustainability accounting; - analysis of the relationship between business strategies and financial performance; - implementation of a system for evaluating sustainability performance; - analysis of the influence of big data information on sustainable performance; - analysis of the effects of supply chain operations on the environment; - analysis of the influence of eco-innovations on sustainable performance; - analysis of the balance between sustainable operations, efficient management and the financing perspective; - analysis of the relationship between ethical leadership and sustainable performance;	16	(Turan *et al.*, 2008; Gadenne *et al.*, 2012; Turan & Needy, 2013; Abdul Aris *et al.*, 2016; Javed *et al.*, 2016; Suriyankietkaew & Avery, 2016; Büyüközkan & Karabulut, 2018; Eide *et al.*, 2020; Gupta *et al.*, 2020; Yadav *et al.*, 2020; Avery, 2021; Ch'ng *et al.*, 2021; Ramos *et al.*, 2021; Samad *et al.*, 2021; Algarni *et al.*, 2022; Dey *et al.*, 2022)
Organizational sustainability	- developing the organization's management; - designing tools to stimulate organizational sustainability transactions in business; - analysis of the relationship between organizational sustainability and financial performance;	9	(Todoruț, 2012; Birnik, 2013; Merriman *et al.*, 2016; Pushkar & Dragunova, 2016; Calabrese *et al.*, 2018; Hussain *et al.*, 2018; Tamayo-Torres *et al.*, 2019; Lee & Raschke, 2020; Liedong *et al.*, 2022)
Organizational performance	- analysis of the relationship between human resources management and organizational performance; - analysis of the relationship between quality management and organizational and financial performance; - development of managerial tools to increase organizational performance.	3	(Cho & Ahn, 2018; Xu *et al.*, 2020; Martins Scheffer *et al.*, 2021)

In the literature we notice an intense concern for different areas of interest of sustainability: sustainable development, sustainable performance, integrated sustainability, corporate sustainability, organizational sustainability, sustainable accounting, social-corporate responsibility, organizational performance.

For sustainable development, the organization pays special attention to the relationship between practices related to sustainability, reporting on achievements in terms of sustainability and financial performance (Lueg *et al.*, 2019). The sustainable development of an organization requires its long-term survival (Nader *et al.*, 2022), and the longevity of an organization depends on its impact on the environment and society, but also how well it performs financially (Lawler & Worley, 2012).

Although financial performance is still the main goal of many organizations, they are beginning to study and implement practices on sustainable development (Afzal *et al.*, 2017). Researchers (Esteves *et al.*, 2012; Lawler & Worley, 2012; Istrate *et al.*, 2017; Batista & Francisco, 2018; Wang *et al.*, 2018; Lueg *et al.*, 2019; Barbosa *et al.*, 2020; Ren & Jackson, 2020; Xu *et al.*, 2020; Nader *et al.*, 2022) demonstrated that in order to ensure market competitiveness and corporate reputation, organizations need to implement triple sustainability practices: economic, environmental and social improvement practices. These practices must be analyzed according to the organization size, to the level of business maturity, strategic planning and organizational structure (Batista & Francisco, 2018). Thus, among the sustainable practices supported by researchers we can list:

- reporting on the results of organizational sustainability (Lueg *et al.*, 2019; Yang *et al.*, 2020);
- exploiting the internal resources (entrepreneurial orientation, social importance, business planning tools, motivation and leadership style of organization leaders, ethical leadership, etc.) of the organization (Suriyankietkaew & Avery, 2016; Cheah *et al.*, 2019; Dyck *et al.*, 2019; Phillips *et al.*, 2019; Eide *et al.*, 2020; Xu *et al.*, 2020; Dey *et al.*, 2022);
- implementing a culture of sustainability in organizations (Abdul Aris *et al.*, 2016);
- implementation of ecological strategies in business (Sharma *et al.*, 2010; Gadenne *et al.*, 2012; Lawler & Worley, 2012; Birnik, 2013; Istrate *et al.*, 2017; Lin *et al.*, 2019; Yusoff *et al.*, 2019; Stahl *et al.*, 2020);
- adapting accounting to sustainable development (Lamberton, 2005; Gray, 2010; Contrafatto & Burns, 2013; Pavlopoulos *et al.*, 2017; Büyüközkan & Karabulut, 2018; Traxler *et al.*, 2020; Frost & Rooney, 2021; Beusch *et al.*, 2022);
- the use of strategic tools (Sustainability Balanced Scorecard, Triple Bottom Line, Sustainability-Oriented Service Innovation, Sustainable Strategic Management, Data Envelopment Analysis) to support the sustainability strategy of organizations (Turan *et al.*, 2008; Turan & Needy, 2013; Journeault, 2016; Calabrese *et al.*, 2018; Barbosa *et al.*, 2020; Martins Scheffer *et al.*, 2021);
- focusing on eco-innovation and green technologies (Gadenne *et al.*, 2012; El-Kassar & Singh, 2019; Ch'ng *et al.*, 2021);
- implementation of ecological supply chain management (Bastas & Liyanage, 2018, 2019; El-Kassar & Singh, 2019; Tamayo-Torres *et al.*, 2019; Samad *et al.*, 2021);
- transition actions from a human resources management based on financial indicators to a human resources management based equally on economic, environmental and

social performance (Gadenne *et al.*, 2012; Merriman *et al.*, 2016; Cho & Ahn, 2018; Wang *et al.*, 2018; Ren & Jackson, 2020; Stahl *et al.*, 2020);

- practices to improve the moral and ethical guidelines of employees in the field of sustainable development (Yang *et al.*, 2020; Ab Wahab, 2021; Dey *et al.*, 2022);
- inclusion of knowledge management and information systems at the heart of organizational sustainability (Esteves *et al.*, 2012; Martins *et al.*, 2019; Abbas, 2020; Gupta *et al.*, 2020; Yadav *et al.*, 2020; Avery, 2021; Kavalić *et al.*, 2021);
- actions to assess sustainability performance (Büyüközkan & Karabulut, 2018; Ramos *et al.*, 2021);
- developing relationships and agreements with business partners (Lee & Raschke, 2020).

