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CONTENTS

EDITORIAL 2022-2

Military, political and economic aggression against a sovereign country in the center of Europe has revealed many unexpected social paradoxes following the financial consequences of the COVID-19 pandemic. First, the huge package of sanctions levied against Russia by international authorities has had a much less profoundly negative effect on its finances than expected. Second, this aggression halted the united global aspiration for universal sustainable development. Third, it not only destroyed the social, economic and informational infrastructure in Ukraine, but also revealed new progressive sources and institutions of industrial development, along with new cosmic information and safety control channels. This war has also revealed the decisive importance of separate national energy and food-supply safety nets for all living in an international society. All of these problems are also very interesting from the perspective of efficiency research, and their solutions will require intellectual productivity and significant human talent.

This IE-2022:2 issue is mostly dedicated to research in Fintech, marketing, new investing and innovation from the authors of nine countries countries. In relation to the first of these, the publication by Oday Tamimi and Ildikó Orbán (Hungary) is dedicated to the correlations between such accounting indices as cash flows, IAS 7, IAS 33 and earnings per share regarding net cash flow from operating and financing. Shoaib Khan and Abdulrahman Saad Abdullah Al-harby (Saudi Arabia) present a study on Fintech and the impact of digital payments on financial intermediation using global World Bank development indicators. Raúl de Arriba and Santiago Luzuriaga analyze how government subsidies enable arts creation under conditions of inequality in Spain.

Christos Ziakis and Dimitrios Kydros (Greece) use machine learning algorithms to investigate consumer attitudes toward the technique of online behavioral advertising on Twitter by applying the CRISP-DM framework. Jana Majerova et al. (Czech and Slovak Republics) revise some aspects of generational stratification in brand-value building, management and marketing communication strategy in relation to the specifics of the study cohort, using contingency evaluation to test their hypotheses.

Andrii Kaminskyi et al. (Ukraine) investigate environmental, social and corporate investing strategies in the context of the COVID-19 pandemic. They present a comparative analysis of risk-return based on Exchange Traded Funds, taking account of the Global Economic Policy Uncertainty Index. Serhii Lehenchuk et al. (Ukraine & Oman) reveal how the profitability of knowledge-intensive companies depends on the effectiveness of R&D and intellectual capital management using the example of medical technology firms. I Wayan Arsawan et al. (Indonesia & Ukraine) present their findings on the role of knowledge and creativity on employees' innovation capability, on stimulating knowledge sharing, and on enhancing time sufficiency.

The impact of international real estate investment on tourism growth is detailed in an empirical review by Maja Nikšić Radić (Croatia), which also provides some suggestions for the industry. This issue of IE-2022:2 finishes with an interesting review by Alexander Verlaine (Hungary) concerning the econometrics of Luxembourg's post-Cold-War defense expenditure (as a share of GDP per capita).

Antanas Buracas

THE CORRELATION BETWEEN STATEMENT OF CASH FLOWS, IAS 7, AND EARNINGS PER SHARE, IAS 33: A CASE STUDY AT DAIMLER AG (MERCEDES-BENZ)

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Abstract: *The present paper aims to examine the relationship between cash flows from operating, investing, and financing activities from one side, and earnings per share from the other, for Daimler AG (Mercedes-Benz) – one of the largest and oldest multinational automotive corporations in the world. The paper is based on the analytical and descriptive approaches, and tests the hypotheses of the study using the annual reports for the period of 2010–2020. The analysis of data is performed using the IBM-SPSS 25 statistical program in addition to Microsoft Excel 2013. This study uses the techniques of descriptive and inferential statistics. Based on the results, this paper concludes that there is no relationship between net cash flows and earnings per share; there is also no statistically significant correlation between cash flow from investing and earnings per share. Regarding the net cash flow from operating and financing, there is a statistically significant relationship between this independent variable and earnings per share; at the same time, the correlation is positive for financing activities but negative for operating activities with earnings per share. Multinational automotive corporations such as Daimler AG (Mercedes-Benz) should show a link between cash flows and earnings per share when making decisions related to operating and investing activities because the relative difference between the statement of cash flows and earnings per share is important for external users, especially investors.*

Keywords: *statement of cash flows, IAS 7, earnings per share, IAS 33*

JEL Classification Codes: *M40, M41*

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Introduction

The start of interest in financial statements began with the establishment of large enterprises and the separation of the ownership of the entity from its management. The reasons for this are: management may use this information; it has to cover any shortcomings in performance; and it may also display misleading information to achieve illegal goals such as reducing taxes, not distributing profits to shareholders, or improving the company's financial position in front of target groups of lenders, creditors, or others. For these reasons, it is the duty of countries to regulate accounting disclosure by obligating enterprises to use internationally accepted accounting standards (Ball, 2006; Das & Zhang, 2003; Hung & Subramanyam, 2007).

The economies of developed countries depend on these major entities, so it is important to possess annual financial reports for each company. These financial reports must disclose specific and useful financial information, because the disclosure of excess information puts the entity in a weak position relative to its competitors. Likewise, insufficient disclosure will lead to a decrease in the level of credit reputation for investors and shareholders. Among these important financial reports, which are the subject of this study, is the statement of cash flows, the most important modern financial statement and one of the main requirements for large institutions that all investors look towards (Clinch et al., 2002).

The first attempts to find a statement of cash flows occurred when companies operating in the United States at the end of the 1950s took the initiative to present an accompanying analytical statement reflecting the developments that occurred in their funds through a comparison between two successive financial positions, and this comparison showed the elements of increase and decrease that occurred during the period.

Despite the novelty of the statement of cash flows compared to other financial statements, it has undergone remarkable development in the Financial Accounting Standards Board (FASB) since its inception in 1985 (Broome, 2004). The FASB confirmed that the statement of cash flows provides useful information about the operating, investing, and financing activities of the entity. It also provides information about cash receipts and payments, which helps in determining numerous factors such as the liquidity, flexibility, and profitability of the entity and the risks surrounding it (Farshadfar & Brimble, 2008).

Accounting for cash flows has occupied an important position at the academic and professional levels. The FASB established SFAS 95 in November 1987 regarding the preparation of the statement of cash flows (Vent et al., 1995). Since its issuance, this standard has been subject to support on the one hand, and strong criticism on the other. This standard obligated American joint-stock companies to issue the statement of cash flows instead of the statement of changes in the financial position, which was in use until this date, and is considered one of the earliest statements calling for publishing the statement of cash flows in the financial reports of entities, especially after the crisis that befell the American financial markets in 1987 and led to the collapse of the money and contract markets (Vent et al., 1995). The standard recommended that the cash flows in the statement be analyzed in discrete areas as cash flows from operating, investing, and financing activities, while allowing the entity to prepare the statement according to any of the direct or indirect methods.

IAS 7 was issued in 1992 by the International Accounting Standards Committee (IASC), and replaced the previous standard issued in 1987. This statement is presented as an integral part

of the audited financial statements included in the annual reports issued by joint-stock companies (Kent & Birt, 2020). Stock market development and recovery are some of the goals that countries seek to achieve.

For the management of the entity, stock return reflects the overall performance of the entity, and is therefore a measure of success or failure for it. As for investors, identifying the most important factors that control earnings per share is a source of important information and thus helps them make sound investment decisions (Atieh et al., 2020). The presence or absence of a relationship between the performance of shares in previous periods and their performance in later periods depends on many factors, such as the level of the market in which the shares are traded, their efficiency, as well as the degree of investment awareness of those who deal in them.

There are often questions asked about the extent to which the statement of cash flows provides useful information to its users. The statement of cash flows has occupied a large part of previous studies as a tool for presenting financial information in a detailed manner. The relationship between statements of cash flows and various financial indicators in all sectors have been considered, but there are no studies that have linked the pillars of statements of cash flows and earnings per share (EPS), creating an urgent need to conduct several studies that address the factors affecting earning per share. Therefore, this study aims to answer the following research question: Is there a correlation between the cash flows and earnings per share? In order to answer the study question, statistical methods are used in analyzing the data of the study. This study aims to contribute to improving financial reporting and financial analysis by providing a comprehensive picture that shows the extent of the relationship between the variables of the study, which will help each of the users of the financial statements, and in particular the stakeholders of Daimler AG (Mercedes-Benz), to understand the impact of any decision taken regarding the pillars of the statement of cash flows and the extent of their effect on earnings per share. The study is structured in the following way. The second part presents an overview of the previous studies that focused on the variables of this study. The third part is concerned with the data and the statistical methods used for this study. The final part presents the conclusion and future directions.

2. Literature review and hypothesis development

2.1 Statement of cash flows

The statement of cash flows is an analytical statement of the movement of cash changes that took place in the entity, whether increasing or decreasing, and that identifies the reasons for these changes, meaning that it is a depiction of the sum cash transactions (Bala, 2017). It is an annual statement prepared on a cash basis. Its summary is the change in cash and cash equivalents between the beginning and end of the period (Dechow et al., 1998). The statement of cash flows shows the cash impact of all the activities carried out by the entity during the financial period and the nature of this flow, whether it is a cash inflow or a cash outflow. The word cash has a broad concept, including cash and cash equivalents – short-term, highly liquid investments such as treasury bonds, commercial papers, and securities that are intended to achieve a temporary return on idle cash rather than holding it (Kousenidis, 2006).

Schipper (2005) observed that with the emergence of large markets for investments in stocks in the late 1920s, it was natural for the focus to shift to net income and earnings per share,

and with the high level of investment in securities, the interest of the financial community in measures prepared according to the accrual basis increased, considering that net income is the best way to predict future profits (Dechow et al., 1998). This interest began to decline because many successful entities made huge profits, yet they got out of the market because they lacked sufficient liquidity. Many studies also confirm the existence of large numbers of enterprises that went into bankruptcy, even though they were making good annual profits (Orpurt & Zang, 2009).

This is due to many reasons, including the fact that these enterprises depend on their financial statements – on the statement of profit or loss and the statement of changes in the financial position. Because these statements are considered on the basis of accrual and the profits resulting from the application of this basis in the presence of large enterprises with diverse and intertwined activities, it has become difficult to interpret their significance and use them as indicators of the cash flows of the entity (Erasmus, 2010). The entity may have a cash capacity that enables it to fulfill its obligations, but it may not generate profits. Therefore, the net profit figure achieved according to the accrual basis does not enable the availability of cash to pay investors' profits or stock dividends.

The controversy over the ineffectiveness of the statement of profits or loss began in 1975, and this controversy escalated with the increasing number of bankruptcies of entities in the United States of America (Gilchrist, 1995). The statements of profit or loss of these entities disclosed a high net income while they were facing a cash shortage as a result of their lack of cash, even though they were profit-making enterprises and had financial inflows based on traditional financial statements to measure profits (Atieh et al., 2020). Enterprises resort to this statement to enhance their image when comparing themselves with other enterprises or when comparing to themselves in previous years, using methods and policies of different accounting. For example, a firm can change the method of calculating depreciation to reduce the taxes to be paid, or to avoid some restrictions imposed by some countries on enterprises with very large profits, such as nationalization or participation in social burdens (Fletcher & Ulrich, 2010). Figure 1 shows how revenues and expenses can be adjusted to convert them from an accrual basis to a cash basis.
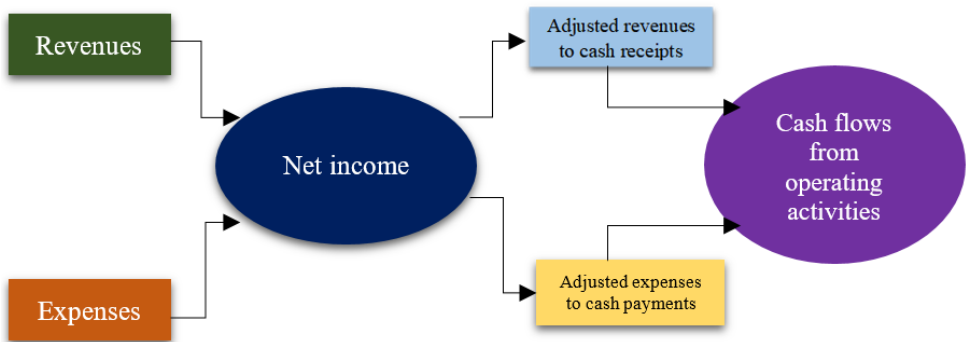
Figure 1. Changing from an accrual basis to a cash basis
Source: *Author's own work.*

Figure 1 shows that the statement of profit or loss prepared according to the accrual basis is one in which all revenues are added, whether these revenues are cash or not, and from which all expenses are subtracted, whether they are cash or non-cash expenses including depreciation and other non-cash expenses. When using the statement of cash flows, only all-cash operations are counted, whether from cash revenues or cash expenses, and the difference between them is calculated to find the net cash flows from operating activities (Farshadfar & Brimble, 2008). This gives several characteristics, the most important of which are: the statement of cash flows cannot be solely relied upon, and the statement of profit or loss cannot be neglected, but both are complementary to one another; and the statement of cash flows gives a clearer picture and is free from misleading information regarding the performance level of entities. Disclosure of cash flows statement information is used to indicate the quality of earnings information (Moonitz, 1956).

When a new entity is established and its operation begins, its main reliance is on activities that help it generate profits, so its focus is on cash flows from operating activities, and with continuity and development, it is directed towards investing activities by purchasing or acquiring long-term fixed assets for use in operational operations. These assets cost the enterprise huge amounts that may not be available to it as a new enterprise, so it resorts to borrowing from others or issuing new shares to cover its needs, i.e., cash flows from financing activities (De Villiers et al., 2003).

2.1.1 Cash flows from operating activities

Many books have dealt with cash flows, and the following is a presentation of the most important definitions that deal with cash flows from operating activities: cash flows from operating activities are cash flows resulting from the main operations of the entity from buying and selling goods and all normal operations that represent the operating cycle of the entity, or they are the main revenue-generating activities in the enterprise and other activities that are not considered investing or financing activities. As defined by (Hamshari, 2020), they are the financial facts and events that relate to the normal activity of the entity which it performs to make profits by practicing this activity. They are also defined by Francis (2010) as the flows related to the activities that enter into the determination of net income. Examples of these types of cash flows include cash collected from customers and cash paid to employees.

The most important elements addressed in the definitions of cash flows from operating activities firstly include all operations and major events in the entity that are carried out for the purpose of trading to achieve profits. Secondly, these flows are characterized by repetition and continuity. Third, they include all events that are not considered part of the cash flows from investing or financing activities (Orpurt & Zang, 2009).

To ensure the success of the entity, it must achieve cash inflows from operating activities higher than cash outflows from operating activities. Net cash flows from operating activities can be obtained by finding the difference between the cash inflows from operating activities and cash outflows from operating activities (Hamshari, 2020). Large positive cash flows resulting from operating are a good sign, and, in the long run, cash flows from operating activities should be the main source of cash in the enterprise. On the other hand, negative cash flows from operating activities indicate that profits are of poor quality and that in the future the entity will be unable to

grow and expand (Bowen et al., 1986; Ketz & Largay, 1987).

2.1.2 Cash flows from investing activities

Cash flows from investing activities are: activities related to acquiring or disposing of long-term assets in addition to other investments; the extent to which expenditures are paid on resources that are used to generate income and future cash flows; or the net cash flows resulting from the activities that an entity undertakes, established from the purchase and sale of fixed assets as well as investments in debt and ownership (stocks and bonds) for other enterprises. These types of cash flows include those associated with the acquisition or sale of productive assets used by the enterprise. Gilchrist (1995) defined them as all transactions related to the acquisition or disposal of non-current assets and the resulting cash flows. Fletcher and Ulrich (2010) considered cash flows from investing activities as those activities that include the acquisition and disposal of long-term assets such as real estate, machinery, equipment, debts, and equity instruments in other entities that do not fall within the description of cash equivalents, or that were acquired for the purpose of trading or dealing and include the sale and purchase of long-term assets. Thus, cash flows from investing are the operations related to obtaining or dispensing with non-current assets such as factories, long-term securities from shares and bonds, loans provided to other facilities and the process of collecting these loans (Bowen et al., 1986; Wilson, 1986). It is concluded that there are important elements in the definition of cash flows from investing activities: first, proving the acquisition process or dispensing with a fixed asset; and second, the acquisition process must be for the purpose of trading (Broome, 2004).

Determining cash flows from investing activities requires an analysis of the budget elements on the asset side that were not analyzed when determining cash flows from activities. These flows show the degree of expansion and growth of the entity and the amounts invested by the entity in: its business; equity investments in other facilities; and the disposal of non-current assets, by studying the items of fixed and long-term assets (Vent et al., 1995).

2.1.3 Cash flows from financing activities

Cash flows from financing activities are activities that result in changes in the size and components of capital ownership and the lending operations carried out by the enterprise, or the cash flows resulting from financing activities related to obtaining financing resources for assets, whether from loans or from issuing shares. Bala (2017) also defined them as cash flows directly related to the self-financing of the enterprise; for example, by issuing new shares or borrowing from banks. They are also considered a method of obtaining the necessary funds to cover the various activities carried out by the entity, whether from operational activities or capital activities. Thus, they are the operations related to obtaining loans from creditors or any transaction of the owners of the entity or shareholders. The general rule that distinguishes financing activities is that they are transactions related to borrowing, as well as transactions related to the owners of the establishment as a result of changing the capital by increase or decrease (Wilson, 1986). For this purpose, long-term liabilities and equity items from the balance sheet are studied.

Funding sources are obtained from one of the following two methods: first, financing by the owners of the establishment from the shareholders, which is represented in basic capital, reserves, and retained earnings; and second, through long-term loans, short-term loans, creditors,

and notes payable (Kousenidis, 2006).

There are two methods of presenting cash flows from operating activities: the direct method and the indirect method. The direct method is also called the profit and loss statement method (Kent & Birt, 2020; Krishnan, 2000), and is a method of showing the cash received and paid for operating activities according to the basic components of cash received and cash paid. This method is based on displaying the main groups of cash receipts, cash payments, and the arithmetic sum of the net cash flows from operating activities and attaching a statement or reconciliation memorandum of net income to arrive at the net cash flows from operating activities. Here, the components of cash inflows and outflows from operating activities are identified, such as cash receipts from sales and services rendered and receipts from customers, as well as cash payments for purchases and operating expenses and the payment of accounts payable (Goyal & Freeman, 2000).

One of the advantages of the direct method is that it enables the user to obtain a better assessment of the relationship between the net income or loss of the entity and its cash flows (Clinch et al., 2002). This method needs to restructure the statement of profit or loss and convert it to a cash basis. It also enables users of the statement of cash flows to understand how cash is generated from operating activities – such as depreciation, which is added in another way and would confuse users of the statement as it is a non-cash expense. By showing cash receipts and payments from operating activities, it provides the necessary information for the process of forecasting future cash flows, and this feature is not available when using the indirect method (Goyal & Freeman 2000). The direct method also provides more useful and appropriate information than the model prepared according to the indirect method, which is in line with the requirements of appropriate disclosure. Finally, the direct method serves the financial analyst in deriving more financial ratios and indicators by providing an abundance of operating activities of the entity (Cornell & Apostolou, 1992). One of the disadvantages of this method is that it does not disclose the separate items of cash inflows and outflows from operating activities; it discloses only cash received from operating activities. This method requires additional effort to prepare cash flows from operating activities, which may be a common reason for not considering it familiar to most entities (Krishnan, 2000).

The indirect method is also known as the profit or loss settlement method based on the effects of operations of a non-cash nature, deferred or accrued amounts for past or future operating cash receipts or payments, as well as items of income or expense related to investing or financing cash flows (Goyal & Freeman 2000; Kent & Birt, 2020). This method begins with the net profit generated from the statement of profit or loss; it is then adjusted by the items of income and expenses that do not contain cash flows, such as depreciation for fixed assets, to transfer the net profit number from the accrual basis to the cash basis by resuming all non-cash expenses again in net income, such as deferred income taxes and depreciation. Then, any other gains and losses incurred by the entity in various operations from selling a fixed asset or early repayment of a loan are subtracted, and the decrease of the change in current assets and the increase in current liabilities are also added, but the increase of the change in current assets and the decrease in current liabilities are subtracted. This means a positive correlation between cash flows and current liabilities and a negative correlation with current assets (Clinch et al., 2002).

One of the advantages of this method is that it is less expensive than the direct method. It

provides a link between the statement of cash flows, the statement of profits and losses, and the statement of financial position. Also, this method is based on a reconciliation of the net income of the enterprise and its cash flows from its operations (Klammer, 2018). On the other hand, there are criticisms of this method, the most important of which is that the indirect method is difficult to understand for beneficiaries because they are not able to access the cash flows from operations, and it does not disclose the details of the cash flows from operational activities (Cornell & Apostolou, 1992). The indirect method also does not explain receipts from customers, receipts from revenue, payments to suppliers and workers, payments for interest and taxes, and causes difficulty for users in understanding how to access cash flows from different operations. Although the accounting standards do not stipulate a specific method for preparing the statement of cash flows, the direct method is recommended by FASB and the International Accounting Standards Board (IASB). Nevertheless, the majority of entities use the indirect method.

2.1.4 Earnings per Share (EPS)

Profitability is the extent of a company's ability to achieve profit by following its operations within a certain period in a manner that ensures the least potential risk. It is disclosed via the explanation of the relationship between the investments that contribute to achieving profits and the profits that the company earned from its operating activities (Scott & Wier, 2000). Earnings per share is classified as one of the profitability indicators that is used for ease of comparison within previous periods, in addition to the comparison of earnings per share with competing companies in the same sector or industry. Earnings per share represents a comfort tool for investors to achieve rationalization in their future investment decisions, which affects the demand for shares (Balsam & Lipka, 1998). The earnings per share index or the share of the common stock from profits is the basic rule for some investors for evaluating a company and the profitability of the ordinary share. Therefore, it is mandatory that public shareholding companies disclose earnings per share because it is important in capital markets for investors. This was stipulated by the IASC, based on IAS 33, regarding the importance of presentation and disclosure.

IAS 33 added in its fourth paragraph that when consolidated financial statements and separate financial statements are prepared in accordance with IAS 27, the requirements for IAS 33 should be presented only on the basis of consolidated statements. An entity that elects to disclose earnings per share of earnings on the basis of its separate financial statements should present information about earnings per share only in terms of comprehensive income. The entity cannot present this information in the consolidated financial statements (BDO, 2014). IAS 33 requires calculating and presenting both earnings per share and diluted earnings per share, using profits or losses from the entity's continuing activity for all periods covered by the presented financial statements (IASB, 2003). If there are profits or losses from the discontinued activities of the entity, then the share of one stock from the discontinued activities must be presented either within the statement of profit or loss or within the notes attached to the financial statements.

IAS 33 also specified that earnings per share and diluted earnings per share should be accounted for even if the company makes losses (IASB, 2003). The earnings per share contain a financial indicator that includes financial information that is of paramount importance in relation to the assessment of the financial condition of the entity, and this information should be disclosed and should be circulated in the hands of all investors because of their necessity in

making investment decisions (Das & Zhang, 2003). IAS 33 added the differences between basic earnings per share and diluted earnings per share, as it was stated that earnings per share is the share of one ordinary share of the profits available to common stockholders. It is calculated by dividing the earnings available to common stockholders by the weighted average common stocks. The following equation is used for calculating basic earnings per share (BDO, 2014; IASB, 2003).

$$\text{EPS} = \frac{\text{Net Income} - \text{Preferred Dividends}}{\text{Weighted Average Shares Outstanding}} \tag{1}$$

In respect of common shareholders, diluted earnings per share is the worst-case scenario. Diluted EPS is used when there is compound capital that includes options to purchase the entity's common stock, securities (convertible bonds, options, preferred stocks, and warrants) convertible into common stock, and when these shares are taken into account in calculating the earnings per share (Ingersoll, 1977; Wiseman, 1990). The entity should apply the following equation to find the diluted EPS:

$$\textbf{Diluted EPS} = \frac{\textbf{Net Income} - \textbf{Preferred Dividends} + \textbf{Paid out dilutive securities (PDS)}}{\textbf{Weighted Average Shares Outstanding} + \textbf{Conversion of dilutive securitites}} \tag{2}$$

$$\textbf{DS} = \textbf{Preferred Dividends (Not net of Tax)} + \textbf{Interest Exp (Net of Tax)} \tag{2.1}$$

Diluted EPS is calculated and published in case the entity has securities that are convertible into common shares, and earnings per share is calculated in this case assuming the conversion of these securities into ordinary shares. Thus, the conversion effect on profits (the numerator) and the number of shares (the denominator) are adjusted in the process of calculating the earnings per share (De Villiers et al., 2003; Huson et al., 2001).

In the event of a decrease in the earnings per share upon conversion from the basic earnings per share, the reduced earnings per share shall be considered. In this case, both the basic earnings per share and the diluted earnings per share shall be published. If the process of converting convertible securities leads to an increase in the earnings per share, it is ignored and therefore not included in the process of calculating the diluted earnings per share. Based on the above, the following hypotheses were developed:

H1: There is a correlation between cash flows and earnings per share.

Sub-Hypotheses:
H1.a: There is a correlation between cash flows from operating activities and earnings per share.
H1.b: There is a correlation between cash flows from investing activities and earnings per share.
H1.c: There is a correlation between cash flows from financing activities and earnings per share.
H1.d: There is a correlation between net cash flows and earnings per share.

3. Data and research methodology

This section deals with a description of the study method, identifies the study population and the sample that was selected, and reviews the methods that were relied upon in collecting and preparing data. It also includes the statistical treatments that were used in the application of this study. The study relied on the quantitative analytical method. To achieve the objectives of the study and test its hypotheses, data were collected through secondary sources based on books, literature, scientific journals, articles, university studies and various sources related to cash flows and earnings per share to cover the theoretical aspect of the study. Finally, the financial statements of Daimler AG (Mercedes-Benz) during the period of 2010–2020 were relied upon to cover the practical aspect of the study.

With regard to data analysis, IBM SPSS Statistics 25 was relied upon to calculate correlation and regression analysis to find the relationship between the independent variables – cash flows from operating, investing, and financing activities and net cash flows – and the dependent variable of earnings per share. Kolmogorov-Smirnov analysis was also performed to find out the type of data, establish whether it follows a normal distribution, and determine the use of parametric or non-parametric tests, because parametric tests require that the data have a normal distribution.

4. Empirical results and discussion

Based on analysis of the data in the following tables – describing the variables, the correlation between them, R square, Adj R square, and coefficients – we can determine the relationship between the cash flows from operating, investing, financing, and net cash flows and the earnings per share.

Table 1. Statement of Cash Flows and EPS for Daimler AG (2010–2020)

Year	Independent Variables				Dependent Variable
	CF from **Operating** Activities (millions of €)	CF from **Investing** Activities (millions of €)	CF from **Financing** Activities (millions of €)	**Net** Cash Flows (millions of €)	Earnings Per Share (EPS), €
2010	8,544	−313	−7,551	1,103	4.28
2011	−696	−6,537	5,842	−1,327	5.32
2012	−1,100	−8,864	11,506	1,420	5.71
2013	3,285	−6,829	3,855	57	6.40
2014	−1,274	−2,709	2,274	−1,386	6.51
2015	222	−9,722	9,631	269	7.87
2016	3,711	−14,666	12,009	1,045	7.97
2017	−1,652	−9,518	13,129	1,091	9.84
2018	343	−9,921	13,226	3,781	6.78

2019	7,888	−10,607	5,628	3,030	2.22
2020	22,332	−6,421	−10,747	4,165	3.39

Source: *Annual Reports from 2010 to 2020 for Daimler AG (Mercedes-Benz)*

Table 1 shows the cash flows from operating activities, cash flows from investing activities, cash flows from financing activities, net cash flows, and earnings per share for 11 years from 2010 to 2020 based on the annual reports of Daimler AG. From this table, the highest net cash flows were in 2020 and the lowest in 2014; the highest EPS was in 2017 and the lowest in 2019.

Table 2. Descriptive Statistics

Variables	Mean	Std. Deviation	N
Cash Flows from Operating Activities	3,782,090,909	712,2981,475	11
Cash Flows from Investing Activities	−7,827,909,091	3,920,485,721	11
Cash Flows from Financing Activities	5,345,636,364	8,128,191,340	11
Net Cash Flows	1,204,363,636	1,847,742,583	11
Earnings Per Share (EPS)	6.0	2.18	11

Source: *Authors' calculation.*

Table 2 shows the standard deviation, mean, and number of observations of variables in this paper. It can be seen that the standard deviation for earnings per share is €2.18 and the mean €6. Regarding the independent variable of CF from operating activities, the mean is €3.782 billion and the standard deviation €0.712 billion. For the second independent variable, CF from investing activities, the mean is €−7.827 billion and the standard deviation €3.92 billion. The standard deviation for the third independent variable, CF from financing activities, is €8.128 billion – higher than its mean of €5.345 billion. The last independent variable, net cash flows, has a mean of €1.204 billion and a standard deviation of €1.847. Table 3 shows the correlation between independent variables, the dependent variable (EPS), and net profits is -0.783, which means a strong negative correlation. Table 3 consists of the correlations between the variables of the study.

Table 3. Correlations

Variables	Earnings Per Share	CF from Operating Activities	CF from Investing Activities	CF from Financing Activities	Net Cash Flows
Earnings Per Share (EPS)	1				
Cash Flows from Operating Activities (CFOA)	−.65	1			
Cash Flows from Investing Activities (CFIA)	−.34	.17	1		
Cash Flows from Financing Activities (CFFA)	.65	−.79	−.71	1	
Net Cash Flows (NCF)	−.37	.61	−.30	−.14	1

Source: *Authors' calculation.*

Based on the above table, the correlation between cash flows from financing activities and EPS is .65, a moderate positive correlation. A moderate negative correlation between cash flows from operating activities and EPS is evidenced by a value of −.65. There is a low negative correlation of −.34 between cash flows from investing activities and EPS; at the same time, a low negative correlation between the last independent variable, net cash flows, and the dependent variable (EPS) is shown. On the other hand, the correlation between the independent variables with each other based on this table is −.79. A strong negative correlation between CF from operating activities and CF from financing activities is evidenced. At the same time, the correlation of .61 is moderately positive between operating activities and net cash flow, but a negligible correlation between operating activities and CF from investing activities is shown. The correlation between CF from investing activities and net cash flows is −.30, a low negative correlation that means less of an impact than CF from operation activities, but at the same time more than the −0.14 negligible correlation between financing activities and net cash flows.

Table 4. Adj R square

				Change Statistics		
Variables	R Square	Adj R Square	Std. Error of the Estimate	F Change	df1	df2
CFOA	.419	.355	1.75524	6.499	1	9
CFIA	.113	.014	2.16936	1.146	1	9
CFFA	.427	.363	1.74422	6.695	1	9
NCF	.139	.044	2.13706	1.455	1	9

Model Summary[b]

b. Dependent Variable: Earnings Per Share (EPS)

Source: *Authors' calculation.*

Table 4 involved calculating Adj R square between each independent variable and EPS separately based on simple linear regression. The Adj R square between CFOA rates EPS is .355, which means that 35.5% of the variance in EPS (Dependent Variable) is explained by the CFOA variable (Independent Variable). Adj R square between the CFIA rates and EPS is .014, which means that only 1.4% of the variance in the EPS (Dependent Variable) is explained by the CFIA (Independent Variable).

Adj R square between CFFA and EPS is .363, which means that 36.3% of the variance in the EPS (Dependent Variable) is explained by the CFFA (Independent Variable), and this ratio is the highest among the independent variables. Adj R square for the last independent variable is .044, which means that only 4.4% of the variance in the EPS (Dependent Variable) is explained by the NCF.