In order to implement sustainable practices, the management of the organization must be able to anticipate changes in the needs of investors, find the necessary resources and achieve the proposed objectives (Todoruț, 2012).

Javed *et al.* (2016) and Algarni *et al.* (2022) demonstrate that corporate sustainability performance positively affects financial performance. Sustainable corporate performance consists in the implementation of strategies and practices that seek to protect the natural environment. The relationship between sustainable corporate performance and financial performance is studied from the perspective of a connection and balance between sustainable operational activities, efficient investor management and the perspective of corporate financing.

Sustainability has become an important issue on the international market (Gupta *et al.*, 2020; Yadav *et al.*, 2020), and new technologies such as Big data, Blockchain, Machine Learning, etc. contributes directly or indirectly to achieving sustainability. Information is needed for decision making, but multiplying this information generates large and complicated databases. But if this information is analyzed effectively, it can be an important tool for gaining competitive advantages that lead to sustainable growth.

Researchers (Yadav *et al.*, 2020; Algarni *et al.*, 2022) have identified the factors that influence the adoption of sustainability: sustainable energy resources systems, policies to support sustainability, indicators for measuring sustainable performance. Non-recognition of sustainability issues has led many organizations to face financial losses. Gadenne *et al.* (2012) identified eight significant sustainable performance management practices (environmental management practices, social responsibility, improvement of internal processes, customer-oriented, product innovation, employee stimulation, improvement of profitability and cash flow and capital management) which stimulates seven indicators of organizational sustainability performance (environmental performance, employee performance, customer portfolio performance, social responsibility performance, new product performance, information capital performance, performance financial).

Some researchers consider that a solution for achieving financial performance and organizational sustainability in organizations is adherence to integrated management systems (Maas *et al.*, 2016; Pavlopoulos *et al.*, 2017; Bastas & Liyanage, 2018; Hussain *et al.*, 2018; Bastas & Liyanage, 2019; Barbosa *et al.*, 2020; Beusch *et al.*, 2022). Maas *et al.* (2016) describe an integrated sustainability model based on 3 factors: evaluation, management (accounting and control) and communication, and Hussain *et al.* (2018) present Sustainable Enterprise Excellence, a system that addresses an organizational assessment focused on six areas of performance: governance and strategy, process and execution implementation,

sustainability performance, innovation performance, financial performance and human capital performance. Barbosa *et al.* (2020) propose an integrated management model, Sustainable Strategic Management, through which small organizations create their own management model taking into account the limitations of operational activities, the availability of resources and cultural peculiarities.

Other researchers (Pushkar & Dragunova, 2016; Liedong *et al.*, 2022) have observed that organizations that are concerned with production sustainability, financial and economic sustainability, organizational sustainability, innovation sustainability, become more financially successful, identifying increases in profitability and liquidity. Liedong *et al.* (2022) consider that organizational sustainability and financial performance are not mutually exclusive, they can be implemented simultaneously.

The contribution of the field of sustainable accounting is the use of performance indicators to measure the environmental, social and economic dimensions of sustainability (Lamberton, 2005). Accounting is considered the language of business, and business success is evaluated and analyzed through the prism of this language (Frost & Rooney, 2021). Research on the relationship between accounting and sustainability appeared in the early 1990's (Lamberton, 2005).

Accounting is becoming a very important tool, used in facilitating and creating the levers needed to implement sustainability in organizations. Traxler *et al.* (2020) argue that if traditional accounting optimizes economic performance, then sustainable accounting becomes a successful tool for managing and controlling the social and environmental impact of organizations.

The literature (Lamberton, 2005; Gray, 2010; Contrafatto & Burns, 2013; Pavlopoulos *et al.*, 2017; Büyüközkan & Karabulut, 2018; Traxler *et al.*, 2020; Frost & Rooney, 2021; Beusch *et al.*, 2022) considers that the transparency of the decision-making process in the field of sustainability and accounting creates opportunities to resolve tensions between these two areas. Büyüközkan and Karabulut (2018) argue that models for assessing sustainability performance need to be more balanced and explain the gap between sustainability accounting and the process of assessing sustainability. Sustainability performance assessment consists of two stages: sustainability performance accounting and sustainability performance assessment using the information collected through accounting.

4. CONCLUSIONS

Sustainable and sustainable development have emerged as concepts to mitigate the negative economic, environmental and social effects on present and future generations (Hjorth & Bagheri, 2006; Lozano, 2008; Lozano & Huisingh, 2011; Bastas & Liyanage, 2018). Civil society, public sector entities and organizations have been very interested in developing sustainability (Jennings & Zandbergen, 1995).

The accounting field, in practice, has been easily engaged in organizational sustainability issues (Burritt & Tingey-Holyoak, 2011). If sustainability issues will be part of future accounting practices, then relevant research is needed to insert these practices into the economic activity of entities. Although specialty studies suggest a number of accounting techniques (Sustainability Balanced Scorecards) that would be useful in implementing organizational sustainability, these accounting techniques still have limitations in their application. For example, (Schaltegger) suggests that the use of the Sustainability Balanced

Scorecards technique requires the efficient integration of corporate databases and accounting systems (Schaltegger, 2011). But integration challenges can discourage entities struggling to engage in organizational sustainability.

Accounting strategies should provide information on substitute products and services. Significant accounting techniques used to implement organizational sustainability must focus on innovation and creativity (Schaltegger *et al.*, 2008).

The development of sustainability-based accounting techniques could enable entities to differentiate themselves from competitors, reduce costs and increase their reputation. Such accounting instruments could also inform entities about the negative economic, social and environmental impact and thus make a contribution to a sustainable society.

Currently, a number of accounting tools oriented towards pragmatic objectives are being developed, which are able to provide a perspective on the management of organizational, environmental, social and economic performance (Schaltegger & Burritt, 2010), and the potential for sustainable development (Qian *et al.*, 2018; Burritt *et al.*, 2019), but also to provide responsibilities to investors, employees, community, customers (Burritt & Schaltegger, 2010). However, these management accounting tools focused on organizational sustainability are based on the analysis and synthesis of information from many systems, and many of these technologies are extremely complex and are developed by non-professionals (Malik *et al.*, 2021).

Despite great progress in understanding sustainability issues and the solutions developed to meet this challenge, current business models are still unsustainable. The proposed research approaches a well-developed and scientifically based field, but sprinkled with dissensions created by controversial opinions on the concept of performance or subjectivity of professional reasoning. Although the concept of organizational sustainability has been analyzed and debated in all economic disciplines, however, from a financial-accounting perspective, this concept is still controversial.

As a future research direction, we propose to analyze the influence of internal and external factors (individual, group, organization, institutions) on shaping the identity of organizations to improve their financial performance and increase their organizational resilience. Another interesting approach to the concept of sustainability is to identify the resilience capacity of organizations to ensure achievement and continuity of long-term performance. Although considerable research has been done on resilience, it is not clear what ways organizations are turning to increase their organizational resilience.

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Worldwide Fiscal Progressivity: What can we Learn from Subjective Wellbeing Economics?

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Abstract: The link between fiscal progressivity and subjective well-being at global level is an issue that has hardly been considered in the literature on the Economics of Happiness. Oishi *et al.* (2012) is almost the only work in this field, and they concluded that those countries which had more progressive income tax systems were also happier. Our work use their definition of progressivity as the difference between the upper and lower marginal rate on income, in order to prove its relationship with subjective well-being (SWB), but we have observed that such indicator is not very significant for a sample of 111 countries. Besides, we conclude that the fact that a country's maximum income tax rate is high turns out to have a strong influence on the declared subjective well-being of its citizens. One possible explanation for it could be that they are countries with a high GDP per capita in which disposable income after taxes remains high. However, it must be taken into account that in our work we have managed to isolate the influences that the GDP per capita variable could have using the principal component analysis method.

Keywords: progressivity; subjective well-being; taxation; quality of life; happiness.

JEL classification: A13; H20; I31.

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1. INTRODUCTION

In the last years there has been a blooming of works about economy focus on subjective well-being and happiness[1]. Among these studies there is a branch aim at public economy, but they are very scarce works, on the other hand, those relating subjective well-being and paying taxes. This could be due to the difficulty of the relationship between both concepts as they have two types of effects.

Direct effects, in other words, if just the act of paying produces satisfaction or discomfort. Discomfort would be the product of the decrease of the available net worth, while satisfaction could be produced by moral, cultural or ideological values (as far as they sneak as the Estate in each individual freedom)[2].

Indirect effects are much more obvious as taxes are used to finance public commodities (health, education, infrastructure...) and to redistribute wealth (grants, subsidies...), they produce satisfaction upon those receiving or discomfort when citizens consider that wealth has been misused (waste, corruption...)

All of these relationships may produce many interesting microeconomic studies where factors that encourage an individual to improve or worsen his subjective well-being at paying a specific tax could be explored. However, that is not the aim of this project. In this essay we want to analyse the relationship between fiscalization and well-being at a country level. And more specifically, a fundamental aspect of taxpaying as it is fiscal progressivity, which, at a first instance, is only consider part of nations with higher levels of equality.

Our work wants to cover up a very important hole in academic literature about this topic, as practically, with the only exception of Oishi *et al.* (2012), in economy literature nobody has cover in depth the relationship between fiscalization and subjective well-being at a global level.

With that aim in mind, a sample of 111 countries was taken, to which their progressivity is calculated for 2019, using the higher and lower tax upon wealth of natural persons. In addition, the relationship that the higher and lower tax rate has with well-being will be also analysed.

Subjective well-being was obtained from the Gallup survey for 2019. This variable was one of which was taken into account to calculate the World Happiness Index (WHI in advance) produced by United Nations. It measures the average of the individual perceptions of how good life is depending on the country.

Also, from the construction of WHI we took other variables that act as control variables in our model: GDP per capita, social support, life expectancy, freedom of choice, inequality, perception of corruption, trust in national governments and generosity.

The issue with these control variables is the strong correlation existing among them. Problem that has been solved using the analysis of main components. That way, three components related with subjective well-being of countries have been identified: the "apparent quality of life", the one referring to "institutions and ethics" and the "fiscal progressivity" (FP) or "higher tax rate" (HTR) and "lower tax rate" (LTR).

Upcoming, these three dimensions have been used as variables determining subjective well-being. As we justified in the econometric strategy, we use the method if ordinary least squares, from which we obtain that the coefficient with mayor statistical significance up to be the "apparent quality of life". The "fiscal progressivity" or "higher tax rate" component has a mayor importance than "institutions and ethics" whose effect when introducing other control variables almost disappears.

This work is also relevant for public politics as, more than just confirm the results about progressivity obtain by Oishi *et al.* (2012), we find that the fixation of the higher tax rate is quite determining on the satisfaction at a country level. However, not the same thing happens with lower tax rate. On the other hand, we understand that a very important input of this project consist on isolating the effect that other different variables have upon subjective well-being, that could cause interactions and feedback on the studied variable. Furthermore, another added value of this work is that we offer a systematization of the scarce literature relating taxpaying and well-being.

Apart from this introduction, the present article offers in its 2nd Section with a revision of the recent literature closer to our object of study. The 3th Section is dedicated to the theoretical framework that constitutes the base to implement the later empirical work. The 4th Section is used to define data and the 5th portrays the econometric model. On the 6th and 7th Sections we analyse the results obtain and, eventually, in the 8th Section our conclusions are gathered.