Table 5. *Coefficients for Earnings per Share Regressions.*

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	6.778	.606		11.189	.000
Cash Flows from **Operating** Activities (CFOA)	−1.987E-10	.000	−.648	−2.549	.031
a. Dependent Variable: Earnings Per Share (EPS)					

Source: *Authors' calculation.*

Table 5 shows the linear regression equation to predict the value of Y (Earnings per Share – the dependent variable) in a given value for X (Cash Flows from Operating Activities – the independent variable) with sig = 3.1%. Therefore, confidence >95%, which means that the significance level is less than 5% in this case (accept the alternative hypothesis and reject the null hypothesis).

$$\text{EPS} = \beta_0 + \beta_1 \text{CFOA}_i + e_i \qquad (3)$$
$$\text{EPS} = 6.778 + (-1.987\text{E-10}) \, (\text{CFOA}) + e_i \qquad (3.1)$$

Table 6. Coefficient

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.560	1.518		3.004	.015
Cash Flows from **Investing** Activities (CFIA)	−1.873E-10	.000	−.336	−1.071	.312
a. Dependent Variable: Earnings Per Share (EPS)					

Source: *Authors' calculation.*

Table 6 shows the linear regression equation to predict the value of Y (Earnings per Share – the dependent variable) in a given value for X (Cash Flows from Investing Activities – the independent variable), with sig = 31.2%. Therefore, confidence <95%, which means that the significance level is more than 5% in this case (accept the null hypothesis and reject the alternative hypothesis).

$$EPS = \beta_0 + \beta_1 CFIA_i + e_i \qquad (4)$$
$$EPS = 4.560 + (-1.873E\text{-}10)\,(CFIA) + e_i \qquad (4.1)$$

Table 7. Coefficient

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5.088	.639		7.964	.000
Cash Flows from **Financing** Activities (CFFA)	1.756E-10	.000	.653	2.588	.029
a. Dependent Variable: Earnings Per Share (EPS)					

Source: *Authors' calculation.*

Table 7 shows the linear regression equation to predict the value of Y (Earnings per Share – the dependent variable) in a given value for X (Cash Flows from Financing Activities – the independent variable), with sig = 2.9%. Therefore, confidence >95%, which means that the significance level is less than 5% in this case (accept the alternative hypothesis and reject the null hypothesis).

$$EPS = \beta_0 + \beta_1 CFFA_i + e_i \qquad\qquad (5)$$
$$EPS = 4.560 + (1.756E\text{-}10)\,(CFFA) + e_i \qquad\qquad (5.1)$$

Table 8 shows the linear regression equation to predict the value of Y (Earnings per Share – Dependent Variable) in a given value for X (Net Cash Flows – the independent variable), with sig = 25.8%. Therefore, confidence <95%, which means that the significance level is more than 5% in this case (accept the null hypothesis and reject the alternative hypothesis).

$$EPS = \beta_0 + \beta_1 CFFA_i + e_i \qquad\qquad (6)$$
$$EPS = 4.560 + (-4.412E\text{-}10)\,(NCF) + e_i \qquad\qquad (6.1)$$

Table 8. Coefficient

Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	6.558	.781		8.402	.000
Net Cash Flows (NCF)	−4.412E-10	.000	−.373	−1.206	.258
a. Dependent Variable: Earnings Per Share (EPS)					

Source: *Authors' calculation.*

There is a difference between Table 9 and Table 4 regarding Adj R square between each independent variable and EPS separately based on simple linear regression. However, Table 8 involved Adj R square between all independent variables and EPS together based on multiple linear regression. The Adj R square between CFOA, CFIA, CFFA and NCF (independent variables) and EPS is 41.4%, which means that 41.4% of the variance in EPS (the dependent variable) is explained by the independent variables for this study.

Table 9. Coefficient

Model Summary^b							
Model	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
				F Change	df1	df2	Sig. F Change
1	.648	.414	1.67284	2.766	4	6	.128
a. Predictors: (Constant):							
Cash Flows from Operating Activities,							
Cash Flows from Investing Activities,							
Cash Flows from Financing Activities,							
Net Cash Flows							
b. Dependent Variable: Earnings Per Share (EPS)							

Source: *Authors' calculation (2022).*

Table 10 shows the multiple linear regression equation to predict the value of Y (Earnings per Share – the dependent variable) in a given value for (CFOA, CFIA, CFFA and NCF – the independent variables). The significance level is >5% for all independent variables, which means that confidence is <95% in this case (accept the null hypothesis and reject the alternative hypothesis).

$$EPS = \beta_0 + \beta_1 CFOAi + \beta_2 CFIAi + \beta_3 CFFAi + \beta_4 NCFi + ei \qquad (7)$$

Table 10. Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	6.194	1.389		4.460	.004
CFOA	2.052E-9	.000	6.689	1.557	.171
CFIA	2.187E-9	.000	3.925	1.550	.172
CFFA	2.274E-9	.000	8.457	1.679	.144
NCF	−2.458E-9	.000	−2.078	−1.730	.134
a. Dependent Variable: Earnings Per Share (EPS)					

Source: *Authors' calculation.*

The above table shows the results of regression analysis. First, the coefficient of the cash flows from operating on the EPS is statistically significant and negative, indicating that *H1.a* is accepted empirically based on Table 5. This result offers empirical support for the findings of the few prior studies that found there is a statistically significant correlation between the cash flows from operating and EPS or earnings (Bowen et al., 1986; Farshadfar, 2008; Hamshari, 2020; Ketz & Largay 1987). Second, the coefficient of the cash flows from investing with the EPS is not statistically significant and is negative, leading to the rejection of *H1.b* according to Table 6. There are no studies that investigate this relationship between cash flows from investing activities and EPS, but in general most of the studies indicate that the traditional measures for cash flows including investing activities have a relationship with earnings (Bowen et al., 1986). Third, there is a statistically significant and positive correlation between cash flows from financing activities and EPS based on Table 7, indicating that *H1.c* is accepted empirically. The result that supports the findings of prior studies is that there is a statistical significance between cash flows in general and earnings (Bowen et al., 1986; Farshadfar, 2008). Fourth, based on Table 8 the correlation between net cash flows and EPS is statistically significant and negative, leading to the rejection of *H1.d*. Finally, multiple regression based on Table 10 shows that there is no statistically significant relationship between the pillars of the statement of cash flows and earnings per share (EPS). It may be that these results conflict with some studies that focused on earnings only rather than earnings per share. At the same time, these results provide an important indicator for decision makers relying on the data of a leading group (Daimler Ag) in the market that has a long history of success and financial stability.

5. Summary and conclusion

Based on the results of this study, multinational companies should pay more attention to the statement of cash flows as one of the financial statements used to provide a solid basis for the process of comparing the performance of an entity or for comparing the performance of the same entity in successive financial periods. There must also be consistency between the growth rate in net cash flows and the profitability ratios of the company, and one of the most important of these ratios for investors is earnings per share. Multinational companies must provide sufficient transparency when preparing financial statements, especially the statement of cash flows. When preparing cash flows from operating activities, it is preferable to use the direct method because it discloses each source of cash and how it was spent in operating activities. This is also recommended by IAS 7, as the direct method provides useful information in estimating future cash flows. It is possible to re-conduct such a study that shows the relationship between cash flows and earnings per share by comparing more than one company and different sectors to verify that relationship. Researchers can also direct their studies towards the importance of cash flow statement metrics in making investment decisions.

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THE USE OF FINTECH AND ITS IMPACT ON FINANCIAL INTERMEDIATION – A COMPARISON OF SAUDI ARABIA WITH OTHER GCC ECONOMIES

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Abstract: *This study analyses the use of Fintech/digital finance in Saudi Arabia, comparing the use of various digital finance tools across other Gulf Cooperation Countries (GCC). The study uses the Global Financial Development Indicators Data from 2011, 2014, and 2018 published by the World bank. Graphical trend analysis, covariance, and correlation analysis are used to examine the role of digital payments, the use of the credit card, and use of the debit card to find out their impact on Fintech and the distribution of credit to the private sector. The results suggest that the use of financial technology is increasing in the GCC region, and the use of digital payments, debit cards, and credit cards have a linear dependence on each other and positively contribute to the distribution of credit to the private sector – hence, to financial intermediation in certain aspects. The results also show that Saudi Arabia is ranked four among six regional economies in terms of the use of digital finance. It is also observed that the country has potential for Fintech growth both in terms of supply and demand. To tap into this potential, regulators have introduced a regulatory sandbox to facilitate Fintech startups. Based on the evaluation, cooperation among traditional financial institutions, Fintech startups, technology companies, regulators, and academia could reduce the potential challenges and enhance Fintech in Saudi Arabia.*

Keywords: *Fintech, financial intermediation, Saudi Arabia*

JEL Classification: *G20, G 21, G29, Q25*

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1. Introduction

Rapid technological development, innovation, and evolution are significantly changing the lives of individuals and businesses. Businesses related to financial services and financial institutions are also influenced by this evolution. Blockchain, Cryptocurrencies, Smart contracts and Artificial Intelligence (AI) significantly alter traditional financial business operations. The use of these technologies in the field of finance results in neologisms such as Fintech (using technology in finance), InsurTech (using technology in the insurance business), RegTech (use of technology for regulation), and so forth (Anagnostopoulos, 2018; Rahim et al., 2018; Vives, 2017). These developments have significantly improved traditional financial services businesses. In light of these changes, it is inevitable to examine the use, adoption, and development of technology in the financial sector. Like in other countries, in the Kingdom of Saudi Arabia the Fintech industry is also in the infancy stage. Therefore, the evaluation of the use of various technologies in the financial sector, the adoption of technology from the side of both supply and demand, regulation issues particularly related to Fintech startups, and the impact of Fintech on traditional financial intermediation have significant importance for practitioners, policymakers and other relevant stakeholders.

Technology concentrates on innovations in the communication process and information collection. Communication includes the distribution of services and relationships with customers, while information emphasizes the collection of data and its processing. In financial intermediation, the primary concern is the "functional perspective" of financial intermediaries. The functional perspective in the literature is explained operationally in terms of providing financial services by the financial intermediary (Merton, 1995; Merton & Bodie, 1995; Allen & Santomero, 1997). According to Allen and Santomero (2001), financial intermediaries traditionally played a significant role in minimizing market frictions such as information asymmetry and transaction cost. They further argued that there has been a significant decrease in cost related to market imperfection due to the technological revolution that also increases intermediation in the economy. These intermediaries, particularly banks, provide financing for information-intensive and illiquid securities (Khan et al., 2021; Flannery, 1994). Intermediaries other than banks include insurance companies, pensions, and mutual funds. These financial intermediaries remove the informational barriers and facilitate investors receiving benefits from the markets.

Historically, there has been an evolution in the nature and importance of financial intermediaries such as banks to non-banking capital companies, insurance companies, pension funds, and mutual funds. Banks, as ancient financial intermediaries, channel funds from households to the economy in the form of various types of individual and commercial loans, facilitating the receiving and transferring of payments and also providing other financial services. Financial intermediaries at the epicenter of the financial system perform the function of reallocating the resources of economic units with surplus funds (savers) to economic units with funding needs, i.e., borrowers (Allen & Santomero, 2001, pp. 273). However, the banking industry has faced significant disruption to their business since the 2007–2009 financial crisis due to a decrease in interest income, stricter compliance and regulation requirements along with damage to reputation due to the failure of large banks (Vives, 2019). In addition to these threats, the use of technology and digital platforms in the financial services industry has also disrupted the financial sector. With the development of these tools, traditional banking is moving toward less physical

interaction among its customers. These tools not only help to deliver services to the customer but are also helping to collect a huge amount of data. Fintech or technology companies related to the financial sector are using artificial intelligence to process this big data. This has resulted in the emergence of non-financial companies delivering financial services through new digital platforms that are transforming traditional finance into digital finance. These platforms either directly provide financial services by using advanced technologies or play the role of facilitators between traditional banks on the supply side and customers on the demand side. These developments in technology and Fintech are evolving traditional banking models.

The use of technology in the financial sector is termed Fintech. According to the Financial Stability Board (n.d.), this is defined as "technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services." Another simple definition is provided by Takeda and Ito (2021) "financial innovation realized by information technology (IT)." These developments are influencing several areas of financial services. Even though there is competition between Fintech startups and traditional banks, both are working on common grounds: where traditional banks are adopting and investing in digital technologies, Fintech is providing various new platforms to the banking industry. As a result, technological development has reduced the cost of financial intermediation (Philippon, 2019). For instance, in an *ex-ante* evaluation, Fuster et al. (2019) reported that Fintech lenders were processing mortgage lending applications 20% quicker than traditional lenders in the USA.

Existing literature highlights that Fintech companies are not only more effective than traditional financial services providers, but also possess enhanced efficiency. However, the literature suggests that the reason for performance variation could be due to the difference in the regulatory framework of traditional finance and Fintech companies. In a traditional financial system, the central bank highly regulates the banking sector to ensure financial stability in the economy. On the positive side of Fintech, digital technologies can be applied to solve compliance and regulatory issues, i.e., the regulation of technology or "RegTech" (Vives, 2017). In this regard, at early stages regulators are introducing the *regulatory sandbox* that can facilitate new technological financial services platforms to operate in a specific environment with special regulatory treatment. Hence, with these developments, the role of financial intermediaries as per intermediation theory is evolving in terms of operations and regulation.

Like other economies, to promote Fintech and facilitate the use of digital finance in Saudi Arabia, the Saudi Central Bank (SAMA) has also introduced the regulatory sandbox as a safe space to experiment with financial technology products to promote Fintech in the kingdom. Fintech is in its infancy globally, and Saudi Arabia is no exception. Therefore, this study will explore the answers to the following research questions concerning the evolution of traditional financial intermediation due to technological development by examining the progress of digital finance usage in Saudi Arabia.

1. What is the current status of digital finance platforms in terms of service availability and performance in Saudi Arabia compared to other Gulf Cooperation Countries (GCC) countries?

2. What is the current market situation of Fintech in terms of the supply and demand perspective of the relevant industry in the region?

3. What is the current progress of the regulatory sandbox in Saudi Arabia?

As per the authors' knowledge, no study has examined the use and progress of digital finance and Fintech platforms in terms of performance and regulation both from the supply and demand side. Hence, it is believed that the findings of this study will help existing and forthcoming Fintech platforms to formulate a customer-centered, growth-oriented strategy to meet the demands of financial intermediation in Saudi Arabia. Moreover, this will lend a hand to regulators in revising the regulatory sandbox policies and establishing the procedures for the success of experimental Fintech platforms in the future. Finally, the evaluation of the current status of Fintech and suggestions for the expansion of financial intermediation through digital financial platforms along with traditional institutions will support the achievement of the objectives of the financial sector development plan (FSDP) of Saudi Vision 2030.

2. Literature Review

In the traditional banking system, banks play the role of financial intermediaries in the market to minimize transaction cost and information asymmetry. Due to banks, there has been a significant reduction in transaction cost and information asymmetry (Allen & Santomero, 2001, p. 272). The development of the internet at the beginning of the current century also contributed to the significant decrease in transaction costs. According to Khan et al. (2021), households deposit their savings with banks and banks deliver these funds to borrowers in the form of loans or investments. Traditionally, the development of financial intermediaries/the financial sector, particularly banks, was considered a prerequisite for economic growth because this developed sector facilitates the process of saving for households and converting these savings into investments (Boujlil et al., 2020). Hence, banks play an important role as suppliers of capital in an economy. As per Hoffmann (2011), banks' profitability is dependent on the efficiency of the financial system, which results in an improved supply of capital in the markets to satisfy the demands of capital.

Traditionally, banks provided services such as deposits, lending, clearance of checks and payments, mortgage loans, insurance, consultancy, and so forth. However, with the development of digital technology, there are advancements in lending, payments, financial advising, and insurance (Vives, 2017). Vives further argues that even though a major portion of payments are still dominated by banks, Mastercard, and Visa, innovations in the payment system are coming from non-banking firms such as Google, Apple, or PayPal. According to Zhu et al. (2016), financial innovation has brought traditional financial and digital (internet-based) institutions together, which are not considered rivals but are complementary to each other. According to Philippon (2015), for the USA in the last 130 years, "the annual cost of intermediation is around 2% of outstanding assets; the unit cost of intermediation has increased over the past 30 years." Moreover, the advancement in technology and its use in the financial sector results in the cost reduction of financial intermediation (Philippon, 2019). The disruption in financial services due to technological advancement is initiated by both the supply and demand sides of financial services.

According to the Financial Stability Board (2019, p. 5), Application Programming Interfaces (API), cloud computing, smartphone, mobile banking from providers, and licensing, supervision, and competition from the regulatory perspective are the factors that have an impact on financial innovation on the supply side (also see Vives, 2019; Vucinic, 2020). Meanwhile, customers' preferences and expectations affect it on the demand side – hence, demand is more

customer-centric. This development in digital technology and the resulting changes in financial services are contributing to access to formal financial services. Additionally, other technological instruments that have a significant impact on financial services include trading systems, equity crowdfunding, digital advisory tools, peer-to-peer (P2P) lending, Blockchain, and cryptocurrencies (Philippon, 2016; Thakor, 2020).

According to Thakor (2020), Fintech broadly covers the areas of credit, deposits, investments, payments, settlements, trading, insurance, and digital currencies. Based on data from the Bank for International Settlements (BIS) 2018, Thakor (2020) reported that payments, settlements, and clearing services dominated Fintech services. These payments and settlements were performed using digital wallets (such as PayPal) and cryptocurrencies such as Bitcoin. According to Ernst and Young (2019), the global adoption rate of Fintech was 75% in 2019. It is further highlighted that, in terms of category, adoption payments and money transfers were at the top, with an adoption rate of 74%, followed by insurance, savings and investments, and budgeting and financial planning. Borrowing was adopted at a rate of 27%, the lowest of the Fintech categories in 2019.

As discussed earlier, one of the advantages of financial intermediation is to minimize information and transaction cost. Vives (2017, 2019) proposed that transactions and payments are more exposed to information processing; therefore, they could be affected by Fintech. The technological tools that usually use big data are Machine Learning (ML) and Artificial Intelligence (AI), as they can process information quickly and efficiently. Hence, the potential biggest disruption that Fintech could bring to financial services could be in the payments system (Thakor, 2020). Rysman and Schuh's (2017), study on innovations in payment services concluded that during the last four decades there has been significant digitization and innovation in payment systems, and reported that the three significant innovations are mobile payments, digital currencies, and real-time payments (also see Philippon, 2016). Mobile payments are already popular in emerging economies, particularly in Asia and Africa. According to Zhu et al. (2016), due to the development of the internet, the participation of technology and non-financial companies is increasing and challenging traditional financial institutions. They further elaborated that even the operations of traditional financial institutions are dependent on IT. Hence, Fintech startups, technology companies, and traditional financial institutions are indispensable to each other.

The existing literature also proposes that Fintech is also important for dispatching formal financial services to the majority of the population – i.e., financial inclusion. Studies have shown that mobile payment platforms – for instance, M-Pesa, operating in Kenya, Tanzania, and South Africa, and many others in different countries – have significantly contributed to this. Ozili (2018) reported that financial service users can significantly benefit from digital finance and financial inclusion. However, after the global financial crisis of 2008, the evolution of Fintech is seen as a potential factor for risk and financial instability among academics and practitioners. According to Arner et al. (2015), the change brought about by Fintech startups is creating challenges for regulators of market participation, and the suggestion is that it is too early to formulate rigid regulation. On the contrary, in the context of the traditional financial system authorities have imposed various regulations to control the inherent instability of the financial system, particularly from the central bank (Minsky and Kaufman, 2008). This disruption in financial system technological change is suggested to be controlled by Regulation Technology (RegTech). RegTech

refers to a sub-division of the Fintech sector that focuses on technologies that may facilitate the delivery of regulatory requirements more efficiently and effectively than existing capabilities (Anagnostopoulos, 2018). Researchers have inconclusive views about the regulation of Fintech, with Weihuan et al. (2015) suggesting regulating financial technology but pointing out that balanced regulation to achieve the sustainability of digital finance is challenging. Arner et al. (2015) suggested that RegTech will increase the workload of the regulatory agency, slow down innovation, and have limited benefits. Likewise, Anagnostopoulos (2018) argued that strict central bank regulation somehow contributed to the current technology and working environment of banks. It is also pointed out that banks, either due to their stable business or complicated regulation, are less innovative, and that policymakers are not concerned about the technological development but the application of that technology in financial services.
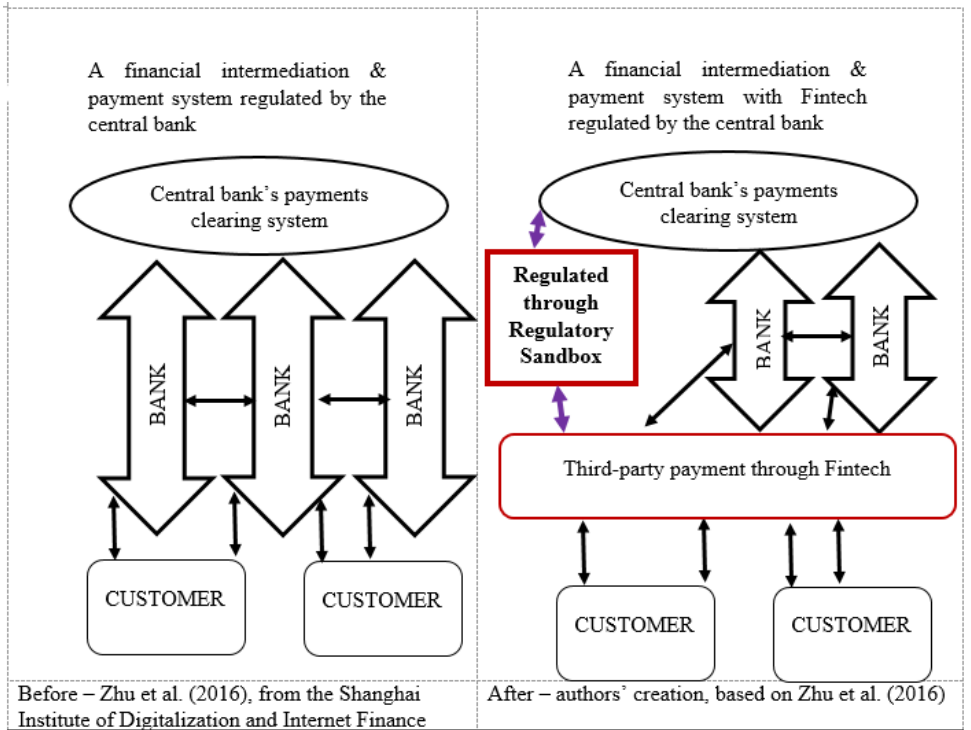
Figure 1. Model of payments and financial intermediation before and after the regulatory sandbox

According to Barefoot (2015), the process and players in Fintech are new and highly dependent on technology and data, and their novel products may become obsolete by the time regulators introduce regulation for the product. To address this, Arner et al. (2015) argue that the companies that develop financial technology can not only help the financial institutions to adopt

it but also facilitate regulators in regulating it. To support Fintech, create a suitable environment for its growth, and minimize obstacles, countries around the globe have adopted the regulatory sandbox concept. According to Bromberg et al. (2017), the objective of establishing a regulatory sandbox is to facilitate Fintech startups in receiving special treatment in regulation, which includes conditional relief from regulatory procedures with exemption from obtaining a financial services license. According to World Bank (2020) data, to provide a dynamic and evidence-based environment to test emerging technologies, regulators around the globe are using the regulatory sandbox idea for the development of Fintech. As per this data, around 56% of sandboxes were created between 2018 and 2019. As cited in Zhu et al. (2016), based on the model of payments and financial intermediation of the Shanghai Institute of Digitalization and Internet Finance, this study modifies their model into the model presented in Figure 1 for payments and financial intermediation in the presence of a regulatory sandbox.

In the traditional intermediation model, multiple customers and multiple banks interact with each other and the central bank plays the central role of completing and clearing payments. The central bank lays down the guidelines for the banks to keep stability in the financial system and to have trust in the payment system while protecting customers' interest and increasing their trust in the system. Boot et al. (2021) argue that the financial system transforms savings into investment, and financial intermediaries overcome information asymmetry and use communication to match supply and demand. In the traditional setup, storing and extracting information may consume more time, but the advancement of technology through the use of big data and AI can store and retrieve information very quickly. Moreover, in the above model, this study also endorses Arner et al. (2015), as Fintech startups not only provide services to customers independently or through financial institutions but can also facilitate the formation of regulation that can maintain financial stability and protect customers from exploitation.

3. An Overview of Fintech in Saudi Arabia

Saudi Arabia is one of the largest economies among the GCC, and one of the major emerging economies in the G20. According to the World Bank 2021 report, the total GDP of the country was 833 billion US dollars. According to SAMA, the total assets of the banks at the end of 2020 were 2,979 billion Saudi Riyal (SAR), which will increase to 4,553 billion SAR in 2030 as per the projection of the FSDP program charter for the year 2021. Hence, it is predicted that the financial sector has strong potential for growth and contribution to the kingdom's economy. The use of the latest technology in the financial sector is not new in the country. SAMA has introduced the Saudi Payment Network (SPAN; known as MADA in 1990) to electronically facilitate payments, make deposits, and encourage customers to use formal banking channels. As per SAMA, the initial objectives have been achieved, and the total point of sales (POS) has increased from 1,274 in 1993 to 721,060 at the end of 2020 (Saudi Central Bank, 2020).

Following in the footsteps of the UK and the USA, SAMA introduced the regulatory sandbox in 2019 to address the regulatory issues faced by innovators and financial institutions in the evolving financial landscapes. The primary objective was to provide a suitable environment for innovative firms to test their ideas. Since its inception, SAMA has issued experimental licenses to seven digital payment platforms, four digital savings platforms, nine crowdfunding platforms, and four micro-lending platforms under this regulatory sandbox (Saudi Central Bank, n.d.). To

further enhance the adoption of the latest technology for financial services, SAMA launched Fintech Saudi in 2018 with the Capital Market Authority (CMA), intending to transform Saudi Arabia into an innovative Fintech hub.

According to the Fintech Saudi (2021a, p. 16) annual report of 2020–2021, the average investment size in Fintech in the kingdom is $2.7 million, compared to the global average of $7.3 million. This report also highlights that the number of active Fintech startups in the country has increased from ten in 2018 to 82 at the end of 2021. Among these, 26% are fully active or operating under the testing license, 32% are at the pre-commercial stage, and 42% are at the registration stage. The survey by Fintech Saudi (2021b) in 2021 reported that 80% of individuals aged 16–39 have used Fintech solutions, and usage decreases to an average of 65% in the 40–60 age group. This survey further reported that, among Fintech solutions, E-payments dominated, occupying 69% of Fintech platforms. This was followed by insurance at 21%, 16% for online budgeting, and 14% for equity crowdfunding. With the emergence of Fintech, most customers rarely physically visit their banks. Moreover, one of the pre-requisites for the use of Fintech is access to technology – especially the internet. As per the World Bank, by the year 2020, 97.6% of the population had the access to the internet. Thus, from the points of view of users and the availability of resources, there is huge potential and room for growth in said sector, but with certain limitations. Figure 2 shows the number of Fintech and total startups in the GCC countries, as per *The Fintech Times* (2021) report on Fintech in the Middle East. These figures suggest that Fintech and the total number of startups in Saudi Arabia lag behind the United Arab Emirates (UAE) among GCC economies.
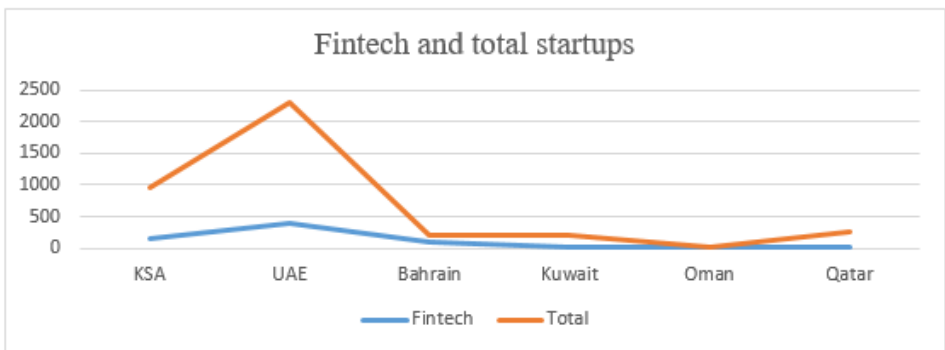
Figure 2. Fintech and total startups in the GCC economies
Source: *Authors' own depiction based on The Fintech Times (2021).*

4. Research Design and Data

To understand the use of digital finance and the development of Fintech in Saudi Arabia, this study employs graphical trend analysis, covariance, and correlation analysis to explore the linear dependence of various payment methods by using the data published by World Bank Global Financial Development Indicators (GFDI). The also evaluates the Fintech startups oper-

ating in Saudi Arabia in comparison to the findings from the GFDI. The data that was published in 2011, 2014, and 2017 is used to compare the use of digital finance tools in Saudi Arabia to the other GCC countries to explore the current status of financial technology adoption. Furthermore, the findings are used to examine the status of the ongoing progress of Fintech startups in Saudi Arabia.

4.1 Variables

Following the study of Ozili (2020) that explored the use of digital finance in Saudi Arabia, this study uses the variables from the World Bank GFDI. Variables are taken from all GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) for a meaningful comparison of the use of digital finance in Saudi Arabia among the regional economies. The variables used in the study are provided in Table 1. According to Fintech Saudi (2021a), payments dominate investment in the area of Fintech – around 93% of investments were made into payments related to Fintech platforms. Hence, the GFDI indicators study uses the variables that are related to financial service payments using financial technology during the period. This includes the percentage of the population within the 15-plus age group who use various digital/electronic platforms to make payments.

Table 1. Variables

Variables	Detail
DP	Percentage of users aged 15+ who use digital payment modes for payments
PCG	Private credit by deposit money banks (percentage of GDP)
PSDC	Domestic credit to the private sector (percentage of GDP)
DC	Percentage of users aged 15+ who use debit cards, digital payments
CC	Percentage of users aged 15+ who use credit cards, digital payments

Source: *Adopted from Ozili (2020) study and data taken from World Bank (GFDI)*

4.2 Methodology

This study adopts a similar methodology to Ozili (2020), and uses graphical, covariance, and correlation analysis to provide a quick understanding of the linear relationship and co-movement of the financial indicators. The Pearson correlation coefficient is used to measure correlations, highlighting the linear relationship between two variables and the strength of the relationship, while covariance is used to find out the direction of the relationship – i.e., how two variables move together (Ozili, 2020; Gujarati, 2009).