2. REVISION OF LITERATURE ABOUT TAXPAYING AND WELL-BEING

We could take as a starting point in this literature Mirrlees approach (1971) of a model of uniform tax over the wealth, in which the individual with different skills to earn maximise a utility function in consumption and leisure. The government pretends to redistribute the income of people with better skills among those with a worse range of them, but these creates an information problem as it is possible to clearly see income but not skills. In this way people with better skills can avoid taxpaying over their income working less.

Oswald (1983), just like Layard already did (1980), takes the standard utility model (according consumption and leisure) whose maximisation determines the work offer adding as a third variable the worry due to others' consumption (defined as the weighted sum of the consumption of every other individual in our society). This variable represents altruism if utility increases as others' consumption does. Or, on the other hand, envy (if utility diminishes as others' consumption increases).

In their own view, van Praag and Ferrer-i-Carbonell (2004), devote a chapter in their book to the relationship between taxpaying and well-being. They create a tax over the wealth from the idea of the "function of well-being of income" from Leyden[3] school of thought, to which some "sacrifice rules" are applied. Equally, they use the same theoretical framework for the construction of a tax over intelligence quotient (IQ) and education. After its application over a specific amount of data, they conclude that its application wouldn't result to a much more different fiscal system than the one we currently have.

Gruber and Mullainathan (2005) analysed the effects of the tax over tobacco in consumers' well-being. They concluded that increasing taxes also increase happiness among smokers. Under the model of rational addiction, tax over cigarettes worsen the situation of regular smokers. However, under alternative models non persistent throughout time, smokers benefit from taxes as they provide a valuable self-control source.

Layard (2006) analyse implications of the optimal imposition according to the well-known adaptation[4] and social comparison[5], ideals took from economic happiness literature. He concluded that taxes have an extra function, apart from financing public services and wealth redistribution, and it is to discourage excessive work aim at being more wealthy than out neighbour.

Weisbach (2008) does a whole revision of the literature relating optimal taxpaying and happiness. Said literature has in common that it tries to introduce social status as an aspect to take into account when designing a specific tax. The conclusion gathered by the author is that findings about happiness may have the potential to change fiscal politics, but, for that to occur, it would be necessary that the investigation came closer to those questions related with the normative sphere of economy.

Different from previous approaches, in our work we want to study the fiscal progressivity, not from the designing point of view, but from an evaluating perspective. This way, it would be analysed how decisions about taxpaying at a country level influence in the average well-being of their citizens.

Following this idea, Lubian and Zarri (2011) created numerous indexes to measure the moral aspect of taxpaying or fiscal honesty and they find a correlation in them with individual subjetive well-being. The authors understand that the fact that some individuals pay taxes, even when the fines for non-payment are so low that it could be beneficial not paying taxes, is due to the fact that taxpaying may be satisfactory in itself.

Akay *et al.* (2012) investigate the effect of taxpaying upon individual happiness. Studying different alterations that occurred in the tax system of German households, they find evidence that a significant and positive effect of taxpaying over well-being, according to net income (maintaining an individual constant life level). Said relation, they believe, it is not only because taxes finance public commodities and fiscal moral from contributors, but also because of the preference of citizens to the redistributors role of the Estate, being because of solidarity or believe in the role of the Estate, or due to" more self-centered behavior, such as risk aversion and the preference for a tight social safety net in case of a shock such as unemployment (a 'veil of ignorance' motive)".

Grimes *et al.* (2016) study the relationship between subjective well-being and tax politics of 35 countries and 130 years-country, resulting in a sample over 170.000 people. They find out that, even though distorting taxes (like tax over wealth) are associated with a slower economic growth, nevertheless they have a higher correlation with well-being that non-distorting taxes (such as VAT). That being said, non-distorting taxes have a lesser impact on well-being for the wealthier classes than for the more disadvantaged classes.

According to fiscal progressivity, Oishi *et al.* (2012), taking 54 countries from Gallup's survey for 2007, finds out that progressivity is related in a positive way with subjective well-being. Furthermore, they prove that this positive effect comes from citizens' satisfaction with public commodities like education and public transport. However, public expenses and taxpaying in general do not result in happiness. Therefore, it is not the idea of a "big government" the one associated with a better well-being, but the role of a fair redistributors of wealth through taxes[6]. These same authors, in a more recent article, show a relationship that turns out to be key: a more progressive taxpaying predicts less inequality of income, which means a greater sense of trust and equity that derives in a higher degree of happiness[7].

Our work estimates progressivity[8] using the two previous articles same method: calculating the difference between higher tax rate and lower tax rate in the tax over income. But, apart from doubling the sample and offering more current data available to this date, we introduce a model of multiple regression in which we achieve isolating the effect that other variables may have on progressivity, to determine the satisfaction with life or subjective well-being of citizens.

3. PROGRESSIVITY AND SUBJECTIVE WELL-BEING: THEORETICAL FRAMEWORK

From a theoretical point of view, according to subjective well-being, the standard economic analysis infers the utility from behaviour (choices) of individuals (revealed choices). That way, Kahneman *et al.* (1997) coined the term "utility of choice" as "the utility of the results and the characteristics used during the decision making process" and the "experimented utility", which is the hedonic quality of such choice.

The subjective approach to the "experimented" utility supposes a complementary point of view profitable to study said well-being for two separated reasons. First, it offers a quite important tool in economy when allowing measuring individual well-being in a direct way from the measures claimed subjectively by the questioned individuals. When the question is about general satisfaction with life, we obtain a quantitative approximation of the individual's well-being. From the average of the answers in a specific country we will obtain a variable that would portray the well-being attainable there. Second, happiness is for most people a main aim, in other words, citizens do not want an income and other vital aspects only by themselves. They want them to increase their odds of being happy.

In this analytical context we consider the judgement of subjective well-being as an ordinal indicator if the individual's utility. The judgements of satisfaction with life are identifiable with subjective well-being. In that manner, as an alternative to standard analysis we could use subjective well-being data as a direct measure of the utility.

According to the previous ideas, we could present a model in which individual utility is represented by its subjective well-being (its "satisfaction with life"), defined by the following equations:

$$subjective\ well-being_i = a_0 + \alpha * fiscal\ progressivity_i + \beta * Zi + \varepsilon_i \quad (1)$$

$$subjective\ well-being_i = a_0 + \alpha * higher\ tax\ rate_i + \beta * Zi + \varepsilon_i \quad (2)$$

$$subjective\ well-being_i = a_0 + \alpha * lower\ tax\ rate_i + \beta * Zi + \varepsilon_i \quad (3)$$

where subjective well-being is the dependent or endogenous variable to the model. As independent variables we took fiscal progressivity and higher tax rate or lower tax rate, just like other explanatory variables (Z), which are most of the variables used for the construction of the IMF[9]: GDP per capita, social support, life expectancy, inequality, the perception if corruption, freedom, trust in national governments and generosity. The definition of all of these variables can be found in the fourth part if this article. The epsilon is used to represent the term of error.

4. DESCRIPTION OF DATA

In our analysis we took into account an amount of data of a transverse nature for 2019, took (except of the variables associated to fiscal progressivity) from the base of IMF's data, created by the United Nations Organization, in its 2020 edition.

For 2019 observations[10] of 137 countries were offered, even though countries with lack of data in any or some of the variables were eliminated for homogeneity purposes, resulting in a total of 111 countries.

The variables used in the study are the following:

Fiscal progressivity, higher tax rate and lower tax rate in tax over income.

First, the fiscal progressivity variable has been constructed according to the methodology used by Oishi *et al.* (2012)[11], in the following manner:

$$Fiscal\ progressivity\ (FP) = higher\ tax\ rate\text{-}lower\ tax\ rate \quad (4)$$

Specifically, in our study we took the difference between the tax rate in the higher and lower levels in taxpaying over income of natural persons (residents) in the different countries, not including social security. For those countries that count with a minimum exempt in taxes, we took as the minimum the first taxpaying type applicable.

The highest and lowest tax rates have as sources the web pages of the different global tax administrations, just as the use of the fiscal guides from the consultants PKF and Deloitte.

On Table no. 1A in our Annex, we detailed the fiscal progressivity, the higher tax rate and the lower tax rate.

Subjective well-being

It is a continuous variable, took from Gallup's Global Survey, covering from 2005 to 2019. Unless we specify otherwise, it is the national average answer to the following question: "Please, imagine a staircase, with steps numbered from 0 (lower step) to 10 (higher step). The highest point of the staircase represents the best possible life for you and the lowest part the worst life possible. On which step on the staircase would you say personally that you are right now? This measure is also known as the Cantril life staircase or, simply, Life Staircase.

GPD per capita

It is defined as the neperian logarithm of the GDP per capita of the country un Purchasing Power Parity (PPP). This variable continues, the GDP is expressed in «real volumes», adjusting the numbers to the differences of prices between countries. The dollar is used for this to date November 28th, 2011, according to the update in 2019 of the World Development Indicators (WDI)

Life expectancy

It is a continuous variable that groups the expectations about the number of years of healthy life when born and it is based in data obtain from the World Health Organization (WHO), that offers data up to 2016. Therefore, the data used are those extrapolated by United Nations for the confection of the IMF.

Social support

Social support (having someone to count on when problems arrive) is the average of binary answers (0 or 1) to the question in Gallup's survey: "If you had problems, do you have relatives or friends that you can count on every time you need it or you do not?".

Freedom of choice

It is a continuous variable resulted from the national average of answers to the question in Gallup's survey: "Are you satisfied or unsatisfied with your freedom to choose what you can do with your life?"

Inequality

GINI index from the Global Bank. It represents in its lowest value (0) the highest level of equality and in its highest value (1 or 100%) the highest level of inequality.

Perception of corruption

Its measure is the national average of the answers to two separated questions from Gallup's survey: “Is corruption generalised in the government or it does not?" and "Is corruption generalised inside companies or it does not?". The general perception is only the average of both answers 0 or 1. In case that there is a lack in the perception of governmental corruption, the perception of corporate corruption is used as the general perception.

The perception of corruption, at a national level, is only the average answer of the general perception at an individual level. In that way, with a scope from 0 to 1, the countries with the highest results are the ones where corruption is perceived in a more generalised way.

Trust in the government

It consists of the national average of answers to the question from Gallup's survey about one's trust in the government, being 0 equivalent to no and 1 equivalent to yes.

Generosity

Generosity is the rest of calculating the regression of the average of the answers to the question in Gallup's survey: "Have you donated money to a charity organization during the last month?" over the GDP per capita.

Variables have been normalised[12], as this is the adequate procedure when counting with different measuring scales.

5. ECONOMETRIC STRATEGY

According to the condition method, it has been proven the existence of multicollinearity between variables. Said correlations between variables make difficult distinguishing the real effect of each one of them upon subjective well-being, as they interact between them and they feed-back, which may bring problems in the estimations and little reliable results when using a multiple regression model[13].

To avoid multicollinearity we use the regression over main components method from Kendall (1958). With this method, original variables change in a new group of non-correlated variables called main components. For this, it is done, in the first place, an analysis of the main components, obtaining three components that encompass the different independent variables. As main components have the trait of being orthogonal, now it is appropriate to do a multiple regression analysis over the dependent variable.

In this analysis it is frequent to start with the consideration of the dependent variable as ordinal, which would demand the use of models such as Logit or Probit in order. However, Ferrer-i-Carbonell and Frijters (2004) - also check out van Praag and Ferrer-i-Carbonell (2006) - have proven that estimation by MCO does not cause important differences in the results. Furthermore, this facilitates the interpretation of coefficients.