5. Results and Discussion

5.1 Graphical and trend analysis

Figure 3 presents the graphical analysis of the use of credit cards for payment purposes. Out of the six GCC economies, data from Oman and Qatar is available in the GFDI only for 2011. Other countries' data is available for 2017 at the latest. In 2017, Bahrain had the highest percentage of credit card use, followed by the UAE. In Saudi Arabia, 17% of the 15-plus population used credit cards for payments. Although the use of credit cards increased compared to 2014, the proportion was still low compared to the other regional economies. The use of debit card graphical analysis for the 15-plus age group among the GCC countries is given in Figure 4. These results show that the use of the debit card for payments is very common in GCC countries. The average proportion of the use of the debit card for payment is more than 75% for Bahrain, Kuwait, and the UAE, while Saudi Arabia had 67%, the lowest proportion among all GCC countries. No data is available for Qatar and Oman. Figure 5 reports the percentage of the population using digital modes for payment purposes in the GCC.
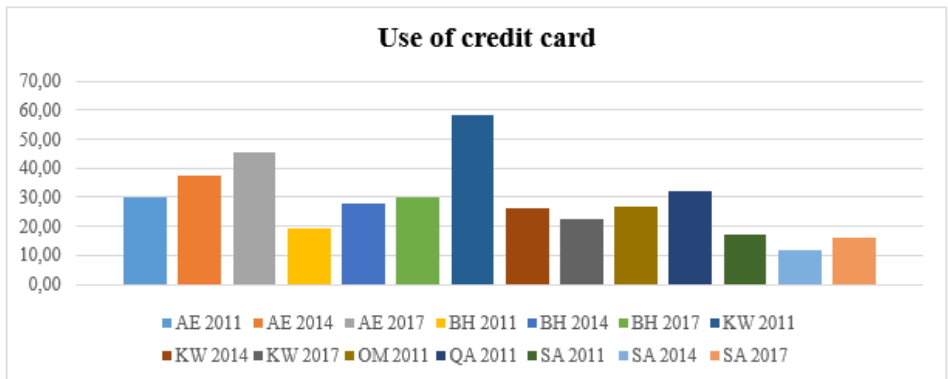
Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.

Figure 3. Graphical analysis of the use of credit cards among GCC countries
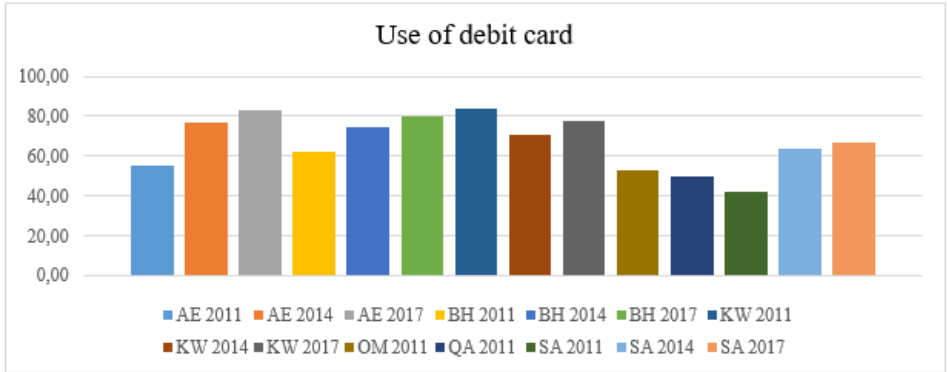
Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.

Figure 4. Graphical analysis of the use of debit cards among GCC countries

Digital/electronic payment data is available for only four countries for the years 2014 and 2017 – the UAE, Bahrain, Kuwait, and Saudi Arabia. The results show that Saudi Arabia lagged behind all these countries, with around 50% of the population using electronic modes of payments while the others had proportions of 60% and more.
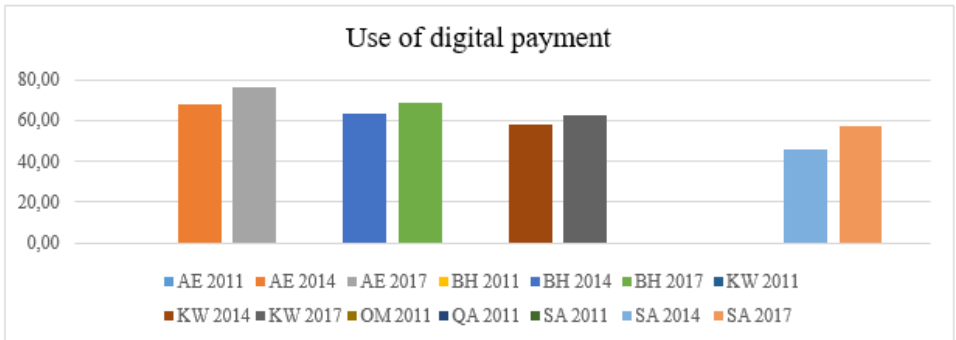
Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.

Figure 5. Graphical analysis for using digital modes of payment among GCC countries

5.2 Test of dependence (covariance) for different methods of payments

Covariance analysis was used to establish the time-varying linear movement or dependence of digital payments, debit card and credit card use in GCC countries. *Covariance* measures the amount of linear dependence between two random variables; a positive covariance means two random variables move in the same direction, while opposite directions implies negative covariance (Wooldridge, 2015, p. 680). Table 2 presents the use of credit cards in these economies. The covariance analysis suggests that the use of credit cards in Saudi Arabia is associated with all GCC economies except Bahrain and the UAE. These results are similar to the results of Ozili's (2020) study on the use of digital finance in the UK, USA, India, and Nigeria. Based on a similar interpretation, the results of this study suggest that an increase in the credit card payment system in Saudi Arabia will positively increase the use of credit cards in Kuwait, Qatar, and Oman.

Covariance analysis of the use of the debit card in GCC economies is presented in Table 3. The covariance analysis of debit card use in the region suggests that there is a negative linear relationship between the use of debit cards in Saudi Arabia, the UAE, Kuwait, and Bahrain.

Table 2. Covariance analysis for Credit Cards among GCC countries

	AE	BA	KU	OM	QA	SA
AE	39.85396	26.86231	−91.2439	69.44862	84.2932	−1.32298
BA	26.86231	20.36169	−71.8357	37.74124	45.8084	−4.48209
KU	−91.2439	−71.8357	256.2507	−117.453	−142.559	19.47791
OM	69.44862	37.74124	−117.453	157.4721	191.1316	12.12689
QA	84.2932	45.8084	−142.559	191.1316	231.9858	14.719
SA	−1.32298	−4.48209	19.47791	12.12689	14.719	5.757956

Source: *Authors' calculation from GFDI data of 2011, 2014, and 2017 (Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.)*

These results are similar to the findings of Ozili (2020), suggesting that if the use of the debit card increases in one economy it will decrease in another economy. Hence it can be assumed that the use of the debit card in inter-country markets is less developed in the region. The covariance analysis of the use of digital payments among GCC economies is given in Table 4. The results show a positive linear co-movement dependence among all economies, which means that the use of electronic payments among all the economies is well developed and is showing a developing trend. The data on Qatar and Oman is not available on GFDI for the use of credit cards. However, in other economies, it can be inferred that the use of financial technology is not only increasing in the domestic markets but also has a significant impact on cross-border payments in the GCC regional economies.

Table 3. Covariance analysis of uses of debit cards among GCC

	AE	BA	KU	OM	QA	SA
AE	138.9827	87.90061	−46.0431	196.7849	183.7921	127.8324
BA	87.90061	55.89696	−26.9514	134.7043	125.8104	80.32857
KU	−46.0431	−26.9514	30.74836	8.0104	7.481511	−46.0639
OM	196.7849	134.7043	8.0104	624.4578	583.2278	163.4475
QA	183.7921	125.8104	7.481511	583.2278	544.72	152.6558
SA	127.8324	80.32857	−46.0639	163.4475	152.6558	118.4673

Source: *Authors' calculation from GFDI data of 2011, 2014, and 2017 (Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.)*

Table 4. Covariance analysis for digital payments among GCC countries

	AE	BA	KU	OM	QA	SA
AE	1167.855	1067.529	972.536	0	0	841.475
BA	1067.529	976.5717	889.5462	0	0	766.9348
KU	972.536	889.5462	810.297	0	0	699.0683
OM	0	0	0	0	0	0
QA	0	0	0	0	0	0
SA	841.475	766.9348	699.0683	0	0	613.0749

Source: *Authors' calculation from GFDI data of 2011, 2014, and 2017 (Notes: AE denotes United Arab Emirates, BH denotes Bahrain, KW denotes Kuwait, OM denotes Oman, QA denotes Qatar, SA denotes Saudi Arabia.)*

5.3 Correlation analysis

The pairwise correlation of the variables is presented in Table 5, and the results show that all variables are positively correlated with each other and the relationships are significant. The use of all digital finance or alternative financial instruments, such as the use of debit, credit cards, and electronic/digital payments, have a positive influence on each other. Moreover, the use of these methods also shows a positive impact on the proportion of private credit by depositing money to banks, and domestic credit to the private sectors increases as a proportion of GDP. These results predict that the use of financial technology is increasing in the GCC, resulting in financial deepening. The use of financial technology is also positively contributing to the increase of deposits and converting these deposits into credit for the private sector.

To examine the progress and use of digital finance and the dependence of variables in the case of Saudi Arabia, the pairwise correlation is calculated and presented in Table 6. These results indicate that the use of credit cards is negatively associated with other variables, showing that the use of financial technology is negatively affecting the use of credit cards in Saudi Arabia unlike the results of other GCC economies given in Table 5. Additionally, the use of alternative payment tools such as electronic payments and debit cards, financial access to private sectors, and deposits, have a positive influence on each other. Hence, the graphical analysis, covariance, and

correlation analysis indicate that the use of alternative finance/financial technology is increasing in the GCC. Digital finance tools or Fintech are growing in the region and are contributing positively to the financial services sector. These results also indicate that the use of digital finance and its related financial services sectors in Saudi Arabia are relatively less developed compared to the other GCC economies, especially Bahrain, the UAE, and Kuwait, even though it is the largest economy in the region.

Table 5. Pairwise correlation between the digital finance variables

	Credit card	Debit card	DP	PCG	PSDC
Credit card	1				
Debit card	0.8277***	1			
DP	0.3427	0.6657***	1		
PCG	0.6339***	0.7819***	0.4592**	1	
PSDC	0.443*	0.6369***	0.3937*	0.7953***	1

Source: *Authors' calculation from GFDI data of 2011, 2014, and 2017 (***, **, * present level of significance at <1%, 5%, and 10% respectively.*

Table 6. Pairwise correlation between the digital finance variables for Saudi Arabia

	Credit card	Debit card	DP	PCG	PSDC
Credit card	1				
Debit card	−0.4896	1			
DP	−0.4208	0.9970**	1		
PCG	−0.1236	0.9258	0.9522**	1	
PSDC	−0.1236	0.0.9258	0.9522	1***	1

Source: *Authors' calculation from GFDI data of 2011, 2014, and 2017 (***, **, * present level of significance at <1%, 5%, and 10% respectively.*

From the GFDI data, it has been observed that payments dominate the use of financial technology and there is a significant decrease in physical cash payments. Likewise, as per the Fintech adoption survey by Fintech Saudi in 2021, Fintech has significantly disrupted payments in Saudi Arabia. This survey reported that 91% of respondents know about alternative modes of payments and 69% are using electronic or digital payments, making it the largest contributor to the adoption of Fintech in the country. The survey also highlighted that 65% of individuals and companies give top priority to payments and seek more support in this area (Fintech Saudi, 2021b). Apart from traditional banks adopting financial technology, SAMA has issued permissions to seven banking and non-banking firms in the area of digital payments under the umbrella of a regulatory sandbox. The following companies are operating under said regulation: Sure, foodics, Skyband, Saudi Fintech company (Alinma pay), and the digital international cash

company AZM Fintech CO. As this permission is for an experimental period, financial data or information about the success, failure, or challenges faced by these firms are yet to be identified. The permitted Fintech companies are predominantly in the area of crowdfunding, followed by payments. Based on the analysis of GFDI data used in the study and the results reported by the Fintech Saudi 2021 survey, it can be concluded that the country has huge potential on the demand side, and the number of permitted companies depicts the interest in the area of Fintech from investors, contributing significantly to the supply side. Additionally, the country has the resources and infrastructure to enhance the adoption and development of Fintech. On the other hand, the same survey pointed out that the availability of a number of individuals with relevant skills and experiences is the main barrier that the industry faces.

Apart from SAMA, the CMA has also issued experimental licenses under the Fintech Lab initiative to 16 companies in the area of Robo-advisory, equity crowdfunding, offering investment in debt instruments, social trading, and real estate (Capital Market Authority, n.d.).

6. Conclusion

This study evaluates the use of digital finance/financial technology in Saudi Arabia. It uses the graphical/trend analysis with covariance and correlation analysis of various digital payments tools by using the GFDI data published by the World Bank in 2011, 2014, and 2017. To examine the progress of digital finance in Saudi Arabia, a comparison is made against the GCC countries. The findings suggest that the use of financial technology has increased across the whole GCC, and different payment methods, such as the use of digital payments, debit cards, and credit cards, have a significant positive association with each other. Moreover, these factors are also contributing to the growth of credit to the private sector in proportion to GDP in the region. The covariance and correlation analysis suggests that the use of technology is positively contributing to various financial services such as payments through debit and credit cards. This association could contribute to the enhancement of these financial services, and could further positively influence the other types of financial services such as the growth of credit to the private sector.

Hence, it is predicted that financial technology is also contributing to financial intermediation through non-bank Fintech startups. This means that the use of technology in the financial sector not only increases the access of individuals to financial services, but also increases access to formal financing for small and medium enterprises. Among six GCC economies, based on the availability of data, it is concluded that Saudi Arabia ranks fourth in the adoption of Fintech. However, it is observed that Fintech is in its early stage of take-off in the country compared to the more developed economy. In this regard, the two regulators, SAMA and CMA, have permitted various Fintech startups to enter the market under the umbrella of a regulatory sandbox. Based on the findings of this study, it is suggested that regulators should facilitate more Fintech startups focusing on financial services rather than payments.

The success, failure, or challenges faced by these Fintech startups are yet to be identified. However, based on the experience of other economies it is suggested that collaboration between industry, academia, and regulatory bodies is desired. Moreover, there should be cooperation between traditional financial institutions, technology firms, and Fintech startups to address current and potential issues in the relevant field. It is assumed that the findings of this study will lend a hand to Fintech startups and traditional financial institutions in observing the current status of

the industry along with its future potential. Moreover, these findings will also help policymakers and regulators to formulate Fintech growth-enhancing policies to align their objectives with the FSDP of vision 2030 in the country. Development in the financial sector will also diversify the economic sectors and decrease the dependence of the economy on the oil sector.

Even though the use of digital finance is growing and the market has growth potential from the sides of both supply and demand, currently the industry is in its infancy in the country. The evaluation of the use of digital finance and regulatory issues, with more comprehensive data on other advanced financial products provided by Fintech companies with advance methodological frameworks, is suggested in the future.

Funding

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PERFORMING ARTS CREATION UNDER INEQUALITY: HOW GOVERNMENT SUBSIDIES IN SPAIN PERPETUATE THE *STATUS QUO*

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Summary. *As economic inequality continues to deepen in the developed world, its ramifications in the social sphere are becoming more apparent. In a context of both public and private belt-tightening, the arts have seen a general decline in terms of cultural offerings, public funding available, and viewership and public participation. In this paper we focus on how the public sector in the Valencian region in Spain is channeling funds to stimulate the production of cultural offerings to make up for the deficiencies in the allocation of resources by the market. Our research focuses on the grants allocated for creation in the performing arts by the Valencian government during the 2016–2020 period, analyzing how the various programs perform both in terms of how the money is spent and how it is distributed, in order to ultimately gauge whether they contribute to their stated goal of mitigating inequality and providing broader and better cultural offerings. We find that although funding has continually risen and even doubled in a four-year period, its allocation is highly unequal and disproportionately rewards the already large and consolidated players. This goes against the stated goal of the policy and perpetuates the inequality of the performing arts ecosystem at large. We conclude with some general recommendations on how to move forward in guaranteeing a robust arts environment for artists, arts creators, and the general public.*

Keywords: inequality, performance arts, grants, public funding, art creation.

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1. Introduction

1.1. *How the art world reflects inequality in society at large*

The world is at its most unequal since the gilded age, especially in the developed world. This exacerbates the deep imbalances in the opportunities and choices people have – imbalances which go beyond income and into the realm of education, health, voice, access to technology, and exposure to risk (United Nations Development Programme, 2020). Though the art world is no stranger to inequality, the drift toward higher austerity and a diminishing middle class has repercussions that are severe and far reaching: an impoverished public and generally less demand for cultural offerings; artists that undergo long periods of job insecurity and spend more time trying to secure funding than in arts creation; and a public sector that is unwilling or unable to lend support. How to tackle these issues is a challenge in which there are fundamental knowledge gaps. Art plays an important role in society, perhaps a role that is frequently overlooked. First and foremost, it functions as a powerful way to express oneself, and also as a way to connect with others. It allows people from different walks of life to see life from a different perspective and it makes everyone feel alive (Kabanda, 2019).

Art has been used as a tool for cultural exchange, education, and expression. In today's day and age, the arts industry mirrors the inequality of the world at large. This can be seen in how artists are compensated for their work and the public funding available to create and produce new material. When it comes to arts funding, the underlying logic is centered on profit, mostly providing financial backing for blockbuster movies, top recording artists, and best-selling books (Schiffrin, 1999). Likewise, the distribution structures of the leading commercial chains promote swift stock rotation, while sales become concentrated around leading artists (Ivey, 2008). When it comes to the music industry, there is a tendency for musical preferences to be socially determined and, as a consequence, highly skewed toward a relatively small group of musicians. This likely reinforces network effects, which means in the end most of us listen to the same music, contributing to the overall winner-takes-all dynamic in which the top 1% of performers take in around 60% of all income (Krueger, 2019).[2]

Other studies have traced the linkages between neoliberal austerity and the inequality that permeates into the fine arts world. Kristina Kolbe researches how wider inequalities exacerbate the unequal distribution of resources, from arts funding to institutions' programming practices (Kolbe, 2022). Drawing on interviews with gallery directors, museum curators, art consultants, and artists, she maps out how austerity politics and intensifying privatization processes have a profound impact on the workings of the sector, recalibrating dynamics between private and public artworlds, and shaping processes of production and curation. Under the present conditions of financialized neoliberalism, she documents how increasing economic precarity brings into relief structural inequalities of gender, race and (post)-colonial legacies already manifesting in the artworld.

A compounding factor is that cultural employment is precarious by nature. Generally there is seasonal employment as well as a high share of self-employed people, and only a minority share of full-time employment, which limits the feasibility of a career dedicated to the arts (Throsby,

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[2] A number higher that the GINI index of most advanced economies.

1994). In 2018, some 86% of employees in the EU-28 had a permanent employment contract, while less than two-thirds of all artists and writers in Spain (64%) and Poland (65%) had a permanent contract. In France, this share was particularly low (60%), compared with the share of employees across the whole national economy with a permanent contract (83%). Gaps of 10% were also registered in Belgium, Malta, Italy, Ireland and Sweden. There are many different strategies from the public sector that try to mitigate these problems, and they all involve some sort of public-private partnership to stabilize the artist's income and working conditions.

1.2. The economic and cultural value of art

When analyzing the value of art in the modern world, it constitutes an activity that is relevant on two levels: both as an economic activity and for its cultural value. As was previously mentioned, the arts can enrich people's lives in monetary ways by providing jobs that people have reason to value, enhancing meaningful social capital, and unlocking people's imagination. This dual economic and cultural dimension is sometimes presented as a dichotomy that confronts two apparently antagonistic ways of understanding performing arts, depending on whether their economic relevance or their cultural contribution is emphasized: at both extremes, the performing arts is either seen as an industry or as a public good that functions as a provider of culture. The economics profession, which informs much of public policy, has yet to appreciate culture, and hence consider its importance in regards to meaningful growth and development (Krueger, 2019). The underlying motivation of economic life is mostly tied with greed and the blind pursuit of money. Economics recognizes that people are motivated by much more than material gain, but refuses to dig deeper into how to incorporate this fact into economic theory and especially public policy. On the other hand, the definition most widely and usefully employed by the art world itself is that the arts exist for the enjoyment and enrichment of life, *ars gratia artis* (Galbraith, 2017). Emphasizing one or the other dimension has consequences on the type of policies that public powers can deploy to promote the performing arts, both in the definition of objectives and in the mobilized instruments.

Focusing on profit as a metric for financial backing is however deeply controversial and its economic sense is also in question. Because of this, in Europe cultural policy sets off to counter market pressure and promote access to new cultural forms, encouraging audiences to discover new art forms for which they may develop an appreciation. A reorientation of public policies concerning the creative and cultural industries is occurring, but this policy choice, even if it appears to offer certain strategic opportunities to the artistic and cultural sector, seems nevertheless to involve serious risks for cultural creation. The main risk involved is that there is an increasing instrumentalization of artistic and cultural activities, which are used for ends which are at least partly foreign to them (in particular, to economic and diplomatic ends). Furthermore, it risks accentuating the trend of concentrating public and private funds on the most prominent arts institutions, thereby threatening to deepen a trend towards a two-tier system and further inequality (Tobelem, 2013).

1.3. Public support for performing arts creators

Sustaining culture as an actor that stimulates economic and social development has become a European Union goal since the Lisbon Treaty introduced culture as both a factor of creativity

and a catalyst for economic growth and employment that is able to improve the whole econom-ic fabric. From a non-economic, sociological perspective, social scientists like Pierre Bourdieu remarked how long-lasting inequalities in the way people access culture are reproduced and per-petuated in successive generations. This critique has become a centerpiece in French cultural policies, in which making culture more accessible is the main goal, through concepts of cultural democratization, cultural diversity, or culture for all. There is, in this regard, a relative conver-gence between the French, Anglo-Saxon and Spanish approaches to public culture funding, even though their traditional financing models are based on opposite grounds, with relative suspicion against the strong implication of the State in the United Kingdom, as opposed to a historically strong demand for public financing in France and Spain, albeit in a more decentralized manner in the latter (Doustaly, 2007). This correlates to marked disparities between them in terms of the amount of public funding being given, which represents around 1% of the French budget and a mere 0.35% of the total state budget in the United Kingdom (Pflieger, 2012). In the Spanish case, this figure stands at a constant 0.25% throughout the last five years, though local governments complement this figure with their own contributions.[3] In more general terms, public funding for the arts in France amounts to €230 per inhabitant, compared to £22.6 in 2009–2010 in the United Kingdom and €34 in Spain in 2021 (National Campaign for the Art, 2020; Government of Spain, 2020).[4]

The disparity in public funding is however reversed when looking at the private sector contributions to the arts. The financial crisis of 2008 that battered many European economies had devastating effects on cultural policy, and cultural institutions began to diversify their sources of income by seeking private donors, encouraged by their own governments (Tobelem, 2013). To this end, governments started implementing favorable tax regimes to encourage patronage and philanthropy. Sponsorship in France is highly promoted by the State, and encouraged by attrac-tive tax laws, which are possibly the most attractive in the world (Pflieger, 2012). In spite of this, sponsorship and the creation of foundations have remained limited in France, compared to the United States or the United Kingdom. Compared to 30,000 foundations in the cultural sector in the United Kingdom, France only totaled 1,800 foundations in 2010. The comparison with the United Kingdom throws light on a different funding allocation: cultural sponsorship in France was about 18% of government funding in 2012, whereas in the United Kingdom it was roughly similar to the government endowment (Doustaly, 2007). In Spain, corporate sponsorship has been acquiring an increasingly important role in the financial structure and internal organization of large cultural facilities, though it still remains relatively marginal in comparison to traditional public funding in all but the largest cultural institutions (Rubio-Arostegui & Villarroya, 2021).

Among the professionals who work in the performing arts we have authors, performers, directors, lighting technicians, sound technicians, set designers, researchers, managers, program-mers, exhibitors, and more. A central piece and starting point of all production in the performing

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[3] In our case study, the Valencian government spends around 0.6% of its budget on culture.

[4] These figures must be taken as a rough estimate, as they come from different budgets referring to different years and because they do not take into account transfers between different administrations (as the State gives a global endowment to local authorities and there are transfers between them). Furthermore, these comparisons can be problematic, as there is no uniform definition of the scope of culture and hence accounting for its funding varies widely. Cultural policy in all nations is fragmented, with funds or laws passed down from different departments or government agencies, but some nations' policies are more fragmented or pluralistic than others (Alexander, 2008).

arts are the creators. These are the agents who devise and make up the project from the outset, which must culminate in its staging in front of the public (Boorstin, 1992). Policies that support artistic creation are configured as complex and multidimensional tools that combine different perspectives. Support for creation includes support for the artist(s), the conditions of their artistic production and the dissemination and/or marketing of their work; and is specified in a series of main project lines, such as purchase funds, grants, scholarships and prizes, along with direct aid to associations and private support funds. Taking into account the particular characteristics that we have previously discussed of creative and artistic activity in general, the performing arts constitute an economic activity that does not fit easily into labor, fiscal or social protection regulatory frameworks. The nature of the work itself, the irregularity and sometimes unpredictability of income, continuous mobility and non-remuneration of phases related to research mean that this group habitually develops its activity in a relatively unprotected environment compared to other sectors (Turrini & Chicchi, 2013). In general terms, public policies to support creation to alleviate these disadvantages materialize through grants and scholarships, with the general aim of encouraging broader participation in the arts, providing a varied cultural offer to the public, and helping artists evolve from the amateur field to become fully professional.

Focusing specifically on artistic creators themselves, the majority of countries do not, in general, contemplate specific or adapted labor regimes for these groups, despite the relative consensus around the peculiarity of the challenges surrounding their way of living. A unique case in Europe, and always taken as a reference, France, has implemented a special regime for the artistic collective (see, for example, Menger, 2012). Since the late 1960s, artists and performers have been integrated into the intermittent regime. This special scheme guarantees unemployment insurance for professionals, as long as they have worked a minimum number of hours per year. This provides fundamental guarantees relating to certain aspects of the artistic endeavor that are notoriously difficult to solve – in this case, the non-remuneration of the phases related to research, development and practice. The French case is relevant because it has developed a system of social protection for artists (which includes unemployment benefits and social security) that seeks to put them on a par with other workers (Galian et al., 2021). Another perspective more linked to support for creation from a business and employment dimension, the Anglo-Saxon model, seeks to shore up the artist's ability to compete in an open market, so that in the medium term they are able to support themselves by their own means (Alexander, 2008). In the Nordic model, which traditionally cultivates a line of support for individual artists, classic approaches close to the French aid system are combined with guidelines that focus on the perspective of employment and the economic sustainability of the artist and their business activity (Heikkinen, 2003). Thus, in Sweden, the Committee for Grants for the Arts implements common measures for all the arts with work scholarships lasting 1 to 10 years, added to income guarantees for a limited number of creators, grants for projects, grants for travel, and residencies and international exchange scholarships. In Norway, aid has recently been more openly oriented towards stimulating artistic production, a circumstance that guides aid towards greater temporary stability and links it to the concept of employment (Rueschemeyer, 2005). The Canadian province of Quebec has also moved in this direction. Its action plan, *Pour mieux vivre de l'art*, is made up of comprehensive measures linked to occupational health and safety, the bonus of retirement plans, the provision of assistance-employment, the transition or itinerary professional career, and the improvement of

remuneration through subsidies and taxation. Thus, it seeks to guarantee an improvement in the quality of life of the artist from their beginnings until their retirement from working life.[5] For its part, Spain does not yet contemplate a separate, tailor-made labor regime for arts creators, in part because of the lack of a national or regional census that can shed light on the collective's composition and characteristics, as we shall discuss in more detail in our results section. Economic assistance is mostly found in the form of funding for arts institutions or individual arts projects and touring, which later trickles down to the individuals.

Another aspect of great relevance at the international level, but of particular interest in relation to Spain, is the interest in cultural decentralization and the recognition of cultural and national diversity, which in this context imply a strong emphasis on local language plays and performances (Boix et al., 2016). This is a product of Spain's quasi-federal philosophy, in which the State is neither truly federal nor fully centralized, resulting in a mixed system in which both the central government in Madrid and each autonomous community provide funding and guidance for arts creation independently. This situation has arisen in large part because of the specific model of democratic transition that took place in Spain, in which the democratization process and the decentralization of its power structure took place simultaneously (Bonet & Négrier, 2010).

2. Methodology

In this paper we analyze the Valencian government's attempt to mitigate the challenges we have previously underlined. We focus on its role in granting subsidies to the creators of the performing arts, which are conceived as a way to stimulate the cultural offerings available to the public and provide some much-needed funding and economic stability, an alternative path for creators that runs in parallel to market-based options.

We focus on the Valencian region of Spain, which is undergoing a rapid expansion of the funding dedicated to the performing arts and serves as a model to study the ways in which the public sector supports the arts at large. Our analysis is therefore valid for the Valencian region, which represents a particular case in Spain. Since the design of the public policies of this nature are a responsibility of the regional governments, how funding is distributed in other regions falls outside the scope of this paper.

Our methodological approach consists of analyzing the Valencian government's distribution of grants for creation in the performing arts during the 2016–2020 period, which are part of the subsidy program for the promotion of performing arts for the theatrical and circus sectors and dance. We also base our work on the analysis of the existing academic literature on support policies for the performing arts, the regulations published in this regard in the Official Gazette of the Valencian government (both regulatory bases and calls for subsidies), and the official data on aid application files.

The research design contains a preliminary phase of conversations, some informal, held with creators of the performing arts and public officials of the Valencian government. The objective of these interviews was to deepen and corroborate our understanding of two intertwined subjects: on the one hand, the objectives of the public aid program in question, as defined in the

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[5] *Pour mieux vivre del'art.* Plan d'action pour l'amélioration des conditions socioéconomiques des artistes (2004). Retrieved from www.mcc.gouv.qc.ca.

official regulations; and on the other, the expectations and concerns of the creators themselves regarding these programs. Once these questions were settled, our analysis turned to the regulatory and financial aspects of the program. In the data analysis, the focus was on the relative ratios of effort, their evolution over time, and the distribution of funds among the applicant companies, using conventional descriptive statistical techniques.

3. Results

3.1. *Subsidies for performance arts creators in the Valencian region*

The economic size of the performing arts sector is typically measured by its contribution to overall GDP, which represented 0.25% of total GDP and amounted to €3,087 million in the case of Spain in 2019 (Table 1). In terms of the national cultural sector, this represented 10.2% of the total amount. In order to obtain an approximate value for the Valencian Region, in the absence of reliable estimates we focus on the relative size of its performing arts companies vis à vis the Spanish total. From this calculus we can assume that the contribution to the GDP of the performing arts in the Valencian Region is around 0.25% of GDP, slightly lower than the national average.

Table 1. Contribution of the performing arts to Gross Domestic Product in Spain

	2016	2017	2018	2019*	2020*
Million €	2,668	3,087	3,148	3,087	n.a
% of total GDP	0.24	0.27	0.26	0.25	n.a
% of culture GDP	9.8	10.9	10.6	10.2	n.a

* Provisional data for 2019. Data for 2020 not available
Author's elaboration from the Yearbook of Cultural Statistics 2021 (Ministry of Culture and Sports)

When it comes to obtaining data regarding the number and demographic composition of the various performing arts professionals in the Valencian Region, there is no census available nor a more specific census of creators in this sector. Identifying the total group of theater, circus and dance creators who are potential applicants for aid based on official data is impossible, as there is no category that separately and specifically includes this activity, neither in the National Classification of Occupations (CON-11) nor in the National Classification of Occupations and Economic Activities (CNAE-93). The lack of an in-depth census is a serious limitation to efforts to support the performing arts collective and one of the main problems that will need to be tackled in the near future, as we underline in our conclusions.

In this paper we study the grants allocated by the Valencian Region for creation and creators in the performing arts during the 2016–2020 period. These are regulated by regulatory framework 33/2016, of July 18, of the Ministry of Education, Research, Culture and Sports, which establishes the bases for the granting of public subsidies under a competitive concurrence regime. The grants for creation are a part of the larger support program for the promotion of the performing arts, which include theater, circus and dance. The subsidy program includes several modalities. Table 2 classifies the different subsidies into two groups: (a) direct support for creation; and (b) other aid to the sector. This report analyses the types of aid considered to directly

support creation.

Table 2. Types of aid for the promotion of the performing arts by the regional government

Direct support for creation	Other Aid
• Grants for the professional production of a stage play	• Aid for the creation of stage writing
• Aid for the emergent production of a stage production	• Aid for attending fairs
• Grants for tours and shows	• Grants for exhibition halls
• Grants for training, research and publishing	• Aid for professional associations and non-profit entities
	• Aid for holding festivals and exhibitions

Author's elaboration

3.2. Objectives, timeline and scope

The 2020 grants program explicitly defines, in article 1.1, that the ultimate goal of the performing arts promotion program is "to allow citizens to have a diversified and rich cultural offer." Further, article 1.2 specifies more and indicates that the purpose of the aid is to "Promote professional scenic creation in the field of theater, circus and dance; support scenic creativity and its dissemination; and promote cooperation between cultural agents and entities in the sector." Beyond this objective, defined in a very general way, there is a lack of specific strategic objectives that could become a guide for the articulation of the different modalities, endowments, requirements and evaluation.

Grants are announced and published annually. Eligible activities must also have an annual duration and be completed before the end of the calendar year. The first basic requirement is to be a professional in the sector; these grants exclude the amateur field, which has other support channels outside of the scope of this paper. The evaluation criteria of the applications constitute a mixture of objective criteria that are more easily quantifiable, and qualitative criteria that are open to subjective interpretation (Table 3).

Table 3. Evaluation Criteria

Criteria	2017	2018	2019	2020
A. Project Proposal	60	60	60	60
- Congruence, projection and artistic relevance	10	10	10	-
- Contemporary creation and in artistic residence	-	-	-	15
- Creation and promotion of audiences and genres	10	10	10	5
- Number of performers	10	10	15	15
- Artistic team	10	10	7	10

- Use of Valencian language	10	10	8	5
- Economic viability of the project	10	10	10	10
B. Company history	20	20	20	20
- Hiring	10	10	10	15
- Artistic background and trajectory	5	5	5	5
- Seniority	5	5	5	-
C. Performance of the two previous years (2016–2019; last exercise for 2020)	20	20	20	20
- Functions in the Valencian Region	8	6	5	5
- Functions elsewhere in Spain	8	7	10	10
- Functions abroad	4	7	5	5

Author's elaboration based on data from the Institut Valencià de Cultura

The nature of the projects that are competing for grants features a wide scope of artistic styles, ambitions and needs. The same can be said of the arts collectives themselves, which are very diverse in terms of size, trajectory, seniority, and number of performers and employees. This means large and consolidated companies coexist with very small companies that are more fragile from a financial point of view. Since there is no census that provides accurate information about all the different actors, we can only indirectly gauge their relative size by analyzing the projects being proposed and granted.

As expected, each applicant will add points more easily for some criteria than for others. Consequently, utilizing the data on aid granted and denied, in this paper we have made an ex-post assessment of the grants program based on the distribution of aid granted. In any case, a priori, the evaluation criteria show that smaller companies will likely score lower than larger, more established companies on several of the objective criteria. Taking into account the fact that objective criteria predominate among the assessment (Table 3), it is expected that there will be – by design – a certain concentration of aid in a small number of consolidated companies.

This is problematic when it comes to designing good public support programs whose main goal is to provide a diversified and high-quality cultural offer to the public. When analyzing the program criteria, the main issue is that the subjective evaluations lack transparency and the objective evaluations unequivocally favor the bigger players. Objective criteria predominate, and although they are more transparent because they are more easily quantifiable, those cultural agents that are larger, have been operating for longer, and employ more performers are guaranteed to score relatively highly regardless of the subjective evaluation of the creative proposal. As the criteria of artistic quality is more subjective and leaves a margin of discretion to the evaluation commissions, this adds an element of uncertainty to the applicants when preparing their proposals, which disproportionately impacts the smaller agents whose livelihoods might depend on getting public funding.

Since the grants provided are a function of the score obtained, the percentage that smaller companies receive is consistently smaller than the amount requested. This can condition the

artistic content of the proposals in an attempt to not lose points at the time of evaluation, endangering the core mission of the grants, which revolves around artistic freedom and variety. Furthermore, the relative weight of some objective criteria such as trajectory, employment totals and expected economic viability makes it difficult for new companies and creators to enter the field and establishes a gap that is hard to bridge between the emerging project modality and the professional production modality. This makes it challenging for many creators to transition from the emerging to the professional field, as the artistic merits and quality of the projects is never rated holistically by the ministry.

3.3. Evolution of the budget and resources allocated to performing arts

The budget of the Valencian government in culture programs amounted to €130.8 million in 2020, which represented 0.6% of the total budget region-wide. The Performing Arts program is the most important of them all and collected 61.4% of the spending on culture. The total budget allocated to subsidies for the promotion of the performing arts has increased considerably in recent years (Table 4). In 2016, the budget received a strong boost compared to 2015, with an increase of 76.2%, which brought it up to €2.25 million. In 2020, the figure rose to €5 million, after an increase of 56.3% compared to the previous year. This represents a growth of 122.2% throughout the period, meaning the budget has more than doubled (Figure 1).

Table 4. Budget for direct support to creation in the performing arts (in €).

	2016	2017	2018	2019	2020
A. Direct Support	1,340,000	1,354,000	1,668,000	1,783,000	2,640,000
B. Other Help	910,000	996,000	1,347,000	1,417,000	2,360,000
Total (A+B)	2,250,000	2,350,000	3,015,000	3,200,000	5,000,000

Author's elaboration based on data from the Institut Valencià de Cultura
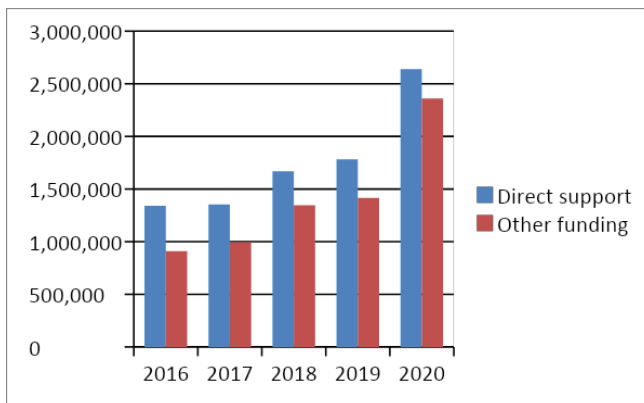
Figure 1. Evolution of the budget (in €).

Author's elaboration

On average, the distribution of aid by modality throughout the 2016–2020 period was aimed at subsidizing professional projects (61.8%); almost a quarter was allocated to touring (23.6%); aid to emerging company projects absorbed 11.3%; and, finally, research and training grants accounted for 3.3% of the budget (Table 5 and Figure 2).

Table 5. Direct support for creation by modalities.

| | 2016 | 2017 | 2018 | 2019 | 2020 | Variation (%) |
	(€)	(€)	(€)	(€)	(€)	2020/2016
Professional montage TOTAL:	870,000	850,000	1,015,000	1,065,000	1,600,000	83.9
- Professional montage (Theater)	700,000	695,000	815,000	850,000	1,300,000	85.7
- Professional montage (Dance)	170,000	155,000	200,000	215,000	300,000	76.5
Emerging montage TOTAL:	120,000	147,000	200,000	220,000	330,000	175.0
- Emerging montage (Theater)	100,000	125,000	155,248	160,000	240,000	140.0
- Emerging montage (Dance)	20,000	22,000	44,752	60,000	90,000	350.0
Tours TOTAL:	320,000	310,000	395,000	435,000	610,000	90.6
- Tours TyC	250,000	250,000	300,000	350.000	490,000	96.0
- Tours DAN	70,000	60,000	95,000	85.000	120,000	71.4
Research & Dev. TOTAL:	30,000	47,000	58,000	63.000	100,000	233.3
- Research & Dev. TyC	20,000	25,000	28,000	28.000	40,000	100.0
- Research & Dev. DAN	10,000	22,000	30,000	35.000	60,000	500.0
TOTAL (A+B)	1,340,000	1,354,000	1,668,000	1.783.000	2,640,000	97.0

Author's elaboration based on data from the Institut Valencià de Cultura
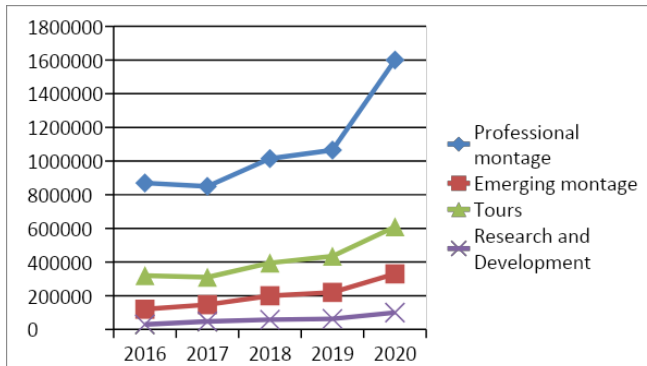
Figure 2. Budget by modalities (in €).

Author's elaboration

From this data, the main takeaway is that while funding has continued to rise, it has not done so evenly. Professional montage, the modality that encompasses the biggest players, has seen the lion's share of the overall budget increase, but in relative terms its size has only doubled. Funding for emerging montage (which encompasses mostly up-and-coming artists and collectives) and tours have seen relatively modest increases in absolute terms, but have tripled relative to their 2016 values. This goes in line with the stated goal of stimulating a diversified and rich cultural offer.

3.4. Distribution of grants for creation

As we have seen, the budget for grants for creation in the performing arts has increased considerably since 2016, more than doubling in value. However, while this has meant that the average grant has risen in value across the board, our analysis shows that the actual distribution of aid is highly unequal: 10.9% of beneficiaries – the most established theater and dance companies – receive half of the grants (Table 6 and Figure 3). Conversely, almost a third of aid applicants have never received a subsidy. From 2016 to 2020, 328 different companies applied for grants at least once. Almost 70%, a total of 229 applicants, received some aid at some point. In contrast, 30% of applicants (99 companies) never received funding (Figure 4).

Table 6. Grants for creation in the performing arts in 2016–2020: general analysis of the period

Budget	
Total budget	€15,815,000
Budget for creation	€8,785,000
% of the total	55.5
Companies	
Applicants	328

Beneficiaries	229
% of applicants that receive grants	69.8
Grants	
Total funding	€8,834,888
Average aid per applicant	€26,935.6
Average aid per beneficiary	€38,580.3
Distribution	
Companies with aid greater than the average: nº	61
Companies with aid greater than the average: % of beneficiaries (% of applicants)	26.6% (18.6%)
Companies with less aid than the average: nº	168
Companies with less aid than the average: % of beneficiaries (% of applicants)	73.4% (51.2%)
Companies without aid: nº (% of applicants)	99 (30.2%)
Aid from the Top 10 companies (% of total aid) (% of beneficiaries)	€2,377,530 (26.9%) (4.4%)
Grants from the Top 20 companies (% of total aid) (% of beneficiaries)	€3,898,254 (44.1%) (8.7%)
Companies that absorb half of the aid: nº	25
Companies that absorb half of the aid: % of beneficiaries (% of applicants)	10.9% (7.6%)

Author's elaboration based on data from the Institut Valencià de Cultura

When analyzing the distribution of aid granted, 18.6% of applicants received aid above the average amount, while 73.4% received aid below the average level. The average aid per beneficiary was €38,580.3, and almost €27,000 per applicant. However, the first 10 companies in the ranking absorbed €2,377,530 in aid, or 26.9% of the total, and the first 20 received €3,898,254, or 44.1%. In other words, 10.9% of the beneficiaries received half of the aid (Figure 3). These 25 companies, which comprise only 7.6% of the applicants, carry as much weight as the other 89.1% of beneficiaries. The latter group splits the other half of the aid, receiving less than €13,359.5 each (one third of the average amount).

While we cannot access the internal guidelines that the government uses to assess the applicants, judging by how the funding is distributed it is reasonable to infer that the objective criteria plays a major role in determining funding levels. Smaller companies and creators may score lower on several of the objective criteria than larger, more established companies. If so, since the percentage of the subsidy decreases in line with the score obtained, even if those smaller

companies obtain aid the percentage of the amount requested that is received will be lower. The same can happen with proposals for stage projects that do not include among their project some of those criteria that score highly in the assessment (such as the involvement of Valencians, a high number of performers, etc.). While outside of the scope of our research, it seems that this can ultimately condition the artistic content of the proposals in an effort to score extra funding points.
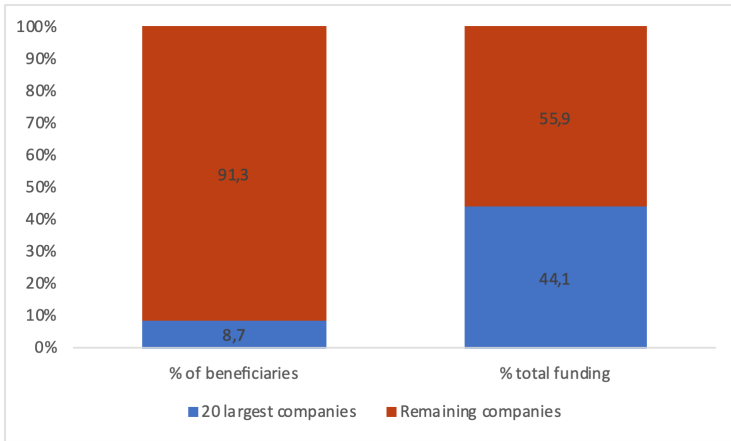
Figure 3. Distribution of subsidies in the performing arts: 2016-2020
Author's elaboration
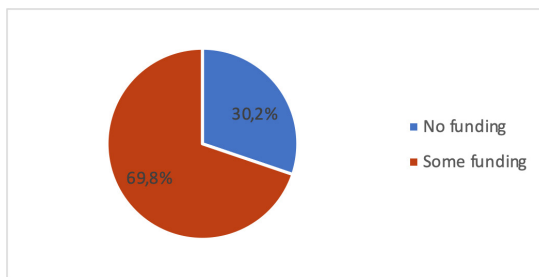
Figure 4. Companies with and without aid: 2016–2020
Author's elaboration

As there is no definitive census of performing arts companies in the Valencian region, it is impossible to conclude whether the 99 companies that did not receive aid comprise the entirety of the performing arts ecosystem that has been left out of the grants program, or if there is another layer that remains completely outside the institutional funding channels of the government.

4. Discussion and conclusions

On balance, the conclusions drawn from our analysis are mixed: on the one hand, funding has steadily increased to the point of doubling in only four years; on the other hand, distribution remains stubbornly unequal and is mostly a function of the design of the grants themselves, which favor bigger companies over individual or small projects. This contradiction goes against the stated goal of the policy, and in order to truly preserve and expand artistic creation it is necessary to guarantee a level playing field for most companies. Otherwise, grants function as solidifiers of the status-quo, working in parallel with market forces and ultimately cementing the differences that were already there.

A public support policy can draw valuable insights from the French and Anglo-Saxon models, depending on the type of help required and the abilities of companies to survive in the open market. Considering the (now) relatively large budget allocated to performance arts creation in the Valencian region, we consider that the implementation of a labor regime that follows the French model and specifically caters to artists and arts creators could be the next logical step in order to guarantee the long-term health of the sector. Conversely, the Anglo-Saxon emphasis on private sponsorship is still insufficiently developed in Spain and the Valencian region, and can provide a welcome funding stream to the most established players, ideally making up for the reduced public funding that they would receive under the more egalitarian model we propose.

Our general recommendation is that funding be distributed more equally between arts creators, emphasizing proportionality, artistic freedom, and variety. A better redistribution of subsidies would facilitate the subsistence of a greater number of creators thanks to the better distribution of financial aid. In any case, such a design change would require an ex-post evaluation in order to assess whether it had really dynamized and expanded the arts creation scene.

 Furthermore, we propose several specific recommendations that we consider relevant to improving the current aid framework. In order to mitigate the unequal distribution of subsidies, a census of companies and creators that allows for a deep dive into the sector and its characteristics is of primary importance. This can help identify the priorities and specific strategic objectives for the sector in the medium term and open up new avenues for future research. This would serve as a preliminary step in the design of a targeted aid system, the end result of which should be to guarantee a fair distribution of the budget between subsectors, circuits, segments and modalities based on the demography, characteristics and strategic priorities of each participant. Differentiating the aid system for theater, circus and dance could be useful in terms of making it easier for artists to finesse their proposals, as each sub-sector has different characteristics and faces different realities, notwithstanding the transdisciplinary nature of contemporary performance languages.

Given the heterogeneity of the sector and taking into account the diversity of artistic proposals themselves, the subsidy system should be divided into two different circuits: one focused on supporting companies and creators that are more commercially consolidated (the cultural industries segment that stands out for its economic value); and another for creators with an artistic profile of more minority proposals (proposals that are deemed of culturally significant value). Following this change, the subsidy system should further segment the companies on both circuits based on objective criteria, such as size, turnover and/or track record. Each segment of aid, composed of companies with similar objective characteristics, must have a budget allocation, modal-

ities, requirements and specific assessment criteria. This would guarantee a level playing field and make clear to all participants what is required of their projects to reach a certain funding level.

Finally, when taking a holistic view of the issue of inequality in relation to the arts, it becomes increasingly evident that, ultimately, there is only so much that these public grants can do to stimulate and nurture artistic creation. If the underlying economic conditions are as fragile as they are, government help on its own will not be able to reverse the declining fortunes of arts creators and their audiences. The artist's medium is endangered by the usual subjects: the combination of a shrinking middle class, rising costs of living, and a general winner-take-all economy that leaves most people struggling to make ends meet. Future research can focus on how to tackle this complex issue by exploring the ways in which a direct funding approach for artists can coexist with a grants structure and provide more stable living conditions in which art creation can thrive.

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USING MACHINE LEARNING MODELS TO INVESTIGATE CONSUMER ATTITUDES TOWARD ONLINE BEHAVIORAL ADVERTISING

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Abstract: *The technique of online behavioral advertising (OBA) is a strategy that has been widely used in the last decade by businesses and advertisers to deliver targeted advertising messages to internet users. It is done by utilizing technology to record the habits of online shoppers, including their searches and the content they visit. Users who browse the internet or use social media view advertisements relevant to their interests, recent searches, and location. We study Twitter users' attitudes about targeted ads using five different machine learning models in this research, applying the CRISP-DM framework. Our primary focus is to develop a benchmark Twitter sentiment dataset related to targeted ads and implement highly accurate machine learning algorithms to predict tweet text sentiments when discussing targeted ads. The machine learning algorithms used are Logistic Regression, Random Forest, Multinomial Naïve Bayes, Multi-Layer Perceptron, and Decision Tree. We use accuracy, precision, recall, and the F1 measure to evaluate their performance. Logistic Regression using the content-based method provides the utmost accuracy of 0.88. We propose a model that allows real-time consumer attitude research regarding retargeting ads. The results show that logistic regression is the most accurate method for predicting customer responses to OBA campaigns and that retargeting and OBA often cause negative feelings in consumers.*

Keywords: *online targeted advertising, behavioral advertising, behavioral targeting, retargeting, machine learning, Twitter sentiment dataset*

JEL Codes: *M31; M37; D83.*

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Introduction

Today, companies that want to advertise to a large consumer audience that uses the internet and social media use online targeted advertising techniques, using advertising platforms such as Google Ads and Facebook Ads (Boerman et al., 2017). In the literature, we often come across similar terms to define this targeting technique, such as online behavioral advertising (OBA), behavioral targeting, data-driven digital advertising, and online profiling (Bennett, 2010). Businesses can target a specific audience based on their demographic profile, online behavior, including their recent searches, and other preferences related to their lifestyle and values (Zuiderveen Borgesius, 2015). Targeted ads therefore target a specific audience who are more likely to be interested in the services and products of the advertised business (Schumann et al., 2014).

The use of this technique based on big data analysis proves to be particularly effective for advertising companies as their advertising message and advertising budget is not disseminated to a wide range of audiences as is the case with traditional advertising methods such as tabloids, television, or the print media. Instead, it is limited to a targeted audience, reducing costs per conversion (Chen & Stallaert, 2014).

Our research focuses on automatically analyzing sentiments using machine learning techniques when people are talking about ads they are getting. This research aims to analyze social media users' opinions about targeted ads, assess whether the user's opinion is optimistic or destructive, and develop a benchmark dataset for sentiment analysis for its potential applications in marketing. We applied and compared multiple machine learning algorithms to find the most optimum technique.

2. Theoretical background

Marketers have been thinking about, arguing over, and implementing personalization tactics to develop effective media strategies (Iyer et al., 2005). According to users' locations, culture, and interests, marketers consume their data to show them ads related to their choice and what they are looking for online, helping companies reach more reliable customers (Johnson & Grier, 2011).

As internet and social media users grow progressively, many agencies and companies use social media to promote their products or services and impact the customer's purchase intention (Alalwan, 2018; Voorveld et al., 2018). Many social media platforms like Instagram, Facebook, Twitter, and YouTube primarily make money by implementing online targeted advertising features (Mitra & Baid, 2009).

Social media users, in particular, supply a wealth of information about their interests on their profiles, making them a niche market for advertisers looking to target them with advertisements based on the information and searches they provide. Technically, advertising platforms can utilize browser history, users' search history, and their interests as manifested from their behavior on social networks using cookies and big data analysis techniques (Boerman et al., 2017). The method of OBA is based on monitoring the websites that a user visits on the internet and the actions that they generally perform online, such as purchases of products and services, to capture

their preferences and interests and then promote relevant ads (Varnali, 2021).

However, users seem to have lost confidence in the way businesses use digital media, especially when it comes directly to personal data (Kim & Huh, 2017). A typical example and operative cause of this controversy by consumers towards companies is the scandal that arose from Facebook and Cambridge Analytica (Heawood, 2018). At this point, it is worth mentioning that the state expects companies to give more control to their users regarding the stored cookies and the processing of personal data, as has been legislated in the GDPR for Europe, the Personal Information Protection Law (PIPL) in China, the Data Protection Act (DPA) in the United Kingdom, the Digital Charter Implementation Act (DCIA) in Canada, and the California Consumer Privacy Act (CCPA) in the United States (Barrett, 2019). These legal frameworks are interdependent but move toward protecting personal data (Voss, 2021).

Various studies indicate that there should be a balance between the use of personal data and the possible invasion of privacy, as it has been shown that a privacy protection policy can be beneficial for both clients and marketers (Kox et al., 2017). Other research shows that businesses often should not apply retargeting techniques (Shin & Yu, 2020), and some researchers have shown that the trusted platform matters (Kim et al., 2019). In addition, the importance of proper targeting is highlighted, as if a targeted ad appears to an irrelevant audience, then they will have a negative attitude towards the targeted advertisement and the advertised product (Cyril de Run, 2007). Similarly, the research of Boerman et al. concludes that OBA's success depends on factors controlled by the advertiser, such as the sensitive or non-sensitive information used to personalize the ad, and consumer-related factors, such as the advertiser's trust in the advertiser's perceived usefulness, feelings of intrusion, and concerns about the privacy of personal data (Boerman et al., 2017).

Researchers have followed various research methodologies to study the influence of OBA and consumer responses, including empirical research with questionnaires (Aiolfi et al., 2021; Beak & Morimoto, 2012) or experimental research (Jai et al., 2013). The subject matter of the OBA is and will continue to be of concern to the research community in the coming years with the advent of the IoT, and the introduction of targeted advertising in media other than computers and mobile phones. Hence, the need to further study the phenomenon with new tools and methods is considered significant (Aksu et al., 2018). Kumar and Gupta (2016) suggested using big data to analyze OBA effectiveness, and this research is also moving in this direction. As presented in the following sections, we analyzed 80,000 tweets regarding users' opinions on targeted advertising and studied different machine learning algorithms.

3. Methodology

People use social media platforms to talk about the ads they are interacting with daily – whether they are related to their interests or a source of frustration. Typical examples are tweets where users sometimes express their satisfaction or dissatisfaction with targeted ads.

We used Twitter to extract data from social media platforms, as Twitter is one of the eminent platforms where users tweet daily about their experiences in every part of life. Another reason to select Twitter is that it is an open-source platform that allows us to scrape a large amount of data using the Twitter API (Makice, 2009).

Our research focuses on automatically analyzing sentiments using machine learning tech-

niques when people are talking about ads they are getting. Our primary focus is developing a benchmark Twitter sentiment dataset related to targeted ads and implementing highly accurate machine learning algorithms to predict tweet text sentiments when discussing targeted ads.

Our focus is on automatically generating precise sentiments of tweets related to targeted ads. To develop and deploy an optimized machine learning model, there is a need to follow a structured approach: cross-industry process for data mining (CRISP-DM) is the most basic and widely used framework for machine learning and data science projects (Schröer et al., 2021; Wirth & Hipp, 2000). The CRISP-DM framework embraces six significant phases: business understanding; data understanding; data preparation; modeling; evaluation; and deployment. Although the framework is flexible, the steps involved to complete all these phases must be specific. In the following sections, we follow all stages of the CRISP methodology in detail to execute our research. The flow diagram in Figure 1 describes all of the steps we performed to carry out the task in detail, from data collection to model deployment.
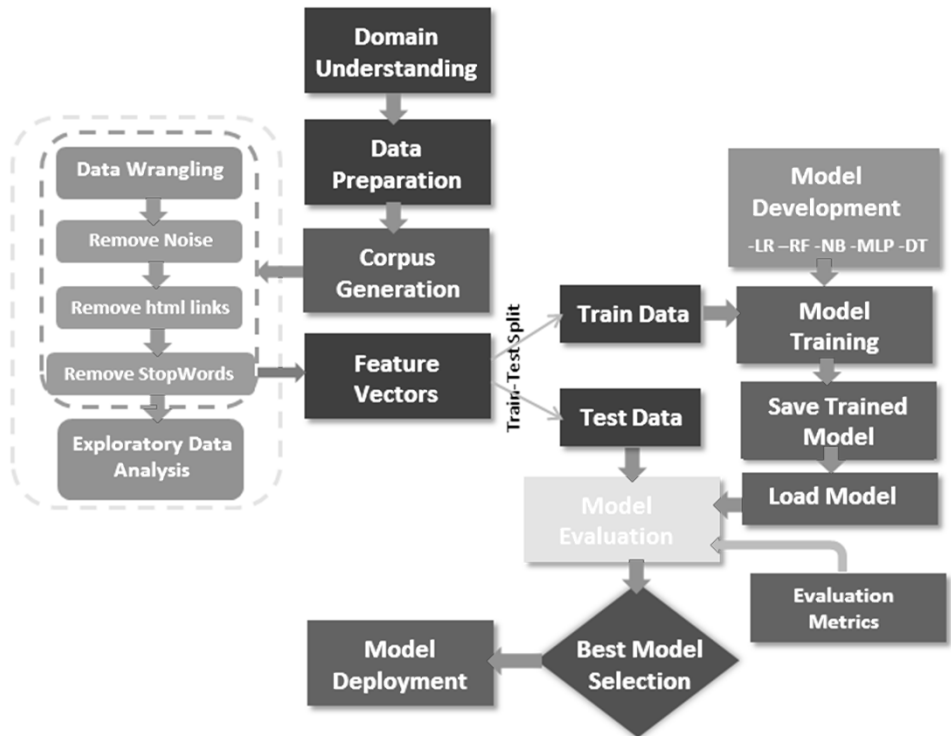
Figure 1. The machine learning model, a detailed flow diagram

3.1. Data Preparation

3.1.1. Corpus Generation Process

3.1.1.1. Data Scraping Methodology and Annotation Process

We scraped Twitter data using the open-source Twitter API. We used the Tweepy library to extract tweets (Wisdom & Gupta, 2016). Some initial conditions were set before scraping: ignore re-tweets; all tweets must be in the English language; timeframe of scraped tweets between 2019 and 2021; tweet must have one of the mentioned tags: #targeted ads, #remarketing, #retargeting, #facebook exchange (FBX), #facebook dynamic ads; only extract text tweets and ignore all images.

The raw data scraped from Twitter had some meta information attached with Twitter text. Thus, the scraped data included 24 features, but after rendering to our requirements, we dropped all other parts and kept only original tweet text. The total number of raw scraped tweets was 80,000.

To produce highly accurate models, we need a large amount of data. So, for the annotation of positive or negative sentiments related to a specific tweet, we used a python-based textblob library that assigns emotions to the dataset according to polarity in the text (Kulkarni & Shivananda, 2021). To analyze the accuracy of the labeled tweets, we manually evaluated 5,000 randomly chosen tweets. After the annotation, we dropped some positive tweets, as positive sentiment had a high weighting in the dataset to keep it balanced. After dropping the positive tweets, the annotated corpus size was 66,000 instances.

3.1.2. Corpus Characteristics and Potential Applications

Data source: we scraped data from Twitter. All tweets that we chose to extract were related to targeted ads and marketing.

Data timeline: all extracted tweets were published between 10 October 2019 and 2 August 2021.

Data tags: to scrape Twitter data we focused on tags including #targeted ads, #remarketing, #retargeting, #facebook exchange (FBX), #facebook dynamic ads.

Applications: the dataset was developed to have potential applications in sentiment analysis tasks not limited to marketing; it can be used in any domain where the problem involves analyzing sentiment from a short text.

3.1.3. Data Wrangling

Some example tweets before data pre-processing:

Had a busy weekend! Just moved to Vancouver... I wonder how my targeted ads will potentially change. haha. #BMC382

Having a strong ðŸ'ª , activeðŸ", and engagingðŸ˜‹ **Instagram presence is an obvious restaurant marketing tip. But are you finding new customers with great images of your food in targeted ads on Instagram?**

To sanitize the dataset, the following data cleaning steps were performed: remove non-ASCII characters; remove HTML links, all #tags, and @tags; remove all punctuation marks; remove all numeric values; remove single characters; remove more than one whitespace in the text (including double space, \t, \n); lowercase letters; remove leading and trailing whitespaces; remove all null values; eliminate stop words; and exclude tweets with a length lower than three characters.

3.1.4. Exploratory Data Analysis

All the statistics mentioned here are from after data pre-processing. Table 1 depicts the top 10 most frequent words in the dataset. It demonstrates that the most frequent words were "targeted" and "ads" because we intentionally focused on these keywords during data scraping.

Table 1. Top 10 most common words in the dataset excluding stop words

#	Common Words	Frequency
1	targeted	64,745
2	ads	52,130
3	ad	20,209
4	facebook	8,116
5	get	8,090
6	like	7,254
7	getting	7,141
8	know	4,322
9	people	4,174
10	one	4,001

Table 2. Lexical analysis of the dataset

#		Positive	Negative	Total
1	Words (Tokens)	435,850	493,915	929,765
2	Word Types (Unique Tokens)	30,405	30,431	43,961
3	Average Tweet Length	13.77	15.12	14.46

Table 3 depicts the total instances in the dataset and the ratio of positive sentiments and negative sentiments in our dataset.