In this way, going deeper in the relationship between variables we can establish a multiple lineal regression in which subjective well-being is the dependent variable or

endogenous from the model and taxpaying progressivity (or in their case higher tax rate or lower tax rate) the key independent variable. The other two components, that later would be defined, act as control variables.

$$Subjective\ well-being_i = a_0 + \beta_1 Life\ quality\ (apparent)_i + \beta_2 Institutions\ and\ ethic_i + \beta_3 Variable\ associated\ with\ progressivity_i + \varepsilon \quad (5)$$

6. RESULTS

Established the origin of the application of the main components method[14], we can check through the chart of communalities[15], that the progressivity variable is explained at a 95,3% by common factors, the higher tax rate at an 85,6% and the lower tax rate at an 87,1%.

Using as criteria of extraction said analysis of the main components method; we obtain[16], for taxpaying progressivity as higher and lower tax rate, three different components catalogued, depending on their composition, in the following way:

Component 1. Life quality (apparent): It covers the variables GDP per capita, life expectancy and social support. To a lesser extent it also contains freedom of choice and inequality. Freedom of choice in the case of the lowest level of taxpaying appears as the second component.

Component 2. Institutions and ethic[17]: It comprehends the variables perception of corruption, trust in the government and generosity.

Component 3. Progressivity or higher or lower tax rate; any of these variables are isolated, meaning they do not group with any other variable inside a component.

Using these three components, the normalized results of the estimation of subjective well-being are presented, using ordinary least squares. Shall we have in mind that each of the columns represents a different regression analysis, depending on the use of variables related to taxpaying progressivity.

Table no. 1 – Estimation MCO of subjective well-being at a country level

	Subjective Well-being		
	Fiscal Progressivity	**Higher Tax rate**	**Lower Tax rate**
(Constant)	2,148E-15	2,155E-15	2,181E-15
	(0,053)	(0,053)	(0,053)
Life	0,827***	0,813***	0,822***
Quality (apparent)	(0,053)	(0,054)	(0,053)
Institutions	0,012	0,026	0,134**
	(0,053)	(0,054)	(0,053)
Variables referring to	0,100*	0,175***	0,054
progressivity	(0,053)	(0,054)	(0,053)
R-fitted squeare	0,685	0,684	0,688
No.	111	111	111

Note: Regressions MCO with standard errors between brackets (they are the same by design of the orthogonal matrix). *p<0,1. **p<0,05. ***p<0,01.

Source: own elaboration; compilation based

We can observe that the institutions and ethics component (perception of corruption, trust in the government and generosity) does not have a significant effect upon subjective happiness,

except when the variable that is used as measure of progressivity is the minimum taxpaying type (Table no. 1). The effect is not present either in the lower tax rate. Progressivity has certain effect, but slightly significant and the coefficient indicates that a 1% increase in progressivity would increase subjective happiness 0,1%. While the maximum taxpaying type has a mayor effect as an increase of 1% in it would involve an increase in happiness of 0,18%, etc.

7. DISCUSSION

7.1 Life Quality (apparent)

We can put together a group of indicators in an "apparent" life quality, which ends up having the highest statistical meaning. We now analyse each of the grouped variables:

Referred to GDP per capita, according to : "Higher incomes are associated with a mayor satisfaction in life, but with decreasing performance as the income increases.

Because of this, Díaz Vázquez *et al.* (2011), consider that income constitutes one of the main determiners of what they name, as a synopsis, "life quality". The analysis they do for social capital also includes that the power of nets and trust in the citizens and in the institutions are also determining for citizens' life quality.

According to the life expectancy variable, it has been proven in the academic literature that its relationship with satisfaction with life functions in a double meaning that could produce distortions: on one hand longevity produces satisfaction with life, and on the other hand, those individuals with a more positive vision of their lives end up having a longer life[18].

About social support, it turns out to be a proxy variable of those called relational goods[19]. These have been studied in great depth in Latin America, where they have vital importance[20].

About the freedom variable, Abdur Rahman and Veenhoven (2018), distinguish inside the term between real freedom and the perception of freedom. In that manner, they place the formulated question from Gallup's survey inside the second group classifying it as a "satisfaction with freedom", correlated in a positive way with satisfaction with life.

About the relationship between inequality in income and the subjective well-being of a country: "not only the level of said incomes are relevant, but also the distribution of said incomes, including reach as well as tendency, which influence in subjective well-being" Diener (1984, p. 554).

The relationship between social equality and subjective well-being is encouraged in the following way: *"* "*First, it seems likely that a greater percentage of individuals will be able to achieve their goals in nations where there is relatively more equal nations. Second, in those places in which inequality is higher inequality conflicts and social justice are more likely to arise"* (Diener *et al.*, 1995, p. 853).

7.2 Institutions and ethics

According to the estimation of the subjective well-being equation, this component of institutional ethics ends up having the least statistical meaning.

As our data reflects, the correlation between the perception of corruption and trust in the government with the GDP is strongly significant[21]; and, also, the same phenomenon happens with the correlation of lack of corruption and subjective well-being[22], but not with the relationship between trust in the government and subjective well-being[23].

When studying the coincidence between these institutional variables and subjective well-being through the regression line, we observe that there is no coincidence between them. This may be due to the fact that effect that the lack of corruption had over subjective well-being was not direct, as it happens because the least corrupted countries are also the richest ones.

About generosity, in the measure of this variable we assume that at a higher GDP, the amount of donations would be higher, due to a greater purchasing power. That way, in its calculus the idea is that generosity would be the donated part not because we have more, but because of kindness. For this reason is why it is interpreted as the rest of the regression of the influence of GDP over the donations. Therefore, the component where it belongs is not the same as the GDP.

7.3 Variables referring to progressivity

We started with the results from Oishi *et al.* (2012), that found a correlation between the differences between the higher tax rate and the lower tax rate (this is, progressivity) with subjective well-being. However, the results of this study, with an extremely big sample of several countries, show that the variable that really has a strong correlation is the higher tax rate.

A possible answer to why in countries with the highest taxpaying types exist higher level of subjective well-being, may be that, in any case, we are talking about countries with a high GDP where the available income is still high. However, we should have in mind that in our study we have isolated the influence that this variable may have.