Table 3. Positive to negative tweets ratio in the pre-processed dataset

#	Sentiment	Frequency
1	Positive	32,654
2	Negative	31,636

3	Total	64,290

Some examples of positive tweets:

1. targeted ads facebook wedding dresses engagement rings;
2. targeted ads love candle;
3. interesting ad placement talk targeted product placement;
4. best targeted campaign ad ever;
5. these targeted ads are really pulling through helping me make my xmas list;
6. targeted ads have given me some amazing book recommendations.

Some examples of negative tweets:

1. phone spying enough give wildly specific targeted ads least spy enough;
2. absolutely insane targeted ad;
3. these targeted ads are getting weird;
4. i hate targeted ads so much;
5. these targeted ads are getting creepy how do they know about my life;
6. how do I stop getting targeted ads for universities i am already a part of.

As can be observed from some of the above example tweets, some of the pre-processed sentences do not make sense according to standard grammatical English language rules. We removed stop words and punctuation and performed other data cleaning steps. However, the clean data is more meaningful to machine learning algorithms. For example, stop words are used to build up sentence structure, but these words have no relevance when identifying sentiments in the text.

3.1.5. Content-based Method

A TFIDF (Term Frequency–Inverse Document Frequency) vectorizer was used to extract the frequency ratio of word unigrams from the dataset. The total number of features we found in the corpus was 43961. To keep the most important and relevant features and reduce complexity during model training, we tweaked the values of TFIDF parameters to max_dif = 0.8 and min_dif = 7. Max_dif excludes tokens with a frequency greater than the given threshold, whereas min_df excludes tokens with a frequency lower than given threshold. After setting the parameter values, we reduced the number of features to 9,407.

3.1.6. Train-Test Split

The dataset was split into two parts to train and evaluate the models' performance. Using 80:20 ratios, we randomly split the data into train and test groups. Our prediction models were then built with training data and tested against a test set.

3.2. Modelling

After cleaning and pre-processing the data in a machine-understandable format, it was directly passed to our models. In this step, machine learning models were developed and optimized to be trained on the dataset.

3.2.1. Model Development

In consideration of automated sentiment analysis systems, the tweets in the dataset have

a long sequence of words or tokens. After applying feature vectors techniques, every token has a different frequency distribution, so there is a need to identify models that can learn the sequence and recognize the significant relation between tokens. Various machine learning models may show different behavior with a dataset. In order to explore which model best fits our dataset, four different machine learning algorithms were evaluated. In addition, Artificial Neural Network techniques produce encouraging results in datasets with complex features, so neural network models with multiple hidden layers were also built using our dataset. The following algorithms were used in our research:

- Logistic Regression;
- Random Forest;
- Multinomial Naïve Bayes;
- Artificial Neural Network;
- Decision Tree.

3.2.1.1. Logistic Regression

Logistic Regression is a parametric model with specific parameters that depend upon input features to predict the output. For binary classification problems, logistic regression is preserved as binomial logistic regression. The following equation depicts the behavior of the algorithm (Hosmer Jr et al., 2013):

$$\ln\left(\frac{p\,(x)}{1 - p(x)}\right) = \beta_0 + \beta_1 x$$

3.2.1.2. Random Forest

Random forest can be applied in both regression as well as classification problems. Random forest is an example of an ensemble learning method where multiple decision trees are designed to make predictions, and results from all trees are pooled together. For classification problems, the random forest output is the class chosen by all trees (Svetnik et al., 2003).

3.2.1.3. Multinomial Naïve Bayes

Multinomial Naïve Bayes is a classification algorithm built on Bayes' Theorem by a hypothesis of individuality amongst predictions. In modest expressions, a Naïve Bayes algorithm undertakes that the occurrence of a specific feature in a label is isolated to the presence of any other supplementary features (Abbas et al., 2019).

$$P(c|x) = \frac{P\,(x|c)P(c)}{P(x)}$$

$$P\,(c|x) = P\,(x_1|c) \times P\,(x_2|c) \times ... \times P\,(x_n|c) \times P(c)$$

- o $P(c|x)$ *is the posterior probability*
- o $P(c)$ *is the label's prior probability*
- o $P(x|c)$ *is the likelihood*
- o $P(x)$ *is the prediction's prior probability*

3.2.1.4. Artificial Neural Network

Artificial neural networks (ANN) can be developed and designed for supervised classification and regression tasks. ANNs can have multiple layers (da Silva et al., 2017). The simplest form of ANN with no hidden layer is perceptron, whereas an ANN with one or more hidden layers is called a multi-layer perceptron (Zou et al., 2008). ANNs learn a predictive function after training on a given dataset.

$$f(.): R^m \to R^o$$
$$where\ m = input\ dimension$$
$$m = output\ dimension$$

Given an input vector vector X= $x_1, x_2, \ldots x_m$ and a target value y, a multi-layer perceptron can learn a nonlinear function to make future predictions. In addition to the linear relation between features, an MLP can also learn nonlinear relations between input and output variables.

3.2.1.5. Decision Tree

Decision trees are non-parametric methods designed for supervised machine learning tasks and work in a tree structure (Safavian & Landgrebe, 1991). The tree structure splits the complete dataset into subsets and continues until all possible paths or rules are met, or the tree reaches its maximum depth and makes a decision towards the final prediction.

3.2.2. Model Training

Training data was used to train the models developed in the previous step.

3.3. Evaluation

3.3.1. Evaluation Methodology

The problem of identifying sentiment from an author's tweet was treated as a supervised classification problem. The sentiment analysis task was considered a binary classification issue, with the goal of distinguishing between two classes: 1) positive, and 2) negative. We used a train-test split to experiment towards the better assessment of content-based methods. Five diverse machine learning techniques were evaluated for the classification task: Logistic Regression,

Random Forest, Naïve Bayes, Multi-Layer Perceptron, and Decision Tree. For the content-based method, word gram features extracted using the TFIDF vectorizer were used as inputs for machine learning algorithms.

3.3.2. Evaluation Metrics

We used the following evaluation metrics for supervised binary classification problems: 1) accuracy, 2) precision, 3) recall, 4) F_1 (Hossin & Sulaiman, 2015).

3.3.3. Model Evaluation

Test data was used to check the performance of the model built and trained in the previous steps. Multiple evaluation metrics were used to compare the model's performance.

To perform real-time evaluations, we ensured that test data was not taken from training data; both of these datasets were disjointed.

During the testing phase, only input features were passed to the model.

We ensured that the structure and number of input features for the test data was the same as the training data to avoid any errors or false results.

3.4. Deployment

3.4.1. Application Phase

When all models were trained and evaluated, the best model with the highest accuracy and F_1 score was trained on the complete dataset and deployed for future predictions. F_1 was chosen to maintain a balance between precision and recall.

3.4.2. Predictions on Future Data

To evaluate the performance of the best model on real-time data, we took an unseen input in text format from a user and predicted positive or negative sentiment.

4. Results

The findings of all five machine learning models on test data that we examined using the content-based strategy are shown in Table 4. The Logistic Regression model outperformed all other models. F1 was also used to evaluate both positive and negative sentiment data. The results showed that the Logistic Regression classifier has the highest average accuracy (0.88), highest average precision (0.87), highest average ROC AUC score (0.90), and highest average F1 score (0.88).

Table 4. Comparison of the results of machine learning models

Model Name	Accuracy	Precision	Recall	F_1
Logistic Regression	0.883419	0.87142	0.897255	0.884149

Random Forest	0.873153	0.865936	0.880471	0.873143
Naïve Bayes	0.799113	0.837127	0.73851	0.784732
Multi-Layer Perceptron	0.876575	0.873246	0.878588	0.875909
Decision Tree	0.827112	0.833013	0.814588	0.823697

Figure 2 plots a graphical visualization of the performance of all models on the test dataset and exposes their comparison. The benchmark model with detailed results is available online at https://github.com/ziakis/retargeting_sentiment_analysis (Appendix).
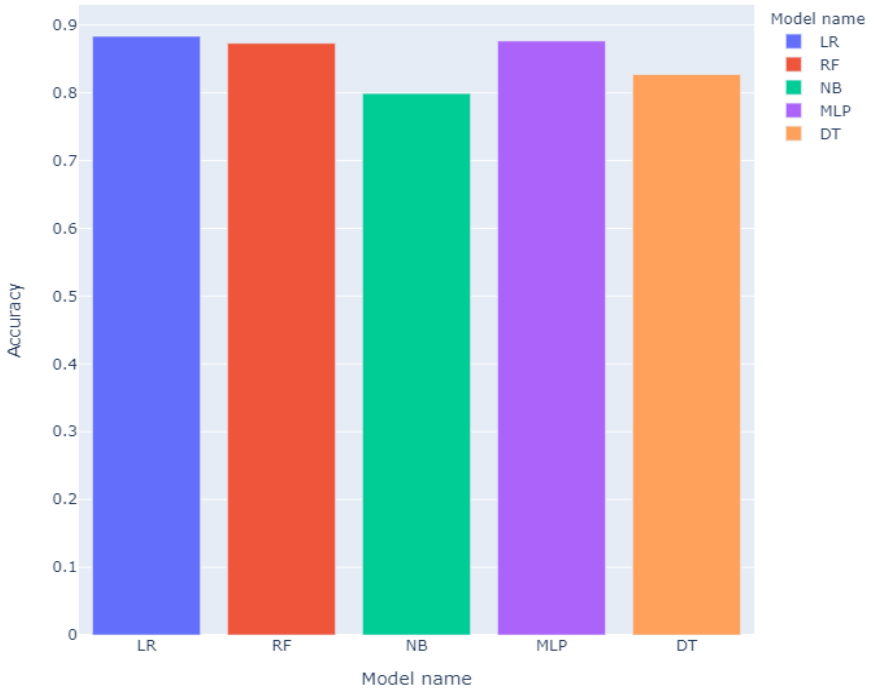
Figure 2. Accuracy comparison of multiple models

5. Conclusions and Discussion

In this project, we developed a benchmark English language Twitter sentiment analysis dataset related to tweets about targeted ads to build and assess sentiment analysis techniques. After cleaning and pre-processing, the developed dataset comprised 32,654 (51%) negative and 31,636 (49%) positive tweets. These results support the assumptions derived from our theoretical foundation, according to which we assumed that retargeting and OBA often cause negative feelings to consumers.

Furthermore, we applied and compared five existing machine learning algorithms, including Logistic Regression, Random Forest, Multinomial Naïve Bayes, Multi-Layer Perceptron, and Decision Tree, using content-based methods to pass input data to machine learning models. We used accuracy, precision, recall, and the F_1 measure to evaluate their performance. Logistic Regression using the content-based method provides the utmost accuracy of 0.88. We propose a model that allows real-time consumer attitude research regarding retargeting ads.

The study's limitations are related to the methodology used and the number of hashtags, tweets, and sources of user-generated content analyzed. In future work, we aim to develop our own proposed machine learning algorithm and address the limitations by enhancing the dataset with a more extended observation period and more social media platforms.

Our findings are relevant for advertisers and digital marketers who are advised to cautiously consider all available information sources, including social media, and utilize sentiment analysis as part of their business strategy.

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Appendix

List of files on GitHub:
- https://github.com/ziakis/retargeting_sentiment_analysis/blob/main/Twitter_sentiment_analysis_targeted_ad.html
- https://github.com/ziakis/retargeting_sentiment_analysis/blob/main/Twitter_sentiment_analysis_targeted_ad.ipynb
- https://github.com/ziakis/retargeting_sentiment_analysis/blob/main/twitter_sentiment_dataset.csv
- https://github.com/ziakis/retargeting_sentiment_analysis/blob/main/twitter_sentiment_preprocessed_dataset.csv

THE THEORY OF GENERATIONAL STRATIFICATION IN THE CONTEXT OF BRAND MARKETING COMMUNICATION STRATEGY

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Abstract: T*he generational approach is becoming widely used to revise patterns in brand value building and management. The need for such revision is a logical consequence of the current situation, where traditional branding principles fail. As turbulent changes are occurring in the macro environment due to the (post)pandemic situation and global socio-economic development, more and more voices are beginning to point out the different natures of the problem. One solution is the application of the generational approach to the practice of brand managers. Thus, strategies would become more personalized and fit crucial market segments focusing on the increase of subjectively perceived brand value. On the other hand, some concepts and theories which have not been checked functionally in the long term perspective, and which have started to be prematurely applied*

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in specific managerial tasks, are being critically discussed. One of such concepts involves the usage of generational stratification in the practice of marketing managers. Thus, the aim of this paper is to analyze the concept of fitting brand marketing communication strategy to the specifics of a targeted generational cohort. Subsequently, this study aims to critically discuss the concept of generational stratification from the point of view of brand management. To fulfill this aim, the method of contingency table evaluation and hypotheses testing via chi-squared tests is used. Data were collected via a consumer questionnaire survey among Slovak inhabitants aged 15 years and above, involving 1,978 respondents in total. Based on this research, it is concluded that generational stratification is not relevant for the purposes of brand marketing communication strategy. On the one hand, its general applicability is proved, but on the other – in selected product categories (personal cars, banks, cola beverages and sportswear) – the link between generation and perception of brand value is not proved.

1. Introduction

In marketing, the generational approach has begun to be a widely used reasoning for observing exceptions from managerial and economic concepts that were so far generally perceived as valid (Signore et al., 2021). Recently, it has also been discussed in the scope of the market consequences of the COVID-19 pandemic – not only from the point of view of the creation of a new generation influenced by the relevant socio-economic crisis and subsequent significant changes (Schramm et al., in press), but also as a phenomenon creating the need to revise the previously formulated theoretical background of the concept of generational stratification and its implementation in managerial practice (Leko Šimić & Pap, 2021; Balinska & Jaska, 2022). This fact is changing the position of the concept of generational stratification in the theoretical platform of the creation of managerial patterns (Nica et al., 2022; Birtus & Lazaroiu, 2022). While the generational approach has been one of various equivalent trends until now, it has recently started to be revised as a traditional concept (Andriulis et al., 2022). To conclude this situation, it can be stated that the concept of generational stratification has been indirectly included into the pillars of managerial theory, especially in the scope of marketing and the general managerial implications of consumer behavior. Surprisingly, this has occurred without proving the real significance of the generational approach in the scope of selected marketing issues. One of such issues is branding. This issue is constantly increasing in its importance by entering into other managerial disciplines and the business functional architecture. Thus, this paper is focused on the analysis of the concept of fitting brand marketing communication strategy into the specifics of a targeted generational cohort. Only by proving the link between the perception of brand value sources and the affiliation of a consumer of a specific generation, along with the theoretical flow of revising the concept of generational stratification for branding purposes under the influence of changes brought about by the COVID-19 pandemic, would this argument be reasoned and useful for the purposes of a real managerial response to the consequences of the COVID-19 pandemic.

The research gap lies in the absence of the verification of the usability of the concept of generational stratification for detecting the specifics of market reactions in the application of selected managerial patterns. This is especially true in those cases where these concepts have previously been successful. Thus, the aim of this paper is to analyze the concept of fitting a brand marketing communication strategy into the specifics of a targeted generational cohort.

2. Literature review

The concept of generational stratification was originally developed in the scope of labor market implications (Soulez & Guillot-Soulez, 2011). Despite the fact that this concept has since been relatively widely incorporated into other managerial theories – especially in terms of marketing (Pileliene & Zikiene, 2019) – its labor market nature still intermittently appears in contemporary scientific literature from different perspectives (Lizbetinova et al., 2018; Machova & Kosar, 2018; Mahmoud et al., 2021). Moreover, generational stratification rises in importance not only in general terms, but also in relation to its marketing implications (Nguyen et al., 2022). One such dimension of the applicability of the concept of generational stratification is branding.

The golden triangle of branding is still the main topic of current research in this area. This triangle is formed by brand value, brand image and brand quality (Bilan et al., 2019). Syah and Olivia (2022) analyzed these three components of brands, focusing on the online fashion industry in Indonesia. Thus, they continued the cross-market prospective of branding research, focusing not only on markets in their region but also in their sectoral structure. Similarly, this trend was also followed by Bonney et al. (2022), who focused on the consumer perception of a brand in the conditions of a specific market. However, the analysis of a specific market is abstracted from the identification of inner common mechanisms across specific product categories. Such an approach would be beneficial from the point of view of wider managerial implications. Husain et al. (2022) applied the categorical perspective of the triangle of the functional mechanisms of branding, focusing on luxury brands. Thus, the trend of switching from analysis of specific product categories into a wider context has been outlined.

In fact, there are two main ideological flows of incorporating the concept of generational stratification into branding. On the one hand, authors focus on the specifics of generations across selected marketing phenomena and managerial patterns (Costa et al., 2019). On the other hand, the reactional mechanisms of generations to selected established marketing phenomena and managerial patterns are analyzed. Thus, Kisieliauskas and Jancaitis (2022), for example, aimed their research at the analysis of the impact of green marketing on perceived brand value in different generations. While the difference between these two approaches seems be solely formal at first, more detailed analysis of the nature of the approaches outlines the significant difference. This difference lies in the importance of the concept of generational stratification – whether it is an explanatory or an explained phenomenon.

Similarly, Davidaviciene et al. (2019) also focused on the influence of social media on generation Y consumer purchase decisions. However, they form a special flow of the second mentioned approach as they analyzed only one selected generation – generation Y, born between 1977 and 1994. In this case, the generational restriction could be caused by the expected social media literacy of the population, although the age level of social media users is increasing. In this case, an approach based on the sub-segmentation of generation Y based on their preferences

towards individual social media platforms would be beneficiary. Such an approach has been applied by Roth-Cohen et al. (2022), who analyzed the responses of generation X, Y and Z members to mobile advertising.

It is obvious that marketing communication is at the center of the interest of scientific research when the concept of generational stratification is analyzed in terms of marketing (Garbarova & Vartiak, 2022). However, there is also another marketing tool which starts to be analyzed in the scope of the specifics of individual generational segments. This is product – especially service as intangible product (Shams et al., 2020). The explanation of this fact lies in the strong communication potential of product itself in case of services, where their intangibility causes many specifics of marketing management. In the wider perspective, it could be said that in case of services both product and communication policy have strong relations to the brand value subjectively perceived by consumers. Traditionally, brand value sources have been individually identified in various contextual concepts respecting the specifics of markets across regions and sectors where brands are operating. The brand value concept, which has universal applicability, was originally created by Aaker (2012), and its validity across regional and sectoral markets has not been denied so far despite the fact that it has been specified by many authors for the needs of the individual characteristics of markets. Its main pillars are: 1) attitudes; 2) attributes; 3) benefits; and 4) imageries, which are formed by individual factors relevant for each sector in respect to the product category on the market. These brand value sources have already been generally analyzed in the context of marketing communication effectiveness and their mutual functional mechanisms. AL-Nsour and AL-Sahli (2022) analyzed the effects of cash and non-cash communications on brand awareness via empirical evidence from Saudi Arabia. Alakkas et al. (2022) focused on the moderating effect of marketing communication and brand identity on corporate social responsibility and firm-based brand equity. However, previous research by the authors of this article has indicated that the importance of brand value sources varies across product categories. Thus, implications for marketing communication and brand value building and management activities based on this marketing tool should also not be uniform, and they should fully respect the individual architecture of the importance of brand value sources and their components (Kliestikova et al., 2019; Majerova et al., 2020; Gajanova et al., 2021).

Thus, it is obvious that there are three autonomous research flows: 1) brand value and marketing communication; 2) brand value and generational stratification; and 3) generational stratification and marketing communication. Their analysis has not only a general character but is also realized in terms of selected markets (regionally as well as by sector). However, a gap in contemporary research has been identified – the analysis of mutual interactions between brand value perception and generations, with implications for marketing communication in terms of brand value building and management purposes. Such an approach would be beneficial, especially from the point of view of brands which are facing the consequences of the COVID-19 pandemic by trying to explain the functional shortages of thus far valid managerial patterns through the nature of the concept of generational stratification. Only by proving the dependence of the perception of brand value sources and the affiliation of the consumer to the specific generation, along with the theoretical flow of revising the concept of generational stratification for branding purposes under the influence of COVID-19 changes, would this argument be reasoned and useful for the purposes of management facing the consequences of COVID-19. However,

the presumption of the authors tends, on the basis of the literature review, towards the critical questioning of the general applicability of the concept of general stratification for the purposes of the generational adaptation of communication activities of brands.

3. Methodology and data

The data were collected via a questionnaire survey focused on the identification of brand value sources not only in general, but also those which are relevant for specific product categories. The questionnaire is a standard tool for consumer research that it allows a huge quantity of relevant data that can be subsequently statistically tested and later on used as an optimal platform for general statement formulation to be collected. Originally, the questionnaire was a part of wider research focused on the identification of brand value sources among markets and products. However, based on data mining approach, the questionnaire was selected as a suitable source of information to fill the research gap identified in this paper. The structure of the questionnaire was as follows: 1) general perception of brand value sources; 2) perception of brand value sources across product categories; 3) demographic identification of the respondent. The specifics of the research presented in this paper involve a focus not primarily on the product categories but on the brand value sources and their relevance for generational cohorts. Thus, the questionnaire was restructured to fit the aim of the research, and the issues which were analyzed were as follows: 1) general preferences of branded product; 2) perception of selected brand value source – imageries in general and across product categories; 3) perception of selected brand value source – attitudes in general and across product categories; 4) perception of selected brand value source – attributes in general and across product categories; 5) perception of selected brand value source – benefits in general and across product categories; 6) general factors influencing respondents' decision making in selected product category.

The questionnaire was first applied in 2017, and since then it has been repeated as a tracking study. Thus, evolution over time can be observed. However, for the purposes of this paper, the data from before 2020 are relevant as the aim of the paper is to prove the significance of generational stratification in the scope of branding implications before the impacts and malformations of COVID-19 were present. This was realized as a computer-assisted web interview (CAWI method) on a socio-demographic sample of 1,978 respondents. These respondents were Slovak residents older than 15 years of age. Such an age limit was set because of the assumption of autonomous buying behavior – 15 years is considered to be a basic age limit to be able to enter into some form of labor contract according to the Slovak legal system. However, in the scope of generational stratification analysis presented in this paper, such a restriction logically causes the exclusion of generation alpha (born in 2011 and later on). Thus, this generation is not included in the research despite the fact that it is a theoretically recognized generation with significant specifics. Specifically, generations are defined as follows:

- baby boomers: born in 1946–1964;
- generation X: born in 1965–1976;
- generation Y: born in 1977–1994;
- generation Z: born in 1995–2010.

The product categories were set to reflect specific patterns of consumer buying behavior: 1) complex buying behavior (passenger cars); 2) dissonance-reducing buying behavior (banks);

3) habitual buying behavior (cola beverages); 4) variety-seeking buying behavior (sportswear). These types of buying behavior were established on the basis of the level of commitment of the consumer in the process of buying behavior and the differences between brands operating on the market. According to Garbarova et al. (2017), in existing types of buying behavior, the following characteristics are relevant: 1) complex buying behavior (high commitment/significant differences); 2) dissonance-reducing buying behavior (high commitment/insignificant differences); 3) habitual buying behavior (low commitment/insignificant differences); 4) variety-seeking buying behavior (low commitment/significant differences).

Statistical analysis of the data of obtained from the questionnaire is based on contingency tables. The formulated hypotheses are statistically tested within this framework by applying chi-squared tests (Krizanova et al., 2014). Specifically, the chi-squared test of independence between two categorical variables was applied (Parobek et al., 2016). The chi-squared test of independence is the best-known statistical method for evaluating qualitative data from questionnaire surveys. This method has been tested in practice in countless empirical studies. At the same time, the method is built on rigorous statistical theory and enables the exact statistical testing of formulated hypotheses. The chi-squared statistic is calculated as follows:

$$\chi^2 = \sum_{i=1}^{m} \sum_{j=1}^{n} \left[\frac{\left(O_{ij} - E_{ij} \right)^2}{E_{ij}} \right]$$

where

O_{ij} is the observed frequency in the i-th row and j-th column of a contingency table;

E_{ij} is the expected frequency in the i-th row and j-th column of a contingency table;
m is the number of rows and n represents the number of columns in a contingency table.
Expected frequencies in contingency tables are calculated according to the formula:

$$E_{ij} = \frac{O_{i\bullet} \cdot O_{\bullet j}}{N}$$

where

$O_{i\bullet} = \sum_{j=1}^{n} O_{ij}$ is the sum of observed frequencies in the i-th row;

$O_{\bullet j} = \sum_{i=1}^{m} O_{ij}$ is the sum of observed frequencies in the j-th column;

$N = \sum_{i=1}^{m} \sum_{j=1}^{n} O_{ij}$ is the total number of observations.
If the null hypothesis H_0: 'Categorical variables are independent' is true, then the chi-

squared statistic χ^2 has a chi-squared distribution with $k = (m-1)\cdot(n-1)$ degrees of free-dom, i.e., $\chi^2 \sim \chi^2(k)$. The critical region is defined as $\left(\chi^2_{1-\alpha}(k);\infty\right)$, where $\chi^2_{1-\alpha}(k)$ is called a critical value and is obtained as $(1-\alpha)$-quantile of the distribution $\chi^2(k)$, α being the level of significance ($\alpha = 0.05$). The null hypothesis is rejected if $\chi^2 \in \left(\chi^2_{1-\alpha}(k);\infty\right)$, otherwise it is not rejected.

The aim of the statistical analysis was to answer the following questions:

Are there differences in perceiving sources of brand value between different generations?

Are these differences between generations stable in time?

In total, around 60 statistical hypotheses were tested in the article, as a corresponding hypothesis was assigned to each question from the questionnaire. Explicitly stating all 60 formulated hypotheses would be confusing on the one hand and, on the other hand, it would not be possible from the point of view of the necessity of not exceeding the permitted scope of the article. However, the exact form of each specific hypothesis follows immediately from the nature of the chi-squared test of independence of two variables of a qualitative nature and from the specific formulation of the given question in the questionnaire survey, all of which were presented in the article. When using the chi-squared test of independence of two qualitative variables, the null and alternative hypotheses are always formulated in the following general form:

H0: the tested variables are independent;

H1: the tested variables are dependent.

One of the two qualitative variables is always the "generation" variable. The second variable depends on the specific question from the questionnaire. If, for example, the questionnaire question "Indicate to what extent you agree with the statement: I prefer branded products" is analyzed, then the null and alternative hypothesis have the following form:

H0: the degree of agreement with the statement "I prefer branded products" does not depend on the generation;

H1: the degree of agreement with the statement "I prefer branded products" depends on the generation.

4. Results

There is a great variety of different aspects of brand value and its sources. Technically, the answers to each question from each questionnaire (performed in 2018 and 2019) are expressed as a categorical variable (or a set of categorical variables). Each categorical variable is then combined together with the generation variable to form a contingency table within which the chi-squared test of independence is performed to test the formulated hypotheses.

4.1. Preferences of branded products

Three categorical variables were obtained for the three statements presented in the question focused on the identification of the extent to which respondents agree/disagree with the selected statements on the Likert scale, where 1 means *strongly disagree* and 5 means *strongly*

agree. These statements were:
- I prefer brand-name products.
- I consider brand-name products to be superior in quality.
- Brand-name products provide me with a prestige and image, which are important to me.

Two categorical variables were obtained for the remaining questions focused on the identification of: 1) the characteristic with the highest influence on choice of brand (product, price, place, promotion); and 2) the reason that would induce change in favorite brand (quality, price, availability, image). Each was combined with the generation variable to obtain the corresponding contingency table. For illustration, the first contingency table is provided in Table 1.

Table 1. Contingency table for the variables of generation and preference of brand-name products (based on a questionnaire from 2018).

Generation	I prefer brand-name products					Sum
	1	2	3	4	5	
Baby boomers	38	89	193	100	18	463
Generation X	39	83	215	92	34	705
Generation Y	64	154	259	167	61	372
Generation Z	45	97	109	98	23	438
Sum	186	423	776	457	136	1,978

Source: Authors' own calculations.

Data in this contingency table represent observed frequencies O_{ij}. The sums in the final row $O_{i\bullet}$ and column $O_{\bullet j}$ were used to calculate expected frequencies E_{ij} according to formula .

The chi-squared test statistic χ^2 was then obtained from .

The same calculations were performed for the remaining categorical variables, and the results are summarized in the following table. The level of significance is α = 0.05 in all cases. Symbols *, ** and *** denote that the result is significant at 10%, 5% and 1% level of significance, respectively. The results of the chi-squared test for questions focused on the preferences of branded products are shown in Table 2.

Table 2. Results of the chi-squared test for questions 1–3.

Statistic	2018					2019				
	Question					Question				
	1a)	1b)	1c)	2	3	1a)	1b)	1c)	2	3
χ^2	42.01	11.42	22.08	11.47	42.93	41.84	37.34	24.49	20.40	45.35
	***		**		***	***	***	**	**	***

Source: Authors' own calculations.

The null Hypothesis H_0 : 'Answers to given question don't depend on generation.' is rejected in all cases except for questions 1b) and 2) in the project from 2018. Therefore, the way respondents answered these questions depended on the generation in most cases.

Perception of selected brand value source: imageries

Respondents were asked to select what shopping for brand-named products causes them to feel: 4a) prestige, 4b) happiness, 4c) enthusiasm, 4d) expectations, 4e) satisfaction, 4f) blame, 4g) confidence, 4h) modern, 4i) positive associations, or 4j) memories. Questions 4a)-4i) were asked for a general brand-name products. Some of these questions were also asked for specific kinds of products:

personal cars: prestige 4a), modern 4h), confidence 4g), memories 4j), satisfaction 4e);

banks: prestige 4a), expectations 4d), satisfaction 4e), confidence 4g), positive associations 4i);

cola beverages: happiness 4b), expectations 4d), satisfaction 4e), confidence 4g), positive associations 4i);

sportswear: prestige 4a), happiness 4b), expectations 4d), confidence 4g), modern 4h).

The reason for such a limitation of the prospective answers to be selected was caused by the specifics of product categories – i.e., if all the general answers would be used in case of all the product categories, the logic of such a construct would be lost. The results of the performed chi-squared test for the general and all the specific cases are summarized in Table 3. The cell is left blank if the question was not asked.

Table 3. Results of the chi-squared test for the items in question 4 in the questionnaire.

$\div^2$		Question									
Year	Product	4a)	4b)	4c)	4d)	4e)	4f)	4g)	4h)	4i)	4j)
2018	general	35.09 ***	13.67	34.19 ***	36.57 ***	15.23	12.25	40.23 ***	23.30 **	28.20 ***	
	personal cars	22.12				24.21 *		32.86 ***	19.57		15.83
	banks	24.40 *			44.85 ***	34.50 ***		35.30 ***		28.80 **	
	cola beverages		18.30		17.77	24.40 *		36.74 ***		27.55 **	
	sportswear	43.07 ***	20.77		31.59 ***			25.41 **	17.35		

	general	33.22 ***	24.34 **	35.94 ***	20.62 *	23.25 **	23.42 **	24.54 **	25.25 **	19.46 *	
	personal cars	22.38 *				11.63		14.60	9.38		23.82 *
2019	banks	17.05			14.92	24.76 *		17.39		14.11	
	cola beverages		20.54		30.79 ***	8.96		18.98		25.96 **	
	sportswear	31.93 ***	24.51 *		25.09 **			23.42 *	18.06		

Source: Authors' own calculations.

Generally, the results show that the way respondents answer questions 4a)–4i) was mostly dependent on generation, and that the dependence was seen more often in 2019 than in 2018. Nonetheless, this result does not hold in the case of specific types of products. In the area of personal cars, the results mostly show independence in both years. In the field of banks, the results are rather unstable over time. Stability of the results can be seen in the area of sportswear.

4.2. Perception of selected brand value source: attitudes

Respondents were asked to select their attitudes towards brand-name products. They were asked both for a general type of product and for specific types of products – personal cars, banks, cola beverages and sportswear. Prospective answers to be chosen were the following:
- 5a) I intentionally buy brand-name products;
- 5b) I am interested in brand-name products regularly;
- 5c) Brand-name products catch my attention as I consider them superior in quality;
- 5d) Brand-name products catch my attention as I consider them more prestigious;
- 5e) I am interested in brand-name products only rarely.

The results of the performed chi-squared test of independence of answers to these questions on generation is summarized in Table 4.

Table 4. Results of the chi-squared test for questions relevant to attitudes.

$\div^2$	2018					2019				
Product	Question					Question				
	5a)	5b)	5c)	5d)	5e)	5a)	5b)	5c)	5d)	5e)
general	16.68	24.40 **	24.32 **	24.26 **	33.38 ***	46.31 ***	50.54 ***	25.75 **	20.18 *	16.90

personal cars	47.63 ***	31.38 ***	31.46 ***	36.74 ***	38.56 ***	76.28 ***	32.75 ***	30.37 **	36.21 ***	27.69 **
banks	51.16 ***	32.30 ***	48.68 ***	46.37 ***	53.73 ***	28.27 **	25.46 **	29.68 **	21.09	25.16 **
cola beverages	67.10 ***	44.32 ***	45.47 ***	40.57 ***	39.30 ***	67.61 ***	44.20 ***	60.34 ***	40.28 ***	14.73
sportswear	56.11 ***	33.18 ***	43.87 ***	32.06 ***	30.11 **	52.63 ***	44.51 ***	24.49 *	31.87 ***	32.44 ***

Source: Authors' own calculations.

The results clearly show that the answers to these questions about respondents' attitudes are dependent on generation in most cases.

4.3. Perception of selected brand value source: attributes

Respondents were asked to select their expectations about brand-name products: 6a) popular, 6b) available, 6c) modern, 6d) superior, 6e) innovative, 6f) improving the image, 6g) good quality to price ratio, 6h) catching the attention, 6i) creative in advertisements, and 6j) supporting the national economy. Questions 6a)–6i) were asked for a general brand-name product. Some of these questions were also asked for specific kinds of products:

- personal cars: popular 6a), modern 6c), image 6f), quality 6g), creative in advertisement 6i);
- banks: available 6b), innovative 6e), image 6f), quality 6g), creative in advertisement 6i);
- cola beverages: popular 6a), available 6b), innovative 6e), quality 6g), creative in advertisement 6i);
- sportswear: popular 6a), modern 6c), quality 6g), catch my attention 6h), creative in advertisement 6i).

The reason for such a limitation of the prospective answers to be selected was the specifics of product categories – i.e., if all the general answers would be used in all the product categories, the logic of such a construct would be lost. The results of the performed chi-squared test for the general and all the specific cases are summarized in Table 5. The cell is left blank if the question was not asked.

Table 5. Results of the chi-squared test for the items in question 6 in the questionnaire.

$\div^2$		Question									
Year	Product	6a)	6b)	6c)	6d)	6e)	6f)	6g)	6h)	6i)	6j)
2018	general	33.37 ***	18.19	28.83 ***	14.42	22.70 **	21.66 **	21.66 **	30.90 ***	22.09 **	13.63
	personal cars	23.95 *		45.72 ***			35.14 ***	41.61 ***		30.41 **	
	banks		29.69 **			34.90 ***	35.91 ***	41.93 ***		26.19 **	
	cola beverages	38.21 ***	19.93			38.63 ***		34.48 ***		50.81 ***	
	sportswear	27.13 **		19.28				21.40	20.24	34.73 ***	
2019	general	36.76 ***	22.71 **	38.41 ***	21.20 **	13.49	22.30 **	28.29 ***	15.97	15.67	22.97 **
	personal cars	32.12 ***		6.92			19.37	15.83		15.71	
	banks		20.70			28.85 **	45.27 ***	16.35		18.85	
	cola beverages	15.94	12.51			34.50 ***		21.21		21.48	
	sportswear	19.06		12.44				32.33 ***	20.08	33.10 ***	

Source: Authors' own calculations.

The results show that the answers to questions about respondents' expectations are mostly dependent on generation, but only in the case of general product. In the areas of personal cars, banks and cola beverages, the results are rather unstable in time – results from the 2018 project suggested dependence on generation in these areas, while the project from 2019 seems the contradict these previous results quite often.

4.5. Perception of selected brand value source: benefits

Respondents were asked to identify relevant benefits of brand-name products via stating how strongly they agree/disagree with the selected benefits on the Likert scale, where 1 means

strongly disagree and 5 means strongly agree. These statements were: 7a) causing happiness, 7b) increasing social status, 7c) facilitating process of making new friends, 7d) catching the attention of others, and 7e) belonging to the lifestyle of respondents. The respondents were asked both for a general type of product and for specific types of products – personal cars, banks, cola beverages and sportswear. The results from the performed chi-squared test of independence of answers to these questions on generation are summarized in Table 6.

Table 6. Results of the chi-squared test for questions relevant to benefits.

$\div^2$	2018					2019				
Product	Question					Question				
	7a)	7b)	7c)	7d)	7e)	7a)	7b)	7c)	7d)	7e)
general	34.19 ***	13.88	25.85 **	12.71	28.87 ***	40.96 ***	35.90 ***	31.69 ***	28.50 ***	52.65 ***
personal cars	33.53 ***	51.43 ***	30.36 **	44.42 ***	32.42 ***	34.89 ***	19.39	28.86 **	26.99 **	34.44 ***
banks	24.71 *	37.67 ***	47.07 ***	33.52 ***	50.35 ***	24.61 *	34.58 ***	33.43 ***	28.51 **	35.72 ***
cola beverages	48.48 ***	35.02 ***	41.72 ***	34.72 ***	33.67 ***	45.49 ***	32.04 ***	28.37 **	24.94 *	15.79
sportswear	36.95 ***	23.27 *	28.27 **	20.94	45.62 ***	41.06 ***	17.34	40.35 ***	14.66	60.00 ***

Source: Authors' own calculations.

The results clearly show that the answers to these questions about respondents' utility from brand-name products are dependent on generation in most cases.

4.6. Factors influencing respondents' decision making in selected product category

Respondents were asked to select the category of products where their shopping behavior is mostly influenced by brand (personal cars, banks, cola beverages, sportswear). Subsequently, they were asked to identify the most valuable brand in the categories. The list of brands was limited and the brands were included based on two conditions – 1) operating in the national market and 2) being listed among the most valuable brands according to the rankings realized in the Slovak Republic.

The results of the chi-squared test for questions focused on the preferences of branded products are shown in Table 7.

Table 7 Results of the chi-squared test for questions 8–9.

Statistic	2018					2019				
	Question					Question				
	8	9a)	9b)	9c)	9d)	8	9a)	9b)	9c)	9d)
χ^2	52.98 ***	51.29 ***	157.22 ***	58.89 ***	103.60 ***	38.04 ***	79.78 ***	174.90 ***	86.95 ***	92.66 ***

Source: Authors' own calculations.

This table illustrates that the answers to these questions about factors influencing respondents' decision making in selected product categories are dependent on generation in all cases, even at the 1% level of significance.

Discussion

The findings of the research invalidate Leko Šimić and Pap (2021) and Balinska and Jaska (2022), who highlight the need for the revision of the thus far formulated theoretical background of the concept of generational stratification and its implementation into managerial practice. However, this is not a general statement, but is focused on the practice of branding where significant implications for the theory and practice of marketing communication could be identified (as has been already noted in wider socio-economic context by Andronie et al., 2021 and Nica et al., 2021). From the point of view of the research of the concept of generational stratification, the complex approach of Roth-Cohen et al. (2022), who analyzed responses across generations and not separately like Davidaviciene et al. (2019), has been proved a prospective one for the purposes of further research in this area. This is because such a complex approach helps to identify hidden mechanisms of generational reactions to the selected activities of a company. In terms of this paper, this approach has been developed, and not only generations in their plurality have been analyzed, but also at a specific point in time focusing on the years before the COVID-19 crisis. This was performed in order to discuss the real importance of the concept of generational stratification, as it has been questioned in the light and shadow of its explanatory and explained nature, which has been significant for Bonney et al. (2022) and Husain et al. (2022). Moreover, the branding research approach of AL-Nsour and AL-Sahli (2022) and Alakkas et al. (2022), based on the cross-market approach where not only region but also sector should be taken into account to develop functional branding strategy in terms of marketing communication, has been also verified. Referring to Aakers's (2012) quadratic typology of shopping behavior depending on the degree of engagement and differentiation and the national socio-cultural profile of the Slovak Republic, relevant sources of brand value were identified in the context of individual types of shopping behavior alternatively (see Fig. 1).

	High commitment	Low commitment
Significant differences between brands	benefits	imageries
	imageries	attitudes
	attitudes	benefits
	attributes	attributes
Small differences between brands	benefits	imageries
	imageries	benefits
	attitudes	attributes
	attributes	attitudes

Figure 1. Sources of brand value in the context of a typology of shopping behavior
Source: Authors' own processing according to Kliestikova et al. (2019); Majerova et al. (2020); Gajanova et al. (2021).

For individual product categories in the context of the typology of purchasing behavior, it could be stated that:

- for complex buying behavior and dissonance-reducing buying behavior where the representative products are passenger cars and banks, it should be respected that the dependence between generation and its perception of brand value source is present in both cases – in the general approach as well as in the case of individual product categories;
- for variety-seeking buying behavior and habitual buying behavior where the representative products are sportswear and cola drinks, it should be respected that the dependence between generation and its perception of brand value source is present only in the general approach, not in the case of individual product categories.

From the point of view of managerial implications, it is important that the character of the product category should be taken into account when the concept of generational stratification is reconsidered for application. However, this should be done not specifically, but in wider schemes of consumer behavior to make it easier for brand managers to apply revised patterns. In this form, the activities of marketing communication could be fitted to the specific conditions of the brand with respect to the relevance of the concept of generational stratification for the perception of individual brand value sources which should be communicated or forced in their perception by consumers. While in case of complex buying behavior and dissonance-reducing buying behavior the concept of generational stratification is relevant and should be fully respected in the process of setting marketing communication, in the case of variety-seeking buying behavior and habitual buying behavior this concept is irrelevant. This is because, in this case, imageries are the main brand value source, and for them the concept of generational stratification is valid only in gen-

eral. However, it would be also interesting to extend the range of analyzed generational cohorts and to focus on generation alpha (consumers born from 2010 onwards) and the so-called silent generation (1928–1945). Despite the fact that these generations can be considered marginal, they should not be ignored as they are present on the market. A very specific category of implications is created by the social aspect of the selected phenomenon. The generational stratification approach has so far been considered a reasoning for many malformations of the application results of managerial patterns. Age is considered a standard demographic variable with a significant impact on consumer behavior. Similarly, other demographic variables with assumed impacts on consumer behavior should also be critically revised. One of such a variables is gender. However, actual trends tend to the phenomenon of gender equality. Thus, the situation is different in comparison with generational stratification. While age is considered to conform to cluster consumers according to this criterion, in the case of gender, the bipolar structure (or tripolar – male, female, other) is to be avoided, and consumers should not be clustered according to this criterion. Based on the results of the authors' previous research, the specification of gender approach applications in the scope of marketing communication and other fields of marketing and managerial theory and practice should also be realized. On the other hand, further research into this issue should be developed mainly regarding to the national psychographic specifics of consumers. This paper has been focused on the Slovak market conditions and, thus, it could be assumed that the findings would not be valid in markets with significantly different psychographic profiles of consumers. Also, when considering products and services designated for the foreign market despite the fact that originally they would be placed on the national market, it should be revised whether the application of research findings would be beneficiary due to the existence of national specifics of consumer perception.

Conclusion

The aim of this paper was to analyze the concept of fitting brand marketing communication strategy to the specifics of a targeted generational cohort. To fulfill this aim, the method of contingency table evaluation and hypotheses testing via chi-squared tests was used. Data were collected via a consumer questionnaire survey that took place among Slovak residents older than 15 years, with a total number of 1,978 respondents. It was established that generational stratification is only generally relevant for the purposes of brand marketing communication strategy. On the contrary, in selected product categories (personal cars, banks, cola beverages and sportswear), the dependence between generation and its perception of brand value source was not proved – especially in case of brand value source attributes and imageries. This finding is crucial, especially for those brand categories where these brand value sources are the most important for the processes of brand value building and management. However, there is still a robust theoretical background which should be revised in detail in the scope of the applicability of the concept of generational stratification in the practice of branding regarding the national psychographic characteristics of the market.

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ESG INVESTING STRATEGY THROUGH COVID-19 TURMOIL: ETF-BASED COMPARATIVE ANALYSIS OF RISK-RETURN CORRESPONDENCE

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Abstract. *This paper examines the risk-return correspondence of ESG investing strategy through turmoil induced by the COVID-19 pandemic. The ESG segment demonstrates growth in the attractiveness of investments, and the investigation of their risk-return characteristics is significant. The goal of this article is to present the results of our research devoted to two ETF groups passing through a pandemic. One group of ETFs corresponds to low-level ESGs (ESG score <2.5), and another to high-level ESGs (ESG score >7.5). A comparative analysis focuses on risk estimations before, during, and after shock. It applies three approaches to measuring risk and a specially constructed pair of indicators. Additionally, trading volume parameters are analyzed. The results indicate differences in passing through shock for the abovementioned groups. Before shock, the second group was slightly less risky. During shock, the first group demonstrated strong linear dependency between the deepness of the shock and recovery rate, unlike the second. After shock, the second group showed a sharper increase in risk. Moreover, it demonstrated a higher correlation inside the group and a correlation with S&P500 returns. These results also reveal that dependency risk changes from the diversification level of the ETF portfolio. A complex analysis of trading volume activity and the Cowles-Johns ratio indicated the essential difference between groups. The final results indicate that ETFs from the ESG score >7.5 group were more strongly affected by COVID-19 shock. This can be expressed by the more severe "jitters" of returns and trading after the shock. The obtained results can be applied in the practice of forming portfolio investment strategies.*

Keywords: *risk measurement, COVID-19, shock, portfolio management, investment, stock market, ETF, ESG score.*

JEL Codes: *G11, G34, O16, R42*

1. Introduction

The COVID-19 pandemic profoundly affected a large majority of economic activity areas. Investment markets were not spared from the scourge. They experienced jitters at the end of January 2020 and crashed in mid-March. This was an exclusively deep shock that covered all segments of financial markets and almost all national stock markets. The nature of such a shock stemmed from the high uncertainty linked to the pandemic and its fallout on the economy. Thus, Altig et al. (2020) analyzed different indicators of uncertainty and presented great changes in these indicators during the COVID-19 pandemic. Moreover, analysis of the Global Economic Policy Uncertainty Index (n.d.) indicates that the Index had been rapidly increasing in April 2020, when its value increased by more than 1.8 times in comparison with January 2020. Conversely, during late 2020 and at the beginning of 2021, it was essential that uncertainty decrease. Thereby, shock gave rise to uncertainty for investment portfolio management. This recovery was coupled with decreasing uncertainty. In February 2021, the uncertainty index demonstrated values that lower than its values at the end of 2019.

Some of the main questions that arose in every investor's mind were: "Is it necessary to reconstruct an investment portfolio throughout this turmoil? What investment strategy is better for roll-out? What types of securities are more stable in returns?" Of course, all of these questions are accompanied by risk-return correspondence dynamics. These questions are as significant for individuals as they are for institutional investors. One of the segments which is in focus here is ESG investing. This segment supposes considering investments with an analysis of three criteria: E (Environmental), S (Social), and G (Corporate Governance). Research (TKB investment, 2019) revealed that 97% of investors in one way or another analyze indicators of ESG. The background for such an approach stem from two points. The first point, the correspondence between sustainability and ESG, is discussed as an example by Niemoller (2021). The second interesting point is: Does this segment demonstrate sustainability through pandemic turmoil? To substantiate this, there are some publications that serve as examples (Drenik, 2020).

The goal of this article is to present the results of our research devoted to two ETF groups passing through the pandemic pipeline. The first group corresponds to ETFs with a low ESG score. The second group corresponds to ETFs with high ESG scores. ESG scoring produced by MSCI was applied.

The logic of our research was as follows. The first step included the creation of two samples of ETFs based on the ETF Database (n.d.). The first sample that we created included 22 ETFs with ESG score >7.5, and the second included 22 ETFs with ESG score <2.5. The second step focused on the structure of the risk assessment system. We utilized three basic approaches: variability, losses in negative situation, and sensitivity. All approaches were applied to two-time intervals: before and after COVID-19 shock. Additionally, we constructed two indicators for the estimation of shock directly using trading volumes statistics. The third step involved the use of comparative

risk analysis. The results indicate differences in risk changes for both groups. During shock, the first group demonstrated a strong linear dependency between deepness of shock and recovery rate, in contrast to the second. The "after shock" time interval showed a sharper increase in risk for the second group. Moreover, higher beta-coefficients with S&P500 returns were revealed in this group. A complex analysis of trading volume activity and the Cowles-Johns ratio indicated essential differences between groups. Outcomes of this research include the observation that ETFs with an ESG score >7.5 were more strongly affected by COVID-19 shock. This can be expressed by more severe "jitters" of returns and trading after shock. The obtained results can be used for understanding the specificities of ESG investing, involving transition risk among other factors.

2. Literature review

The problems of sustainable development are actively discussed by scientists. One way to address these challenges is to promote investment in ESG, which aims to encourage businesses to move to sustainable ways of manufacturing and doing business.

The literature studying the impact of COVID-19 on stock markets is growing rapidly. In particular, Díaz et al. (2021) examine the impact of COVID-19 on the creation of ESG investing strategies. The authors concluded the following: ESG explains the returns of sectoral portfolios during the pandemic; the environmental and social components of ESG are key factors in the observed patterns studied; and the impact of ESG varies across different sectors.

A study of socially responsible stock indices during COVID-19 was conducted by Capelle-Blancard et al. (2021). Their paper notes that the financial performance of SR strategies varied in the COVID-19 pandemic, but the resilience of SR strategies was comparatively higher.

Lööf et al. (2022) investigated the downside risk of stocks based on ESG ratings. The authors concluded that companies with a higher ESG rating are characterized by lower risk, and at the same time such companies have a lower probability of risk.

An analysis of ESG implementation by Latvian companies was conducted by Zumente et al. (2022). The authors noted that companies listed on stock exchanges have the highest level of ESG implementation, followed by international branches of companies. The researchers recommended that policy makers form the motivation to promote ESG principles.

The question of the true motivations of managers of large companies regarding sustainability was discussed by Adams and Abhayawansa (2022). The authors criticized the reporting approaches used in ESG investing and discussed three myths of sustainable development.

Research on the effect of ESG scores on stock returns and volatility during the COVID-19 crisis was conducted by Yoo et al. (2021). The authors concluded that during a financial crisis an increase in ESG score, especially E score, leads to higher returns and lower volatility, while an increase in GC score correlates with lower stock returns and higher volatility.

Among other problems, researchers such as Vasylieva et al. (2021), Derbentsev et al. (2020), Zyma et al. (2022), Izonin et al. (2020), and Sova and Lukianenko (2020) have explored this phenomenon. Kanuri (2020) discussed attracting ESG ETFs for different types of investors. Cardenas et al. (2020) investigated ESG finance in the post-COVID world. Omura et al. (2020) examined the performance of SRI/ESG investments against conventional investments during the COVID-19 pandemic. Ferriani & Natoli (2020) analyzed whether investors take risks related to

ESG factors into account when making portfolio decisions during COVID-19. Rubbaniy et al. (2021) found a co-movement between the health fear index of COVID-19 and returns on ESG stocks. The authors also observed that the safe-haven properties of ESG stocks are contingent upon the proxy of the COVID-19 pandemic. Folger-Laronde et al. (2020) analyzed the differences and relationships between the financial returns of ETFs and their eco-fund ratings during the COVID-19 pandemic-related financial market crash. Pavlova & de Boyrie (2021) showed that higher sustainability ratings of ESG ETFs did not protect ETFs from losses during the downturn, but they did not perform worse than the market.

3. Data and methodology

3.1. *Data for research*

We chose ETFs (Exchange Traded Funds) for analysis to achieve the goal of our research. This is due to the fact that we focused more on portfolio investors. Using ETFs as an investment instrument is relatively easier for portfolio forming with the desired level of ESG score than creating a portfolio using the classical approach – i.e., creating a mutual fund by buying equities or bonds directly on the market and then calculating the portfolio ETF score as a weighted score value. Our choice was based on Equity ETFs, which invest in various stock assets.

The ETFs database was used to create a sample for the research (in the category "Equity"). The preference of using this database lies in the possibility to use a wide range of different parameters, including ESG scores. Such scores, calculated by the MSCI ESG Quality Score (Moen, 2016), take values from 0 to 10. This scoring represents the ESG quality of ETF constituents. A higher score reflects the fact that the ETF (from the standpoint of holding assets) corresponds more strongly to the parameters of E, S, and G. A score of 10 indicates the underlying holdings as best the ESG (either best globally or best in corresponding branch). A score of 0 corresponds to the worst in class in the sense of ESG. Of course, the "best" and "worst" should be used in the framework of MSCI ESG Fund Metrics (MSCI, 2017). We used ESG score values from 2021.

Two groups were selected from the ETFs database. The criteria of including the ETF into a group was as follows:

- Low ESG score group: ESG score <2.5. Such ETFs correspond to the very low ESG level.
- High ESG score group: ESG score >7.5. Such ETFs correspond to the very high ESG level.

In each group, we ordered ETFs by capitalization level. Samples were formed from the 22 most capitalized ETFs in each group. Hence, the first group included 22 ETFs with ESG scores <2.5, and the second sample included 22 ETFs with ESG scores >7.5. The full list of chosen ETFs is presented in Table 1 and Table 2.

It is necessary to note some remarks about the specificity of forming these groups. First, not all ETFs have ESG scores because not all ETFs reference instruments issued by companies. Secondly, it is logical that our procedure of sample creation was narrowed to only include those parts of ETFs which were scored by the abovementioned MSCI methodology.

The next basic methodological point for the creation of our database was structuring the time period into three sub-intervals. The first interval, which was selected in our research as 01

July 2019–15 January 2020, corresponds to the period "before shock". This period was interpreted as a starting point. Put simply, this period is characterized by stability before the pandemic. The second interval was defined as 16 January 2020–31 March 2020. This period directly corresponds to the shock generated by the COVID-19 pandemic occurring. At the beginning of this period, markets felt jittery and crashed in mid-March 2020 after the announcement of a pandemic by the World Health Organization. The third time interval was identified as the recovery period; it was indicated in our research as 01 April 2020–14 October 2020.

The database for research involved daily prices and trading volumes of chosen ETFs in all three periods. The source of these data is: https://www.investing.com.

3.2. Risk measurement methodology

Risk measurement is an essential element in assessing the attractiveness of an investment. The risk measurement methodology is today highly developed. It includes a wide range of different risk measures which focus on a particular aspect of risk. High-quality statistical data provide the possibility to verify the reasonableness of risk measures. The systematic point of view allows for the combination of these measures in the conceptual approaches to risk measurement (Szegö, 2004).

In methodological terms, we consider four such approaches (Kaminskyi et al., 2019):
- return variability approach;
- quantile-based approach;
- sensitivity approach;
- risk-premium based approach.

We used the first three of these approaches in our investigation. The fourth approach supposes considering risk attitudes which were not included in our set of objectives.

All approaches are based primarily on the estimation of the rate of return, which is identified in arithmetic form $R_{t,t+1} = \frac{(P_{t+1} - P_t)}{P_t}$ or logarithmic form $r_{t,t+1} = ln \frac{P_{t+1}}{P_t}$, where P_t is the price of asset at time t. We applied the arithmetic form for daily returns.

In the first approach, we used two indicators. The first is a range = max-min. This indicator shows the framework in which there are fluctuations in profitability. However, it depends on "crisis deviations". Therefore, we applied it to the period before the onset of pandemic shock and during the recovery process. We also applied a baseline in this approach – standard deviation – which leads to H. Markowitz's approach to risk measurement. Generalizations of this measure form a pair of semi-standard deviations (up and down). The consideration of such a pair provides the possibility to divide deviation up and down from the expected return. Investors prefer to interpret risk measures through the lower semi-variation. As part of this approach, we also considered risk assessment by such indicators as skewness and kurtosis. The former includes asymmetry estimation, and the latter is an indicator of the "heavy tail" of distribution. Expected utility theory notes that investors typically tend to increase skewness and decrease kurtosis (Scott & Horvath, 1980).

The second approach is primarily based on such risk measures as Value-at-Risk (VaR). VaR was elaborated in the mid-1970s and is now widely implemented as a regulative measure of market risk (for example, Holton, 2003). The main advantage of this measure is the transpar-

ency of its economic logic. This value involves three components: losses, probabilities, and time horizon. The disadvantage of VaR is that it offers only one point (quantile) of the curve of loss distribution. Some generalization, via the Conditional Value-at-Risk (CVaR) measure, provides more advance estimation and has coherency properties (ADEH, 1999). CVaR is the conditional average of losses beyond the quantile corresponding to VaR. From our point of view, this risk measure is more adequate when considering sharp falls in crisis conditions. We have applied risk measuring procedures for both measures.

The third approach involves risk measurement in the form of some sensitivity indicators. The *β-coefficient* is most used in investment risk measurement sensitivity indicators. Analysis of *β-coefficients* considers signs and values of *β-as.* Such coefficients involve regression coefficients on some market indicators as a market index. We analyzed its application to the leading USA index, the S&P500.

The fourth approach supposes the calculation of risk premium, which involves the risk attitude of the investor. This approach was initially based on the Arrow-Pratt coefficient of risk aversion, and was later highly developed (Levy & Levy, 1991). The application of the fourth approach for shock analysis also raises discussions. This is because risk attitude may change to a great extent through times of turmoil, and this approach supposes the involvement of additional variables that estimate such changes.

Of course, these four approaches are not exhaustive. A more complete view is presented in Szegö (2004).

A special methodological focus was placed on the estimation of risks explicitly in relation to their passing through shock. We introduced two measures for characterizing "risk-return" correspondence in shock.

The first indicator is "shock deepness" (briefly denoted as SD) which is defined as:

$$\text{Shock deepness} = \frac{\text{Minimum price at second sub–interval}}{\text{Average price at first sub–interval}} - 1$$

The second indicator is "recovery rate" (briefly denoted as RR) which is defined as:

$$\text{Recovery rate} = \frac{\text{Average price at third sub–interval}}{\text{Average price at first sub–interval}}$$

The first indicator can be interpreted as a "risk measure" and the second as a "return measure" (this is a not classical return). SD has the nature of a classical return with some specifications which are linked to the average price through the first sub-interval. This is due to its exclusion from consideration in price volatility before falling. RR is concerned with the correspondence between post-shock prices and pre-shock prices. The logic of using such a form of RR is the desire to achieve a comparison with the pre-shock period, not with the "bottom price" in the second period.

It is necessary to note that the nature of the SD and RR indicators is attached to the conditions of the length of the first and third intervals. The consideration of simple average price through the interval would be contrary to the estimation of possible dynamic increases or decreases. Therefore, the starting and ending point of the first interval were grounded by the balance between "too short" and "too long" periods.

In addition, we used the Cowles-Jones ratio indicator (Campbell et al., 1997). Jitters, in our view, methodologically indicate one of the important aspects of risk – namely, deviation from random walks.

Liquidity risk analysis presents another methodological approach which we applied. More generally, indicators of the change in the intensity of trading operations were considered.

3.4. Comparative analysis methodology

The basic methodological point of our research is to provide a comparative analysis of risk-return correspondence for two samples of ETFs. Comparison is considered by applying risk measures from the abovementioned approaches. The daily trading value is given by similar logic. This comparison was realized through three time periods: before shock, during shock, and after shock (see section 3.1. for corresponding years).

The comparative analysis of dynamic risk-return correspondence for three-time intervals is considered to represent a comparison between the reactions to COVID-19 turmoil of ETFs with high and low ESG scores. Table 1 and Table 2 contain data for the jumping-off points for comparative analysis.

Table 1. Source data (ESG score <2.5)

	Before shock		Shock		After shock	
	Average price	Daily trading volume	Minimal price	Daily trading volume	Average price	Daily trading volume
XLC	51.09	2,985,735	51.18	6,258,462	55.67	3,556,277
VOX	89.78	154,773	89.36	394,889	95.72	211,389
ASHR	28.04	3,850,389	27.98	9,890,577	31.32	4,150,657
KBA	31.01	210,641	31.33	255,169	35.83	147,049
KSA	30.74	629,451	26.93	778,645	27.14	406,759
FCOM	34.25	92,081	34.02	192,611	36.31	133,258
CNYA	28.63	60,988	29.31	83,033	33.37	74,410
IPO	30.60	34,042	30.77	25,482	41.02	103,850
SOCL	33.10	15,875	33.43	28,200	42.59	39,245
IXP	58.94	45,505	58.68	91,204	62.77	26,386
KURE	21.94	13,296	24.42	41,053	31.14	72,530
TUR	25.71	501,996	24.95	600,743	21.03	249,715
PGJ	38.16	17,375	40.95	32,856	47.95	21,694
PSCE	7.15	40,259	4.53	85,299	3.33	66,824
PBS	32.77	11,703	30.90	7,819	32.36	8,463
XWEB	82.60	2,688	77.73	2,953	103.65	7,788

CNXT	27.40	10,268	30.70	37,300	36.60	27,131
GLCN	39.94	5,550	38.12	31,806	42.29	7,948
CHIS	20.88	6,546	20.93	5,488	26.23	6,998
CHIC	22.87	2,744	23.90	7,155	25.09	2,616
ASHX	20.01	1,625	20.24	963	23.08	922
KFYP	27.35	10,734	26.14	13,701	27.74	4,196

Source: Investing.com

Table 2. Source data (ESG score >7.5)

	Before shock		Shock		After shock	
	Average price	Daily trading volume	Minimal price	Daily trading volume	Average price	Daily trading volume
EFA	66.26	23,374,275	62.42	45,584,231	61.22	27,039,635
XLF	28.64	46,143,333	26.98	89,618,654	23.62	66,792,847
VGK	54.97	3,138,271	52.03	6,481,923	50.57	4,687,664
EFG	82.09	184,530	80.01	406,095	83.98	485,408
XLB	58.48	5,826,884	54.06	11,175,192	57.97	6,709,051
BBEU	24.11	504,198	22.80	2,296,282	22.14	2,359,947
SOXX	221.35	487,374	234.77	965,555	271.72	871,968
ESGD	65.21	127,473	61.91	327,471	60.95	290,216
BBCA	25.13	164,132	23.51	335,796	22.84	258,952
SMH	124.78	4,297,681	133.35	5,916,154	154.82	3,641,606
IEUR	46.74	591,375	44.30	1,135,528	43.05	502,852
RDVY	32.82	201,670	31.86	571,833	31.02	285,136
IDV	31.34	730,324	29.57	1,743,387	25.04	1,036,261
EWC	28.92	2,003,941	26.92	4,065,385	26.20	2,656,038
SOXL	13.13	12,597,319	14.46	30,818,269	13.03	26,995,109
BBAX	25.42	111,444	23.25	345,623	22.16	315,934
VAW	127.47	57,620	116.63	180,820	123.71	105,028
EWU	31.99	2,414,865	29.26	4,093,408	25.82	3,484,672
IQLT	30.40	214,095	29.51	514,854	29.75	523,998
IXG	64.97	79,380	60.14	164,354	52.57	38,844
RYT	184.79	42,553	187.11	75,811	198.32	41,478
EPP	45.76	492,927	41.65	858,241	39.58	542,106

The source data demonstrate higher changes in average prices through the shock pipeline.