The measure of progressivity as the difference between the higher tax rate and the lower tax rate may be the target of criticism, as it does not take into account the income section neither the existence of an exempt minimum. Being or not a good progressivity measure, in this study we have proven that it does not have a significant correlation with subjective well-being. It does have a strong correlation with the higher tax rate, an indicator took by the source not being the calculus strictly required and subject to interpretation, and so in the taxpaying academic literature sometimes it is used as an indicator of progressivity[24].

8. CONCLUSIONS

The relationship between income and satisfaction with life has been one of the fields that more interest has awakened among studies about the economy of happiness. For this reason, it is strange that the relation between taxes and happiness has not been studied in greater depth. Inside fiscal matter, progressivity in a key question, as it defines to what extent a nation compromise to act in a collective way to eradicate inequality.

This article supports a whole revision of the academic literature that analyse the effects of taxpaying in our well-being. This literature was quite unfocussed, as it was a matter between disciplines such as economy, fiscal law and sociology.

About the way of calculating taxpaying progressivity, for this study, we took 111 countries, to which the difference between higher and lower taxpaying type over income was calculated.

A great leap forward compared to other similar articles is that we achieved isolating the effect of progressivity, from the "noise" that other variables could have caused that are also related with satisfaction with life, through the analysis of main components method.

As for the results, we observe the importance of the dimension of the "apparent" life quality that involves variables quite relevant like GDP per capita, life expectancy, relational goods, freedom or inequality.

Nevertheless, it is obvious that the correlation of taxpaying progressivity as it has been calculated, over subjective well-being, is superior to the component that involves variables as important as the perception of corruption or trust in the government.

A very important contribution from our work is finding out the strong influence that the fixation of a higher tax rate in taxes over income has over subjective well-being. No relationship was found between lower tax rate and well-being. This brings the conclusion that the effect of progressivity is the product of the fixation of taxes in the higher levels of income that is relieved when during the analysis the lower tax rate is subtracted.

A possible explanation to why the higher taxpaying types over income for natural persons have such a strong influence upon subjective well-being could be found in a Eurostat publication: "Taxation trends in the European Union": Direct taxes allow for a better redistribution as it is impossible introducing progressivity in indirect taxes. Therefore, "the recourse to direct taxes, which are more 'visible' to the electorate, tends to be greater in the countries where tax redistribution objectives are more pronounced; this usually results also in higher top personal income tax rates." (Eurostat, 2014, p. 20). For this reason, it is suggested that higher tax rate influence in subjective well-being as far as it is a manifestation of the compromise of a country when redistributing its wealth.

That the maximum taxpaying type of a country is high ends up having an extremely significant effect upon subjective well-being, so we hope that with this work in a near future more interest would be awakening about its use as an indicator of the progress of a specific nation.

Finally, it should be mentioned that are multiple the possibilities extensions of this analysis. First, the relationship between taxes and happiness through the exploitation of micro data should be studied; trying identifying through which channels taxes achieve to produce happiness. For example, the public commodities that produce the most well-being to citizens could be analysed (health, education...) and if it is only the act of paying for those commodities what produces said happiness. Also, temporal series could be used to determine if events that make citizens happier when paying taxes exist ("Are citizens happier paying taxes after COVID-19 as they have seen the importance of collectively financing public services?"). Moreover, other data bases could be used, other countries consider or taking other more sophisticated indicators to measure taxpaying progressivity or social inequality. Ultimately, a huge field of study exist for a discipline that, despite its importance, still slightly studied nowadays.

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ANNEX

Table no. 1A – Calculus of progressivity. Included countries

Country	TMI	TMS	PF	Country	TMI	TMS	PF	Country	TMI	TMS	PF
Albania	13	23	10	Greece	22	45	23	Nicaragua	15	30	15
Argentina	5	35	30	Guatemala	5	7	2	Níger	30	30	0
Australia	19	45	26	Guinea	5	40	35	Nigeria	7	24	17
Austria	25	55	30	Honduras	15	25	10	Norway	18,5	38,2	19,7
Azerbaijan	14	25	11	Hungary	15	15	0	Panama	15	25	10
Bangladesh	10	30	20	India	5	35,88	30,88	Paraguay	8	10	2
Belarus	13	13	0	Indonesia	5	30	25	Peru	8	30	22
Belgium	25	50	25	Iran	10	20	10	Filipinas	20	35	15
Benin	10	30	20	Ireland	20	40	20	Poland	17	32	15
Bolivia	25	25	0	Italiy	23	43	20	Portugal	14,5	48	33,5
Bosnia and Herzegovina	10	10	0	Côte d'Ivoire.	2	36	34	Rumania	10	10	0
Botsuana	5	25	20	Japan	5	45	40	Ruanda	20	30	10
Brasil	7,5	27,5	20	Kazakhstan	10	10	0	Senegal	20	40	20
Bulgaria	10	10	0	Kenya	10	30	20	Serbia	10	10	0
Burkina Faso	12,1	25	12,9	Kirguistan	10	10	0	Sierra Leone	15	30	15
Cameroon	5	35	30	Letonia	20	31,4	11,4	Slovakia	19	25	6
Canada	15	33	18	Libano	4	21	17	Slovenia	16	50	34
Chad	10	30	20	Lesoto	20	30	10	Sudafrica	18	45	27
Chile	4	35	31	Liberia	5	25	20	South Corea	6	42	36
Colombia	19	39	20	Lituania	20	32	12	Spain	19	45	26
Comoras	5	30	25	Luxembourg	8	42	34	Sri Lanka	4	24	20
Congo	1	40	39	Macedonia	10	10	0	Esuatini	20	33	13
Costa Rica	10	25	15	Madagascar	20	20	0	Sweden	30	52	22
Croatia	24	36	12	Malaui	15	30	15	Switzerland	0,77	11,5	10,73
Denmark	8	56,4	48,4	Malasia	1	28	27	Tanzania	9	30	21
Dominican Republic	15	25	10	Mali	3	3	0	Tailand	5	35	30
Ecuador	5	35	30	Mauritania	15	40	25	Togo	0,5	35	34,5
El Salvador	10	30	20	Mauricio	10	15	5	Tunez	1	36	35
Estonia	20	20	0	Mexico	1,92	35	33,08	Turkey	15	35	20
Ethiopia	10	35	25	Moldavia	12	12	0	Uganda	10	30	20
Finland	6	31,25	25,25	Mongolia	10	10	0	Ucrania	18	18	0
France	14	45	31	Montenegro	9	11	2	U.K.	20	45	25