4. Results

4.1. Measuring the impact of shock and recovery rate

Applying the SD and RR indicators allows us to set interesting dependencies. Figure 1 provides a visualization of this in a 2-dimensional space. Comparative analysis shows the differences in the passing of shock. The first difference is expressed in the more compact nature of high ESG-scoring ETFs. The second difference is in the form of dependency between RR and SD. This tendency looks like a linear form in the case of the group with ESG scores <2.5. The below linear regressions demonstrate this – namely:

$$RR = 1.87 \cdot SD + 1.13 \ (R^2 = 0.74) \text{ for ESG score} < 2.5,$$
$$RR = 1.68 \cdot SD + 1.01 \ (R^2 = 0.58) \text{ for ESG score} > 7.5.$$

Figure 1. Correspondences between fall and recovery
Source: *Constructed by authors*

This can be economically interpreted as follows. The passing through shock of high ESG-score ETFs is more homogeneous. The low ESG-score ETFs demonstrated a more direct tendency towards a "deeper fall", corresponding to lower "recovery rate". The mean value approach indicates that the low-scoring group demonstrates better values

Mean-value approach		
	ETFs with ESG scores <2.5	ETFs with ESG scores >7.5
Average SD	−1.68%	−3.79%
Average RR	109.86%	94.89%

Moreover, the linear coefficient for the low-scoring group is higher (1.87 vs 1.68).

4.2. Changing risk-return correspondence: variability approach

This part of the comparative analysis includes changes in the values of indicators of the variability of returns. The first metric we looked at was range (= max-min). This indicator, of course, represents a rough estimation of return variability, but still indicates frameworks. Statistical analysis indicates that high ESG-scoring ETFs had a lower average range before shock. After shock, they had a higher average range. This indicates that shock more strongly affected increased risk for the group of ETFs with scores >7.5.

Statistical estimations of means, standard deviations, skewness, and kurtoses are presented

in Table 3 and Table 4.

The basic regularities are as follows.

Before the shock period, averages values (through the sample) for risk-return correspondence indicators from the ESG score >7.5 group were better than for the ESG score <2.5 group. The mean of expected returns was higher. The means of standard deviation and kurtosis were lower in the ESG score >7.5 group, as illustrated in Figure 2. Average skewness and kurtosis were the reverse – these values were better for the ESG score <2.5 group.

After the shock period, averages values (through the sample) for risk-return correspondence indicators from the ESG score <2.5 group were better than for the ESG score >7.5 group.

In terms of the changes after experiencing shock, expected returns in the ESG score <2.5 group grew more than in the ESG score >7.5 group. Other indicators, except kurtosis, transformed less than in the ESG score >7.5 group.

Table 3. Statistical risk means for the ESG score <2.5 group

ETFs	min		max		mean		std		skewness		kurtosis	
	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock
XLC	-0.0355	-0.0461	0.0286	0.0660	0.0009	0.0025	0.0094	0.0162	-0.6395	-0.0394	2.1387	1.9691
VOX	-0.0320	-0.0495	0.0274	0.0680	0.0009	0.0025	0.0089	0.0160	-0.5842	-0.0595	1.8851	2.3769
ASHR	-0.0419	-0.0462	0.0346	0.1124	0.0004	0.0026	0.0115	0.0176	-0.4504	1.5892	1.2423	9.7936
KBA	-0.0448	-0.0465	0.0333	0.1059	0.0005	0.0026	0.0115	0.0166	-0.5768	1.5712	1.7070	10.0045
KSA	-0.0255	-0.0478	0.0245	0.0589	-0.0005	0.0019	0.0100	0.0141	-0.0458	0.4453	-0.5460	3.9001
FCOM	-0.0311	-0.0508	0.0267	0.0680	0.0008	0.0025	0.0088	0.0160	-0.5522	-0.1613	1.8433	2.4916
CNYA	-0.0477	-0.0453	0.0335	0.1033	0.0006	0.0027	0.0115	0.0166	-0.6388	1.4048	2.3258	8.9255
IPO	-0.0391	-0.0574	0.0412	0.0770	0.0005	0.0058	0.0127	0.0215	-0.3896	-0.1045	1.0434	0.7895
SOCL	-0.0442	-0.0450	0.0257	0.0523	0.0010	0.0041	0.0109	0.0169	-0.7561	-0.2828	1.9059	0.7192
IXP	-0.0297	-0.0439	0.0258	0.0639	0.0007	0.0022	0.0078	0.0145	-0.5828	0.0514	2.4362	2.6091
KURE	-0.0495	-0.0666	0.0333	0.0456	0.0012	0.0032	0.0136	0.0200	-0.6050	-0.3775	1.8344	0.3810
TUR	-0.0414	-0.0440	0.0411	0.0495	0.0011	0.0006	0.0152	0.0183	-0.0635	-0.1338	0.3548	0.2442
PGJ	-0.0542	-0.0564	0.0613	0.0448	0.0013	0.0029	0.0156	0.0185	0.1649	-0.2988	1.9645	0.1029
PSCE	-0.0815	-0.1339	0.0994	0.1447	-0.0017	0.0038	0.0281	0.0430	0.3966	0.3072	1.0471	1.4597
PBS	-0.0359	-0.0740	0.0263	0.0744	0.0004	0.0034	0.0100	0.0192	-0.8698	-0.3494	2.1583	2.9716
XWEB	-0.0447	-0.0604	0.0193	0.0897	-0.0001	0.0052	0.0115	0.0214	-1.0524	-0.2150	1.7052	1.8559
CNXT	-0.0442	-0.0584	0.0360	0.0874	0.0014	0.0034	0.0138	0.0190	-0.2284	0.2539	0.2013	2.7298
GLCN	-0.0478	-0.0447	0.0363	0.0754	0.0004	0.0027	0.0121	0.0151	-0.7353	0.4576	2.3145	3.3770
CHIS	-0.0333	-0.0531	0.0389	0.0512	0.0007	0.0026	0.0107	0.0158	-0.0716	-0.1057	1.2243	1.4439

CHIC	-0.0556	-0.0426	0.0577	0.0607	0.0007	0.0017	0.0153	0.0157	0.0133	0.0450	1.8385	0.9389
ASHX	-0.0496	-0.0495	0.0268	0.1018	0.0004	0.0027	0.0106	0.0161	-0.9948	1.4147	3.4185	9.7346
KFYP	-0.0692	-0.0435	0.0288	0.1203	0.0001	0.0018	0.0122	0.0165	-1.3565	2.5448	6.8359	18.2393
Average	-0.0445	-0.0548	0.0367	0.0782	0.0005	0.0029	0.0123	0.0184	-0.4827	0.3617	1.8581	3.9572
Rate of increase		123.2%		213.4%		536.0%		149.0%		-74.9%		213.0%

Source: *Estimated by authors' calculation*

The average range through ETFs returns increased from 0.0811 to 0.1330 (64.0% growth).

**Table 4.** Statistical risk means for the ESG score >7.5 group

ETFs	min		max		mean		std		skewness		kurtosis	
	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock	Before shock	After shock
EFA	-0.0274	-0.0536	0.0179	0.0530	0.0004	0.0016	0.0094	0.0146	-1.0341	-0.2549	3.0644	1.9799
XLF	-0.0371	-0.0818	0.0204	0.0718	0.0007	0.0015	0.0089	0.0227	-0.9148	-0.0871	2.0577	1.3147
VGK	-0.0284	-0.0586	0.0216	0.0494	0.0005	0.0017	0.0115	0.0160	-0.7902	-0.4023	2.4369	1.6262
EFG	-0.0282	-0.0441	0.0149	0.0487	0.0006	0.0020	0.0115	0.0129	-1.1492	-0.2257	3.0478	1.9098
XLB	-0.0317	-0.0773	0.0206	0.0744	0.0002	0.0030	0.0100	0.0195	-0.5866	-0.2973	0.8729	2.5089
BBEU	-0.0282	-0.0582	0.0203	0.0471	0.0004	0.0016	0.0088	0.0155	-0.8399	-0.3700	2.4285	1.6158
SOXX	-0.0441	-0.0635	0.0308	0.1020	0.0017	0.0037	0.0115	0.0229	-0.3428	0.1158	0.3455	2.3958
ESGD	-0.0257	-0.0548	0.0172	0.0518	0.0005	0.0016	0.0127	0.0144	-0.8794	-0.3061	2.2728	2.1138
BBCA	-0.0241	-0.0579	0.0153	0.0566	0.0005	0.0020	0.0109	0.0156	-0.9663	-0.3676	2.6873	2.6222
SMH	-0.0431	-0.0614	0.0304	0.0994	0.0018	0.0037	0.0078	0.0225	-0.3102	0.1348	0.2670	2.1080
IEUR	-0.0283	-0.0599	0.0222	0.0509	0.0005	0.0017	0.0136	0.0158	-0.8184	-0.3725	2.5320	1.8805
RDVY	-0.0362	-0.0734	0.0235	0.0884	0.0011	0.0023	0.0152	0.0204	-0.7915	0.0045	1.9653	2.8219
IDV	-0.0295	-0.0705	0.0234	0.0467	0.0007	0.0011	0.0156	0.0176	-0.7140	-0.4811	2.5668	1.8959
EWC	-0.0266	-0.0575	0.0137	0.0519	0.0004	0.0020	0.0281	0.0157	-1.0634	-0.3914	3.4778	2.1439
SOXL	-0.1302	-0.1908	0.0935	0.3051	0.0051	0.0111	0.0100	0.0688	-0.3214	0.0820	0.2442	2.2862
BBAX	-0.0354	-0.0634	0.0190	0.0664	0.0001	0.0018	0.0115	0.0168	-0.8606	-0.1458	2.4490	2.4672
VAW	-0.0324	-0.0818	0.0204	0.0751	0.0002	0.0030	0.0138	0.0200	-0.6038	-0.3162	0.8658	2.6335
EWU	-0.0286	-0.0655	0.0296	0.0459	0.0003	0.0007	0.0121	0.0174	-0.2578	-0.4868	2.7447	1.3036
IQLT	-0.0258	-0.0491	0.0153	0.0441	0.0006	0.0017	0.0107	0.0137	-0.9900	-0.3253	2.3760	1.5025
IXG	-0.0328	-0.0757	0.0198	0.0652	0.0005	0.0013	0.0153	0.0201	-0.8412	-0.1394	2.1821	1.7904

RYT	-0.0389	-0.0672	0.0265	0.0904	0.0009	0.0026	0.0106	0.0191	-0.6702	0.0521	1.5348	3.7655
EPP	-0.0388	-0.0627	0.0231	0.0671	0.0001	0.0017	0.0122	0.0168	-0.9826	-0.0387	4.1519	2.4502
Average	-0.0365	-0.0695	0.0245	0.0751	0.0008	0.0024	0.0123	0.0199	-0.7604	-0.2099	2.1169	2.1426
Rate of increase		90.6%		206.3%		198.0%		98.4%		-		1.2%

Source: *Estimated by authors' calculation*

The average range for the ESG score >7.5 group increased from 0.0610 to 0.1445 (137.1%), which is higher than for the ESG score <2.5 group. Risk-return correspondence on the basis of the classical H. Markowitz approach is given in Figure 2.
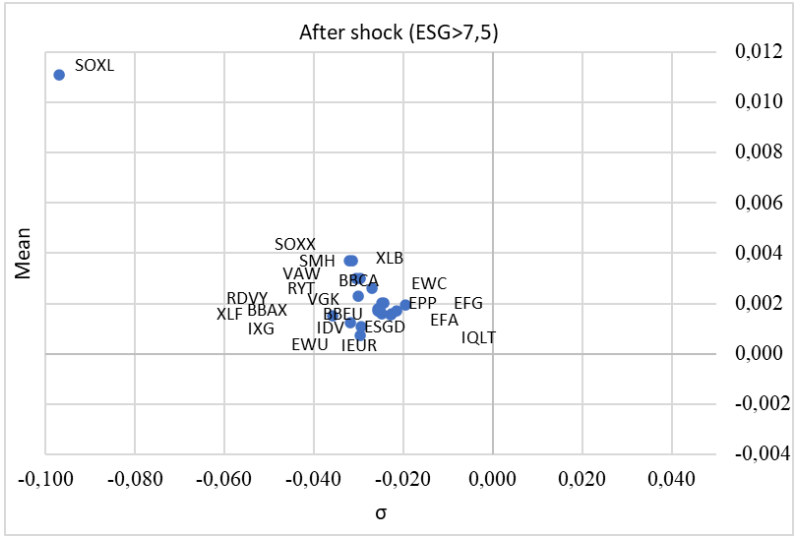
Before shock (ESG>7,5)

After shock (ESG<2,5)
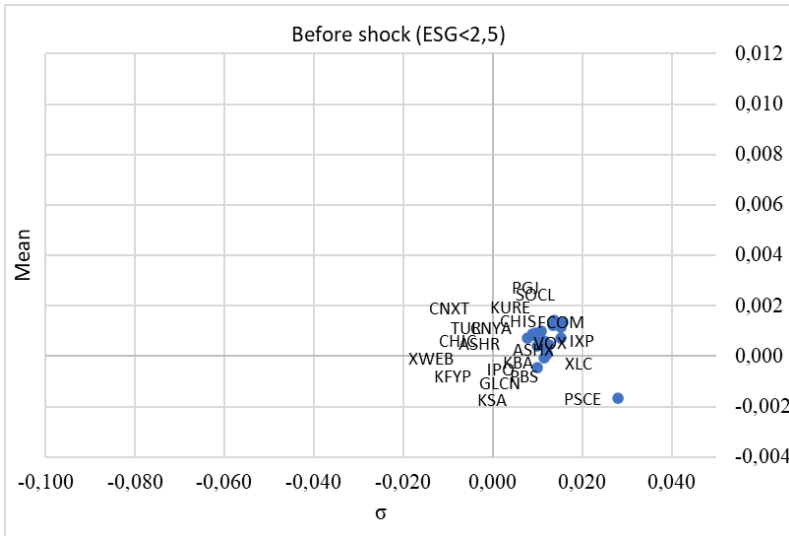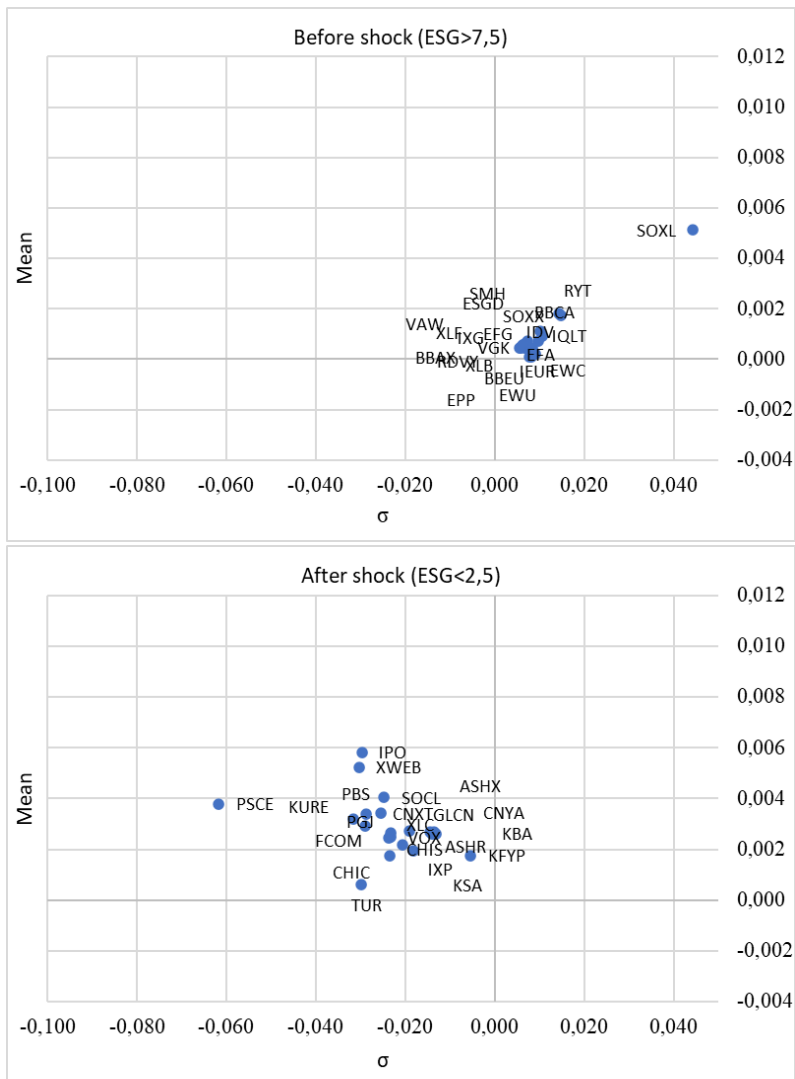
Figure 2. Risk-return correspondence comparison from variability pint of view
Source: *Estimated by authors' calculation*

These results indicate that the range and standard deviation from the before shock period were higher in the first group (ESG score <2.5). After shock, the situation became reversed. These indicators became higher in the ESG score >7.5 ETF group. In the ESG score <2.5 group, skewness changed, and kurtosis grew. Skewness remained negative and kurtosis remained the same in the ESG score >7.5 group.

4.3. Changing risk-return correspondence within the Value-at Risk approach

Consideration of the risk-return correspondence within the VaR approach presents certain differences from the previous approach. The main difference is that risk measures (VaR and CVaR) did not change essentially for the ESG score <2.5 group. In contrast, these measures grew to a considerable degree for the ESG score >7.5 group.

Another important fact is that these measures were better before the shock for the ESG score >7.5 group. However, after the shock the reverse was true. ETFs from the ESG score <2.5 group demonstrated better values of risk measures. This is similar to the results in section 4.2.

Table 5 and Table 6 present changes in the values of risk measures.

**Table 5.** Risk measurement by VaR and CVaR (ESG score <2.5)

Stocks	VaR		CVaR		CVaR/VaR	
	Before shock	After shock	Before shock	After shock	Before shock	After shock
XLC	-0.0158	-0.0235	-0.0221	-0.0351	1.3965	1.4902
VOX	-0.0147	-0.0232	-0.0205	-0.0350	1.3923	1.5065
ASHR	-0.0195	-0.0141	-0.0263	-0.0305	1.3467	2.1716
KBA	-0.0197	-0.0131	-0.0261	-0.0294	1.3236	2.2474
KSA	-0.0171	-0.0182	-0.0191	-0.0301	1.1205	1.6561
FCOM	-0.0146	-0.0237	-0.0205	-0.0356	1.4025	1.5031
CNYA	-0.0196	-0.0144	-0.0265	-0.0300	1.3495	2.0940
IPO	-0.0214	-0.0296	-0.0305	-0.0413	1.4246	1.3926
SOCL	-0.0187	-0.0247	-0.0273	-0.0361	1.4577	1.4640
IXP	-0.0129	-0.0206	-0.0175	-0.0318	1.3567	1.5442
KURE	-0.0228	-0.0315	-0.0337	-0.0415	1.4807	1.3154
TUR	-0.0239	-0.0299	-0.0317	-0.0413	1.3281	1.3792
PGJ	-0.0229	-0.0288	-0.0330	-0.0386	1.4369	1.3401
PSCE	-0.0439	-0.0617	-0.0581	-0.0881	1.3239	1.4291
PBS	-0.0179	-0.0288	-0.0267	-0.0424	1.4951	1.4754
XWEB	-0.0218	-0.0303	-0.0305	-0.0457	1.4009	1.5071
CNXT	-0.0220	-0.0253	-0.0290	-0.0391	1.3165	1.5436
GLCN	-0.0212	-0.0190	-0.0309	-0.0294	1.4567	1.5494
CHIS	-0.0168	-0.0233	-0.0238	-0.0328	1.4133	1.4075
CHIC	-0.0237	-0.0235	-0.0334	-0.0315	1.4088	1.3386
ASHX	-0.0190	-0.0135	-0.0260	-0.0294	1.3684	2.1745
KFYP	-0.0226	-0.0053	-0.0290	-0.0279	1.2848	5.2383
Average	-0.0206	-0.0239	-0.0283	-0.0374	1.3766	1.7622
Rate of increase		16.2%		32.2%		28.0%

Source: *Estimated by authors' calculation*

Table 6. Risk measurement by VaR and CVaR (ESG score >7.5)

Stocks	VaR		CVaR		CVaR/VaR	
	Before shock	After shock	Before shock	After shock	Before shock	After shock
EFA	-0.0119	-0.0229	-0.0171	-0.0322	1.4361	1.4081
XLF	-0.0172	-0.0356	-0.0257	-0.0483	1.4934	1.3544
VGK	-0.0126	-0.0257	-0.0180	-0.0364	1.4325	1.4190
EFG	-0.0121	-0.0195	-0.0172	-0.0284	1.4184	1.4535
XLB	-0.0157	-0.0296	-0.0214	-0.0421	1.3640	1.4246
BBEU	-0.0125	-0.0248	-0.0180	-0.0350	1.4361	1.4112
SOXX	-0.0237	-0.0320	-0.0324	-0.0505	1.3657	1.5800
ESGD	-0.0116	-0.0226	-0.0165	-0.0318	1.4190	1.4044
BBCA	-0.0100	-0.0243	-0.0151	-0.0364	1.5091	1.4957
SMH	-0.0229	-0.0313	-0.0310	-0.0482	1.3544	1.5408
IEUR	-0.0123	-0.0252	-0.0176	-0.0355	1.4366	1.4093
RDVY	-0.0172	-0.0300	-0.0257	-0.0440	1.4903	1.4672
IDV	-0.0124	-0.0294	-0.0183	-0.0411	1.4778	1.3977
EWC	-0.0104	-0.0248	-0.0154	-0.0366	1.4856	1.4752
SOXL	-0.0712	-0.0969	-0.0963	-0.1520	1.3525	1.5687
BBAX	-0.0148	-0.0257	-0.0201	-0.0385	1.3627	1.4990
VAW	-0.0158	-0.0305	-0.0215	-0.0427	1.3574	1.4001
EWU	-0.0132	-0.0296	-0.0194	-0.0406	1.4694	1.3688
IQLT	-0.0112	-0.0215	-0.0156	-0.0304	1.3920	1.4173
IXG	-0.0148	-0.0317	-0.0220	-0.0431	1.4859	1.3590
RYT	-0.0181	-0.0270	-0.0260	-0.0437	1.4364	1.6199
EPP	-0.0141	-0.0252	-0.0188	-0.0375	1.3313	1.4893
Average	-0.0171	-0.0303	-0.0241	-0.0443	1.4230	1.4529
Rate of increase		177.2%		184.3%		102.1%

Source: *Estimated by authors' calculation*

Before shock (ESG<2,5)
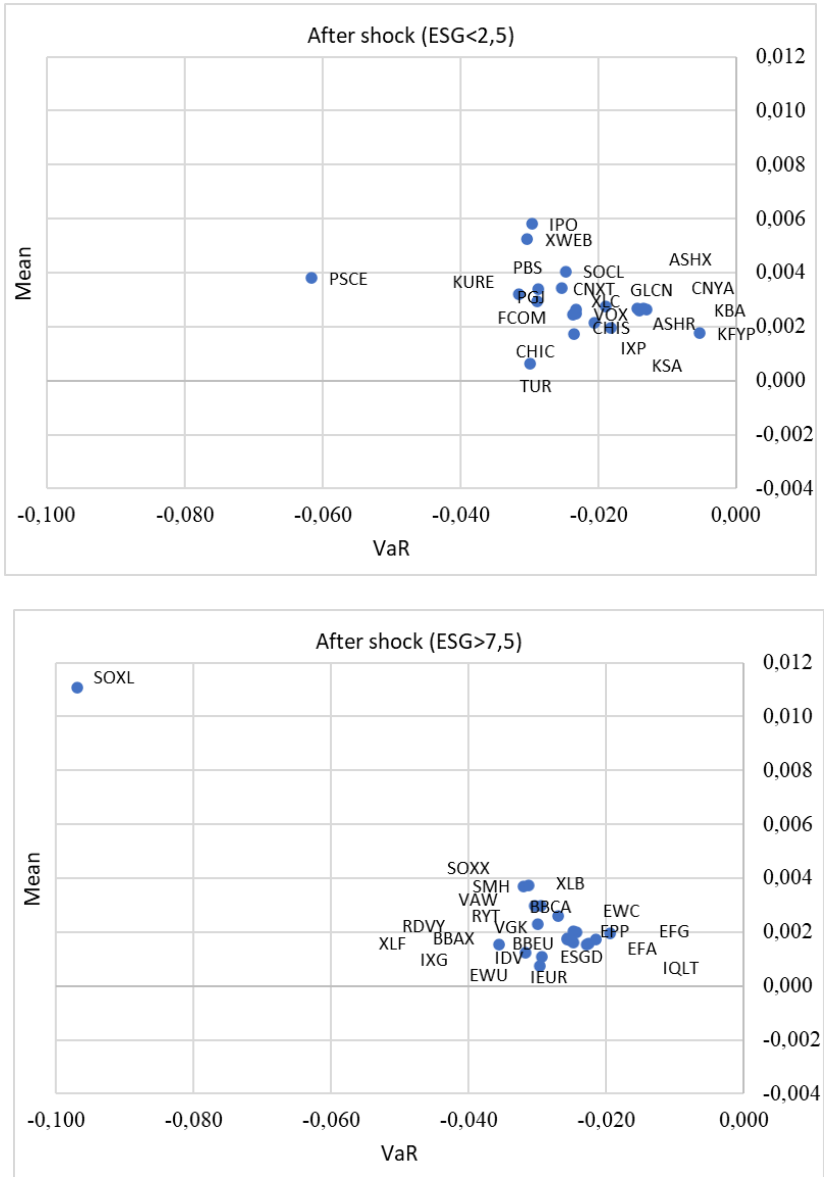

Before shock (ESG>7,5)
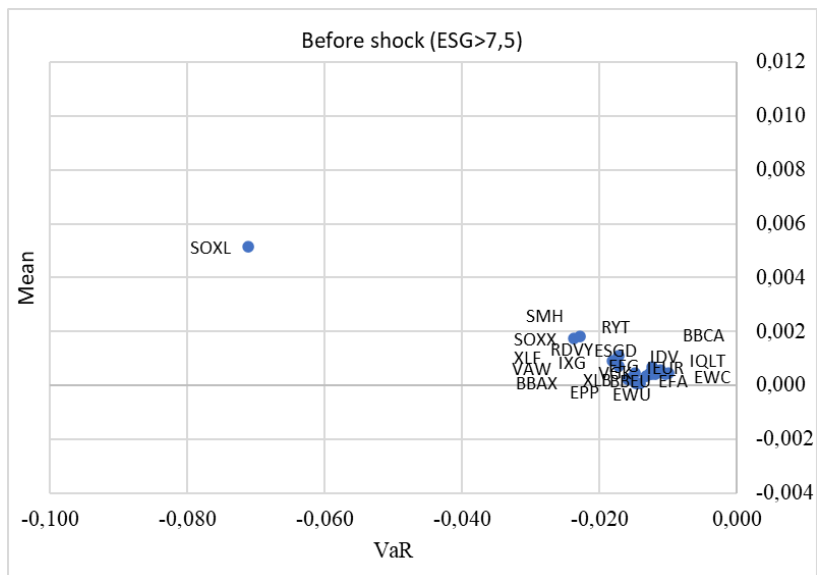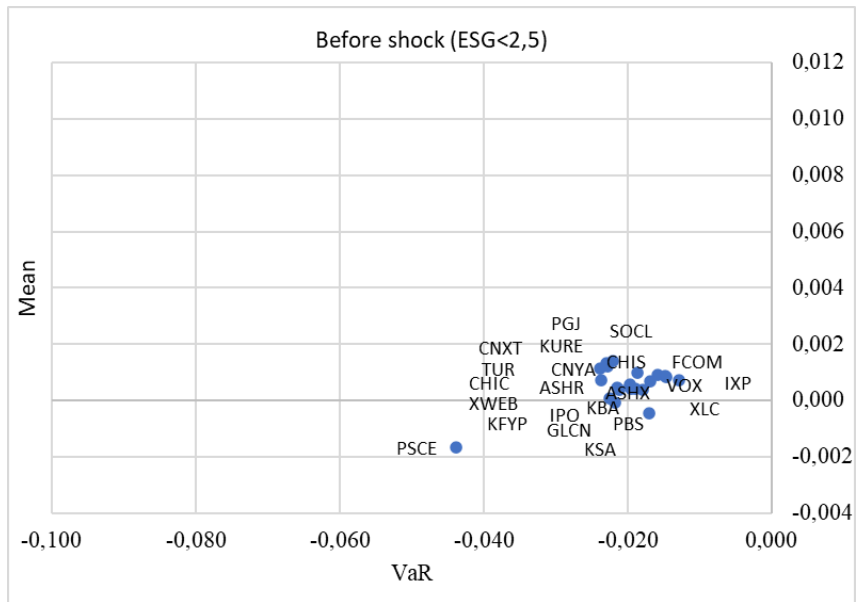
Figure 3. Value-at-Risk estimation

Source*: Estimated by authors' calculation*

4.4. Diversification effect

We have indicated some special effects during our research. Namely, the analysis present-ed in sections 4.2 and 4.3 involved the consideration of the diversification effect. Changes for low diversification ETFs were sharper. The ETFs considered in this research differ by number of components, ranging from 25 to 1,361. We divided each group into 3 diversification levels (Table 7.). These results disclose the diversification effect. The amount of risk at the level of low diversification is higher than in other segments. Moreover, this effect is more pronounced for the second group (ESG score >7.5).