Country	TMI	TMS	PF	Country	TMI	TMS	PF	Country	TMI	TMS	PF
Gabon	5	35	30	Mozambique	10	32	22	U.S	10	37	27
Gambia	5	25	20	Myanmar	5	25	20	Uruguay	10	36	26
Georgia	20	20	0	Namibia	18	37	19	Uzbekistan	12	12	0
Germany	14	45	31	Nepal	1	36	35	Zambia	25	37,5	12,5
Ghana	5	30	25	Netherlands	18,65	51,95	33,3	Zimbabue	20	45	25

Source: own elaboration

Table no. 2A – Communalities of progressivity variable

	Initial	Extraction
Zscore(Progressivity)	1,000	,950
Zscore: GPD Pc	1,000	,888
Zscore: Social Support	1,000	,777
Zscore: Life Expectancy	1,000	,863
Zscore: Freedom	1,000	,600
Zscore Generosity	1,000	,475
Zscore: Corruption	1,000	,728
Zscore: GINI	1,000	,340
Zscore: Government Trust	1,000	,796

Note: Extraction Method: analysis of main components.

Source: own elaboration

Table no. 3A – Communalities of higher tax rate

	Inicial	Extracción
Zscore (Higher tax rate)	1,000	,856
Zscore: GPD Pc	1,000	,882
Zscore: Social Support	1,000	,778
Zscore: Life Expectancy	1,000	,857
Zscore: Freedom	1,000	,555
Zscore Generosity	1,000	,573
Zscore: Corruption	1,000	,761
Zscore: Government Trust	1,000	,791
Zscore: GINI	1,000	,406

Note: Extraction Method: analysis of main components.

Source: own elaboration

Table no. 4A – Communalities of lower tax rate

	Inicial	Extracción
Zscore(Lower tax rate)	1,000	,871
Zscore: GPD Pc	1,000	,872
Zscore: Social Support	1,000	,758
Zscore: Life Expectancy	1,000	,862
Zscore: Freedom	1,000	,564
Zscore Generosity	1,000	,596
Zscore: Corruption	1,000	,738
Zscore: Government Trust	1,000	,817
Zscore: GINI	1,000	,336

Note: Extraction Method: analysis of main components.

Source: own elaboration

Notes

[1] Regarding the equivalence of both terms, see Ferrer-i-Carbonell (2013).
[2] For an in-depth analysis of the origin of the State interfering in individual subjective well-being through public policies, see Bjørnskov *et al.* (2012).
[3] The Leyden approach or school consists of an economic current of measurement of well-being, which emerged in the seventies and eighties at the University of Leydenv.
[4] According to this author, it implies that: "Having once experienced a higher standard of living, we cannot revert to where we were before and feel the same as we did then" (Layard, 2006, p. 5).
[5] That is, the comparison of the income that an individual makes between his own and that of others.
[6] In this sense, Bjørnskov *et al.* (2007) empirically analyzed whether the size of government was favorable or detrimental to life satisfaction, in a cross section of 74 countries. The results showed that the average satisfaction with life decreases with the increase in public consumption.
[7] Oishi *et al.* (2018) find that the poorest 40% of Americans feel significantly happier when their taxes are more progressive (understanding that the level of progressivity depends on the difference between the upper and lower marginal tax rates); while the 20% of the richest do not see their happiness affected by it.
[8] "A tax is progressive when its rate is higher for the rich (...), and lower for the more modest", Piketty (2015, p. 668).
[9] The variables not used have been those for which data for the year 2019 are barely available (those related to trust) and neither the Gini index of family income reported in the Gallup World Poll, since inequality was measured with the index Gini of the World Bank.
[10] From the data and appendices section of the World Happiness Index for the year 2020 2020 (https://worldhappiness.report/ed/2020/#appendices-and-data) go to the table "data for Table 2.1" and there are selected the data for the year 2019.
[11] The robustness of the calculation of progressivity as the difference between tax rates was tested by Oishi *et al.* (2012, p. 87).
[12] Subtracting the mean and dividing by the standard deviation.
[13] See the reflection on this matter carried out by Martela *et al.* (2020, p. 3).
[14] The KMO index from Kaiser-Meyer-Olkin of simple adecuation (if it is close to 1 its meaning is high)is at 0,695 for progressivity, at 0,710 for higher tax rate and at 0,705 for lower tax rate and in the Barlett esferification test (being positive when being under 0.05) the three cases ar at 0.00.
[15] The communal charts are charts 2, 3 and 4 from the annex.
[16] According to the rotating components matrix.
[17] The idea for this denomination was taken from Layard (2020, p. 56).
[18] Search Diener and Chan (2011).
[19] "As relational goods we understand the expressive/affective dimension, non instrumental from the interpersonal relationships" (Iglesias *et al*, 2013, p. 577).
[20] Search Velásquez (2016) and Rojas (2018).
[21] Matching with Tavits (2008) who, using data for 68 countries, concluded that the effect of corruption eclipsed de ones from the rest of macroeconomic variables.
[22] Layard (2020, p. 229) points put a close relationship between happiness and the behaviour of governors.
[23] Tavits (2008) confirms that corruption conditions the effect of representation, in a way that having the chosen party governing increases well-being when they are transparent parties, but this does not happen when they are corrupted.
[24] Search as an example Piketty (2015, p. 680).

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