Table 7. Diversification effect

ESG score <2.5	STD estimations				ESG score <2.5	VaR estimations		
Number equi-ties in ETF	Before shock	After shock	Ratio of increas-ing		Number equi-ties in ETF	Before shock	After shock	Ratio of increasing
>100	0.011	0.017	1.508		>100	-0.019	-0.019	1.020
51-100	0.012	0.018	1.505		51-100	-0.020	-0.022	1.128
<51	0.015	0.022	1.454		<51	-0.024	-0.032	1.335
ESG score >7.5	STD estimations				ESG score >7.5	VaR estimations		
Number equi-ties in ETF	Before shock	After shock	Ratio of increas-ing		Number equi-ties in ETF	Before shock	After shock	Ratio of increasing
>100	0.007	0.016	2.192		>100	-0.013	-0.025	1.952
51-100	0.008	0.018	2.209		51-100	-0.014	-0.029	1.990
<51	0.021	0.033	1.625		<51	-0.033	-0.047	1.422

Source*: Estimated by authors' calculation*

4.5. Changes in liquidity and correlation: complimentary estimations

Liquidity was considered by using such indicators as average daily trading volume for ETFs. Our consideration of changes in risk-return supports the assumption regarding changes in daily trading activity through different periods. A comparison of this is presented in Figure 4. Average trading volume increased in the during shock and after shock periods in comparison with the before shock period.
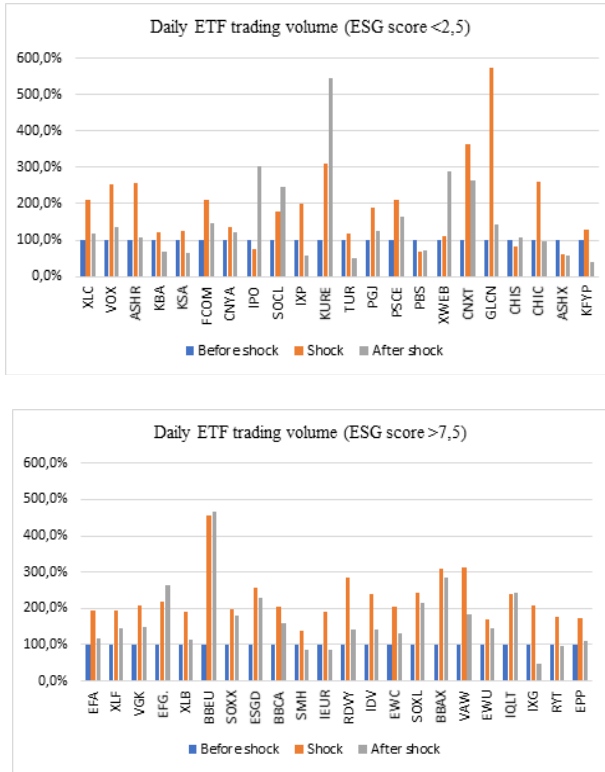
Figure 4. Daily trading volume for ETF

Source: *created by authors*

The ratio of trading volume increases for the second group is higher than for the first group – approximately 22% for shock and 27% after shock (in comparison to before shock).

Table 8. The ratio of increasing average daily volume in comparison with its level before shock

ESG score <2.5		
Number equities in ETF	Before shock	After shock
>100	2.647	1.185
51–100	1.288	1.323
<51	1.744	1.249

ESG score >7.5		
Number equities in ETF	Before shock	After shock
>100	2.509	1.933
51–100	2.055	1.364
<51	1.931	1.483

More detailed analysis involves sensitivity analysis. We analyzed correlations and the beta-coefficient between the returns of ETFs and the returns of the S&P500. This analysis demonstrates the differences between groups and is presented in Table 9. It should be noted that sensitivities and correlations are higher for the ESG score >7.5 group.

Table 9. Sensitivity analysis

	CORRELATION WITH S&P		BETA WITH S&P	
	ESG score >7.5	ESG score <2.5	ESG score >7.5	ESG score <2.5
Whole period	0.91	0.74	1.09	0.76
Before shock	0.85	0.65	1.11	1.00
During shock	0.95	0.84	1.08	0.74
After shock	0.87	0.62	1.10	0.72

This effect is supported by the estimation of the CJ coefficient. The aftershock in the group of ETFs with ESG score >7.5 demonstrates a lower value of this indicator: 0.83 against 1.01 for the ESG score <2.5 group. Before the shock, the average values of the CJ coefficient are approximately equal in both groups.

Liquidity (trading volume indicator) can be considered an additional parameter that complements risk measuring. The basic logic of using a liquidity framework can be explained by no less than three factors. The first factor focuses on the possible problem of low liquidity. As liquidity shows a very low level, it may impact price and, correspondingly, return. Each large trade will affect the returns of assets. Therefore, it may not be correct in this situation to apply measures of ETF market risk (because "market risk" is distorted). The second factor reflects the interdependency between risk-return correspondence and liquidity changing. When risk grows and returns to growth (or the reverse), investors will reconstruct their portfolios, which tend to have higher liquidity. The third factor is connected to portfolio reconstruction during the shock period. We find that the third factor is dominant in the situation under consideration. Investors who focus on ETFs with a high level of ESG score started to more intensively reconstruct their portfolios throughout the pandemic.

The explanation of our results corresponds to the rapid change of investors' preferences. Investors who were stable before the shock period, preferring higher quality of E, S, and G scores, started to switch over to performance measures during shock times. This led to the intensive reconstruction of their portfolios and increases in the risk of return dynamic for high ESG-scoring ETFs. Investors who preferred low-scoring ETFs focused on those most likely to perform initial-

ly. Therefore, they also reconstructed their portfolios, but not so intensively.

Discussion

It is necessary to note that the nature of the indicators introduced attach conditions to the length of the first and third intervals. The consideration of simple average price through the time interval under study may be contrary to perceiving possible increased or decreased price dynamics of concrete ETFs. Therefore, the starting point and ending point of these intervals should be grounded on some balance between periods being too short or too long.

This research was conducted on a sample of ETFs which were ESG scored. The background to this is a special methodology of ESG scoring proposed by MSCI ESG Fund Metrics. The preference of using this scoring is raised from the methodology of estimate ESG score directly for ETF. At the same time, another approach can be performed, involving the application of S&P Global ESG Scores (S&P Global, 2021). The crucial differences in these ESG scores arise from the estimation of companies directly. To some extent, this is a focus on "raw materials". The question of which approach is better for the estimation of passing turmoil remains open.

Conclusion

COVID-19 induced shock effects for the whole of economics, and its consequences will be felt for a long time. This "black swan" had a significant impact on investor sentiments. Rapidly increasing uncertainty in March 2020 led to the reformatting of investment portfolios. Contemporary researchers analyze various aspects of the shock felt by the financial markets. The aim of our study was a comparative analysis of the passing through of shock of ETFs with high- and low-level ESG scores. The basic grounding statement of such a goal was an ever-growing interest in companies that focus on the components of E, S, and G.

In our opinion, these results indicate several interesting points. The first point is that ETFs with high ESG scores were affected more by shock. Considering a pair of imposed indicators, SD and RR, allowed us to reveal some patterns. The first of these was a strong linear dependency between RR and SD for the ESG score <2.5 group. Secondly, comparative analysis of risk levels identifies the following risk changing pattern: before shock, the second group (ESG score > 7.5) was slightly less risky; after shock, the second group showed a sharper increase in risk. Moreover, it demonstrated a higher correlation inside the group and a correlation with S&P500 returns. These results also reveal that dependency risk changes with the diversification level of the ETF portfolio. The complex analysis of trading volume activity and Cowles-John's ratio indicated essential differences between groups. The results suggest that ETFs from the ESG score >7.5 group were more strongly affected by COVID-19 shock. This can be expressed by more severe "jitters" of returns and trading after shock.

By combining the results of the evaluation according to different approaches, indicators of the daily average trading volumes, and CJ indicators, we have formed the following explanation.

The implementation of ESG criteria is a wide-ranging process. It includes many risks, one of which is the "transition risk" to ESG. However, investors are not yet certain in maturity of ESG transformations. As a result of the shock, they do not have a single vision. They actively reconstructed their portfolios at shock, and the growth of trading volumes, which was expressed in the

volatility of returns, is one such indicator of this. At the same time, ETFs with low ESG scores were more understandable for investors. Thus, it can be concluded that to a large extent these results show the evidence of "transition risk" during shock.

We observe that the dynamic of risk-return correspondence for investments with high implementation of the ESG principle should continue. This is important for better understanding their role in investment portfolio management.

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THE INVERTED-U RELATIONSHIP BETWEEN R&D AND PROFITABILITY: EVIDENCE FROM THE SLOVAK MEDICAL DEVICE INDUSTRY

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Summary. *In the knowledge economy, the activities of knowledge-intensive enterprises largely depend on the effectiveness of intellectual capital management and the processes of its creation – research and development (R&D). The present paper analyzes the relationship between the R&D and profitability of the Slovak medical device companies, which belong to high-value-added, knowledge-intensive industries. A sample of 26 companies operating in the Slovak medical device industry for the period of 2015 to 2019 is considered. For data analysis purposes, GRETL software is used. The current study deploys the panel data regression analysis methodology. A regression mod-*

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el is constructed that includes one dependent variable and four independent variables. Using the Breusch-Pagan test and the Hausman test, the feasibility of using the Fixed Effects Method as an estimated parameter for the regression model is substantiated. Diagnosis of the adequacy of this model is performed on the basis of the Normality test, Autocorrelation test, and Heteroscedasticity test, and the feasibility of model estimation is substantiated with robust standard errors. The modeling results show that there is a curvilinear (inverted-U) relationship between R&D and the profitability of Slovak medical device companies, which confirms the hypothesis of the study. RDI has a significant negative impact on ROA at a 1% level, and RDI2 has a significant positive impact on ROA at a 1% level. The current results suggest that more investment in R&D is better for profitability, but only within the zone of optimal R&D activities. Medical device companies that carry out minor R&D activities are encouraged to improve their R&D investment policy to improve their quality and effectiveness.

Keywords: *innovative management, inverted-U relationship, research and development, profitability, medical device companies.*

JEL Classification: *E22, O32.*

INTRODUCTION

The development of the knowledge economy and global competition, where the main source of value creation for business entities is making investments into R&D, innovations, and technological progress (Kabir, 2019; Ullberg, Edvinsson & Yeh-Yun Lin, 2021), provides for the need to identify the most effective directions for such investing. The existence of a high level of risk related to R&D investments, as well as uncertainty about the possibility of obtaining innovative products and services, causes scientists to pay considerable attention to analysing the impact of R&D activities on profitability, as well as identifying those areas for increasing profitability that can be used by companies' management in reviewing R&D investment policy.

A literature review on the problems of R&D investment shows, in general, that investing has a positive impact on business activities (Griliches, 1979; Archarungroj & Hoshino, 1999; Del Monte & Papagni, 2003; Jen Huang & Ju Liu, 2005; Nord, 2011; Özkan, 2022). However, studies conducted by many scientists provide a significant number of warnings related to the feasibility, intensity, and effectiveness of R&D investments for a diverse range of enterprises varying by share of high-tech or low-tech sectors, different stages of innovation, economic development, science intensity, etc. This is justified by the existence of a considerable number of factors affecting the effectiveness of R&D investments for a specified company. As a result, the above-mentioned leads to a lack of universal rules on the procedure for implementing and determining the appropriate volume of R&D investments which enables companies to reach the expected level of profitability.

In our empirical study, we focus on the specific features of an enterprise as well as its external business environment and the peculiarities of the industry. The results of this research enable managers of enterprises to form and incorporate changes into R&D investment policy. This matter is relevant for knowledge-intensive enterprises as they are referred to as cornerstones of the knowledge economy, since their creation of value largely depends on the effectiveness of R&D investment (Van Hemert & Nijkamp, 2010; Doloreux, Shearmur & Rodriguez, 2016; Özkan, 2022). The absence of a linear relationship between the volume of R&D investment and the level of prof-

itability of the enterprise further requires the determination of such a relationship for a particular industry (Jen Huang & Ju Liu, 2005; Fortune & Shelton, 2012; Booltink & Helmhout, 2018; Qi & Deng, 2019; Chou et al., 2022). This enables us to identify a system of parameters, based on which a completely new or adjusted existing R&D investment policy of a company can be built.

The hypothesis of the study is the existence of an inverted-U relationship between the R&D and profitability of knowledge-intensive enterprises. We assume that not all R&D activities by knowledge-intensive enterprises have a positive impact on their profitability. The peculiarities of the industry, the region and many other external factors affect the the amount of R&D, which has a positive impact on profitability. To identify the most effective R&D amount and provide management with recommendations on R&D investment policy, it is necessary to conduct a separate empirical study on the example of a group of enterprises belonging to one industry in one country.

The object of this study is the performance of Slovak medical device companies which belong to a knowledge-intensive industry – which is, in its turn, highly value-added – for the 2015–2019 period. The medical device industry is characterized by active R&D investment and a rapid pace of technological innovation. However, in this industry, it takes a long time to launch new products, and there are always regulatory issues due to safety and validity (Yeom et al., 2021). The incurring of R&D costs and registration costs related to intellectual property rights form the basis for competitive advantages for medical device companies, i.e., a fundamental driver of their profitability. In this regard, for such enterprises the development of an effective R&D investment policy is one of the priority tasks for management.

Although this industry accounts for a relatively small share of total industrial production in the Slovak Republic, it is actively supported financially and institutionally by the government via the creation of a variety of new opportunities for potential investors. This includes stimulating cooperation between companies and scientific institutions, developing a program of investment incentives, establishing knowledge transfer from an academic environment to a medical device business, and creating conditions for benefiting from synergy with the pharmaceutical industry. Having more than one hundred historical examples of successful medical devices that were produced in Slovakia and wide support of this industry from the government, in recent years Slovakia has become an increasingly attractive investment destination for companies producing single-use medical equipment. Most of the medical equipment produced in Slovakia is designated for foreign markets. In accordance with the Recovery and Resilience Plan of Slovakia, investments into the healthcare system increased to 1.16 billion euros in 2021 (Slovak Investment and Trade Development Agency, 2022). Another reason for choosing the object of the study is that the Slovak medical device market is one of the more developed in the Central and Eastern European regions. Entering the eurozone, the terms of trade with Slovak enterprises were significantly simplified and unified, and the pricing system became more transparent, which, in turn, greatly facilitated relations with importers. Considering the case of Slovak medical device companies, the study of the impact of R&D on these companies' profitability is particularly interesting both from the perspective of belonging to knowledge-intensive industries and in terms of the active governmental support of further development of such businesses in the Slovak Republic.

This paper is structured as follows: section 1 provides a literature review; the data and methodology are explained in section 2; the results are presented in section 3; section 4 contains

a discussion and future research perspectives; and section 5 summarizes the conclusions of this study.

LITERATURE REVIEW

In the context of the development of the knowledge economy, characterized by an increase in investment into innovation and technological progress worldwide, more and more scientific attention is paid to the problem of the ratio of innovative efforts of enterprises and the return on them (Franko, 1989; Del Monte & Papagni, 2003; Danielson & Press, 2005; Qi & Deng, 2019). At the level of enterprise, the main indicators of such a relationship are investments in R&D and profitability. The classic authors of economic theory, J. Schumpeter and K. Arrow, considered the problem of the dependence of innovative development on the level of development of competition and the strong market position of a company. However, the management of a company is interested more in reverse dependance, which shows the relationship between R&D and profitability. This enables them to determine a satisfactory amount of investment in R&D to achieve the maximum level of profitability or determine the possible losses/expenditures of the company that it is to incur to achieve the planned goals.

Several scientists have studied this issue based on the contribution of Griliches (1979), who first addressed the role of R&D in ensuring productivity growth. His fundamental ideas were to consider R&D not only as costs, but also as capital, alongside the need to determine return on R&D expenditures for various sectors of the economy while ignoring lagged R&D effects on profitability.

Analysis of papers on the impact of R&D expenditures on financial performance or profitability of a company shows that studies were conducted by scientists on the examples of various sectors of the economy, including: firms in the chemical and pharmaceutical industry (Archarungroj & Hoshino, 1999); manufacturing firms (Del Monte & Papagni, 2003); non-finance firms (Natasha & Yanthi, 2009); pharmaceutical companies (Nord, 2011); pharmaceutical firms (Fortune & Shelton, 2012); manufacturing firms (Ayaydin & Karaaslan, 2014); oil production companies (Varahrami, 2015); manufacturing companies (Lome, Heggeseth & Moen, 2016); mining firms (Rafiq, Salim & Smyth, 2016); pharmaceutical companies (Freihat & Kanakriyah, 2017); medical device companies (Luo, Hu & Yu, 2018); pharmaceutical companies (Dalvadi & Mansuri, 2018); production companies (Erdogan & Yamaltdinova, 2019); Big Data companies (Qi & Deng, 2019); pharmaceutical companies (Eldawayaty, 2020); and industrial firms (Özkan, 2022). Moreover, the examples of companies at different levels of innovative capacity and technological development (i.e., high-, medium-, low-intensity), and in different countries worldwide (e.g., China, Egypt, Italy, India, Indonesia, Iran, Japan, Jordan, Norway, Taiwan, Turkey, USA) have been considered.

In such studies, authors mainly determine the presence of the positive significant impacts of the different indicators which characterize the R&D activity of the company (R&D costs, R&D expenditures, R&D intensity, R&D intensity squared) on different types of indicators of financial performance or profitability (IRR, ROA, ROE, ROS, GPM, EPS, Operating Income Margin, Ordinary Income Margin, Profit Margin, Yearly Growth Rate, Aggregate Growth). As some results show, companies engaged in R&D coped with the consequences of the financial crisis more effectively (Lome, Heggeseth & Moen, 2016). Moreover, companies more active in R&D are more profitable than younger non-innovative firms (Rafiq, Salim & Smyth, 2016).

The basis for determining the impact of R&D on profitability is often chosen to be the activities of enterprises for different periods of time, from 3 to 10 years. Various methods, such as the method of least squares, logistic regression, panel data regression analysis with different estimators (fixed effect method, random effect method), are used to assess the extent of the impact.

Thus, a significant number of researchers confirm the existence of a positive linear effect of R&D on the profitability of companies. At the same time, some scientists have discovered no significant relations of R&D with profitability (Del Monte & Papagni, 2003; Eldawayaty, 2020; Özkan, 2022), or in some cases even a negative relation with profitability indicators (Eldawayaty, 2020). This can be partially caused by the imitation of the process of creating innovations by the enterprises (Del Monte & Papagni, 2003), their low-quality level (Fortune & Shelton, 2012) or the possibility of obtaining a return on R&D in subsequent reporting periods (Özkan, 2022). The rationale for no significant or negative relations through the recognition of such reasons still indicates that scientists support the position on the existence of a linear relationship between R&D and profitability.

However, some scientists have found the presence of a nonlinear relation, characterized by a change in the level of R&D impact on profitability depending on the number of R&D investments of the company. Thus, Jen Huang and Ju Liu (2005) discovered that innovation capital investments have an inverted U-shaped curvilinear relationship with performance. The presence of the same relationship was found by Erdogan and Yamaltdinova (2019) when studying the impact of R&D impact on the financial performance of production companies listed in Borsa, Istanbul; by Booltink and Helmhout (2018) in the case of the non-high-tech European SMEs; and by Chou et al. (2022) in a study of Taiwanese food firms. Data from the above-mentioned studies reveals that R&D has a positive significant impact on profitability, and R&D squared has a significant negative impact. Subsequently, expanding R&D investments has a marginal diminishing or even negative effect on profitability.

Studies by Fortune and Shelton (2012) and Qi and Deng (2019) show a reverse nonlinear relation: the indicator of R&D has a negative impact on profitability, whereas R&D squared has a positive one. This means that investments in R&D have a positive effect on the profitability of the company within a certain optimal range only. In case of going beyond such a range – towards either increasing or decreasing the number of investments in R&D – a negative impact on the profitability of a company is observed. We refer to the studies which indicate the existence of a positive or negative linear impact of R&D on profitability to be a special case of an inverted-U relationship between such variables. Considering the above, the objective of this study is to investigate the existence of a non-linear relationship between R&D and the profitability of Slovak medical device companies.

In the following section, the data and research methodology are explained and the hypothesis of the study is tested. Then, the data analysis results, limitations and implications are discussed, and future research perspectives are proposed.

DATA AND METHODOLOGY

To test the suggested research hypothesis in this study, the activities of 26 Slovak medical device companies (Appendix A) for the 2015–2019 period were analyzed. The data used in this study was obtained from the annual financial statements of Slovak companies, available on

the official websites of the companies, as well as from the Slovak FinStat (2022) database. The 2015–2019 period was chosen for analysis taking into consideration the fact that the financial statements of companies in the Slovak Republic are published in statistical databases with a time lag of up to 1.5–2 years. Therefore, 2019 was the last year with full and reliable financial information available for conducting our research.

According to the classification of SK NACE 2, the companies chosen for this study belong to group 32500: "Manufacture of medical and dental instruments and supplies". In terms of form of ownership, medical device companies are mainly represented by limited liability companies (24), one company is a joint-stock company, and one is a general partnership. The analysed population of companies has the following structure by type of ownership: private domestic – 94%; international with a predominant private sector – 3%; foreign – 3%.

To explain the relation between R&D and profitability, one dependent variable and four independent variables (R&D variables, control variables) were chosen. The variables used in the analysis and their calculations and abbreviations are given below in Table 1.

Table 1. Variable definitions and abbreviations

Variable	Calculation	Abbreviation
Dependent Variables		
Return on Assets	Net turnover/Total Assets	ROA
Independent Variables		
R&D Variables		
Research and Development Intensity	R&D costs/Total Sales	RDI
Research and Development Intensity Squared	Squared function of R&D	RDI2
Control Variables		
Leverage	Total liabilities/Total Assets	LEV
Size	Logarithm of Total Assets	l_S

Source: *compelled by the authors*

Return on Assets (ROA) ratio was used as a dependent variable, which reflects the profitability of the enterprise in relation to the assets invested to generate revenue. This ratio actually reflects the quality of assets used, regardless of their size, characterizing their financial and operational performance. The choice of ROA as a dependent variable, in relation to which the impact of R&D of the enterprise was studied, was also made by Archarungroj and Hoshino (1999), Jen Huang and Ju Liu (2005), Danielson and Press (2005), Ayaydin and Karaaslan (2014), Varahrami (2015), Erdogan and Yamaltdinova (2019), Qi and Deng (2019), Eldawayaty (2020), and Özkan (2022).

The dynamics of ROA of the Slovak medical sphere and medical device companies during the 2015–2019 period is presented in Figure 1.
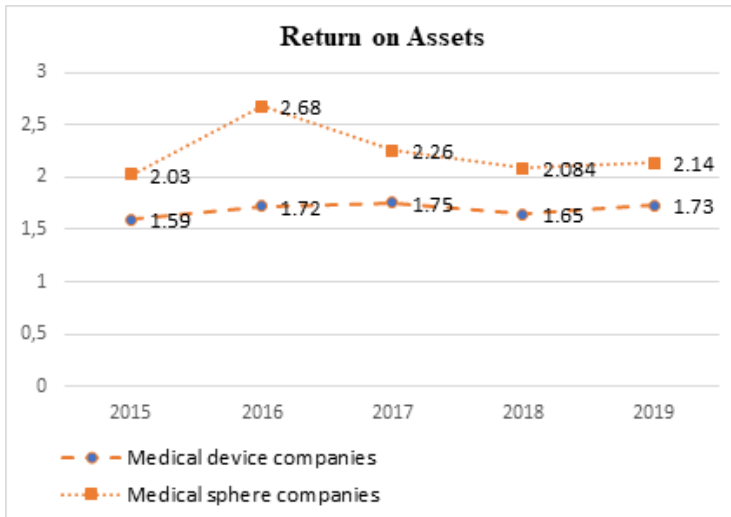
Figure 1. Development of ROA in the Slovak medical sphere and medical device companies in the 2015–2019 period

Source: *developed by the authors*

Figure 1 shows that the average value of ROA during the five-year period (2015–2019) underwent movements or fluctuations. For medical device companies, ROA ratio increase is seen during the 2015–2017 and 2018–2019 periods, and a decrease in ROA ratio is observed from 2017 to 2018. In 2017–2018, the general tendency of ROA for the medical device companies illustrates the general changes in this indicator for the medical service companies in the Slovak Republic.

The independent variables identified for this study were divided into two groups. They were calculated based on the use of the financial statements of the Slovak medical device companies, as well as updated financial information disclosed by the FinStat (2022) database. The first group of independent variables comprises the variables that characterize R&D activities, i.e., R&D intensity (RDI) and R&D intensity squared (RDI2). The choice of these two variables is grounded based on prior research which reveals that R&D intensity is an indicator of R&D investment that may result in financial performance. R&D intensity is calculated as the ratio of R&D costs to total sales of a company. R&D intensity was applied to detect the non-linear relationship between R&D and profitability. These two variables are also used in a number of studies carried out by Fortune and Shelton (2012), Booltink and Helmhout (2018), Qi and Deng (2019), Erdogan and Yamaltdinova (2019), Eldawayaty (2020); Özkan (2022), and Chou et al. (2022).

To avoid the impact caused by other variables that are excluded from our model, this paper refers to prior research (Jen Huang & Ju Liu, 2005; Booltink & Helmhout, 2018; Qi & Deng, 2019; Ievdokymov et al., 2020; Eldawayaty, 2020; Chou et al., 2022; Serpeninova et al., 2022; Zavalii, Vikarchuk & Constantinou, 2022). Furthermore, two company characteristics were chosen to be control variables: leverage (LEV) and company size (l_S).

To determine the existence of an inverted-U relationship between R&D and profitability for Slovak medical device companies, panel data analysis was used. After controlling R&D variables and control variables, we have the following empirical model:

ROA it = α + β1 RDI it + β2 RDI2 it + β3 LEV it + β4 l_S it + ε it

where: ROA – dependent variables; $_i$ = entity and $_t$ = time;
α – identifier;
μ – variance introduced by the unit-specific effect for unit i;
β – regression coefficient;
RDI, RDI2, LEV, l_S – independent variables; $_i$ = entity and $_t$ = time;
$ε_{it}$ – error term.

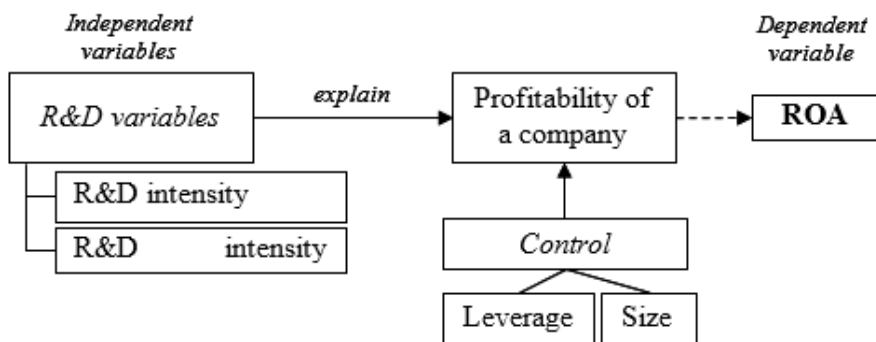The theoretical framework of the study is given below in Figure 2.

Figure 2. Conceptual framework of the study
Source: *developed by the authors*

RESULTS

Table 2 presents the descriptive statistics for each variable (observation, mean, median, standard deviation, minimum, maximum).

Table 2. Descriptive statistics of variables for this study

Variables	Observation	Mean	Median	St. Dev.	Minimum	Maximum
ROA	130	1.69	1.46	1.12	0.00247	7.54
RDI	130	0.218	0.144	0.253	0.0192	1.87
RDI2	130	0.111	0.0208	0.342	0.000	3.51
LEV	130	0.598	0.535	0.460	0.0609	2.32
l_S	130	11.2	11.0	1.42	8.08	16.2

From Table 2 it can be concluded that the largest deviations in variables are related to ROA and l_S. The differences between the minimum and the maximum values of ROA point out that the profitability levels of medical device companies are quite distinct. For some variables (ROA, LEV, l_S), the mean value is greater than the standard deviation, thus the data in these variables has a small distribution. In particular, standard deviation for RDI is 0.253. The average leverage ratio is 0.598, which means that approximately 60% of the total assets of medical device companies are financed by taking out loans.

Based on the constructed correlation matrix (Figure 3), where correlation coefficients between the variables of a model are given, it is generally possible to conclude the absence of a multicollinearity problem. The indicator of correlation between RDI and RDI2 is 0.9, which may indicate the partial existence of a problem between independent variables. However, Özkan (2022) states that this is normal in the regression analysis performed to check the effect of interrelated variables on the financial performance indicators.
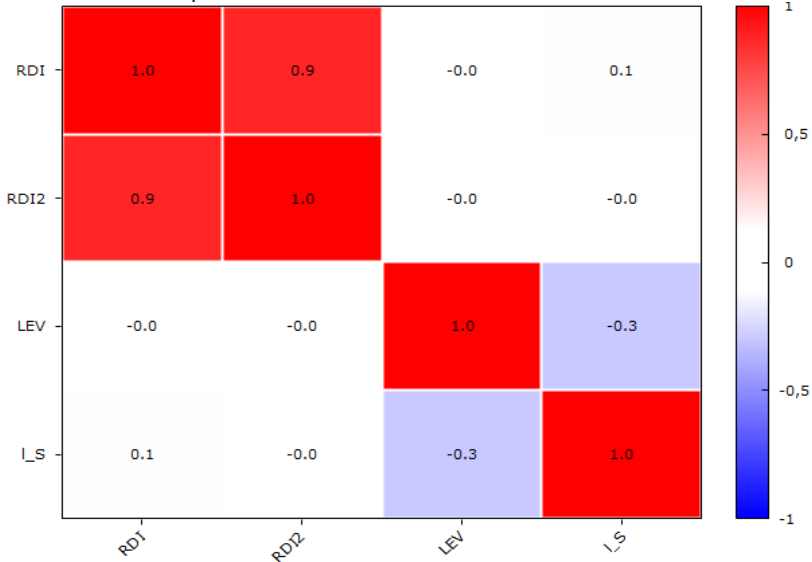

Fig. 3. Correlation matrix of the model

Source: *calculated via Gretl software package*

Before carrying out regression analysis of panel data, we chose a method that adequately corresponds to the data of the formed model. Having applied the *F*-statistics test, it was established that for the value $F(25, 100) = 19.1524$, *p*-value (8.47724e-028) is less than 0.05, which testifies against the null hypothesis regarding the adequacy of the pooled OLS model, and confirms the feasibility of using the Fixed effects method (FEM). The feasibility of preferring this method to the Random effects method (REM) was also confirmed by the application of the Hausman test and the Breusch-Pagan test. Thus, the *p*-value (0.0146436) of the Hausman test is less than 0.05, which refutes the null hypothesis regarding the consistency of REM estimates in favor of FEM.

The *p*-value (3.71094e-033) of the Breusch-Pagan test is less than 0.05, which also testifies against the null hypothesis regarding the adequacy of the pooled OLS model, and, in turn, confirms the feasibility of using FEM.

In order to check the adequacy of a model with data on the activity of the medical device companies and to identify ways of its improvement, the model should be diagnosed through the Normality test, the Autocorrelation test, and the Heteroscedasticity test using the Gretl software package.

The results of the analysis of the normality of the distribution of the residuals of a model made it possible to reveal the non-normality of the distribution of errors. In particular, this was the case for the *p*-value of 2.24623e-017, which is less than 0.05 and does not confirm the null hypothesis regarding the normality of the distribution of residuals. Applying the Wooldridge test for autocorrelation in panel data made it possible to reveal the absence of first-order autocorrelation, since the value of $F(1, 25) = 4.21696$ with *p*-value = 0.0506228, which is greater than 0.05, confirmed the null hypothesis regarding no first-order autocorrelation. To determine the level of heteroscedasticity of the model, the non-parametric Wald test was used, which enabled the identification of its presence. In particular, it made it possible to obtain *p*-value = 0. This value is less than 0.05, as a result of which the null hypothesis – that the objects have the same variance of errors – is not confirmed, and there is heterogeneity of observations characterized by unequal variance of the random error of the model.

The unsatisfactory results of the Normality test and the Heteroscedasticity test indicate the low adequacy of the model for the data used. To improve it, the use of robust estimators was proposed, which allow outliers in a model to be identified and their impact on the results of panel data regression analysis to be minimized or eliminated. Such a practice of model estimation with robust standard errors is quite common among scientists who analyze the relationship between the R&D and profitability of a company (Özkan, 2022, Chou et al., 2022).

Tables 3 and 4 present the results of analysis carried out using FEM. The use of FEM allows the β-coefficients of the model to be effectively estimated based on the fact that α are fixed unknown parameters of the model (omitted or unobserved), which are independent of errors ε$_{it}$. It also allows the influence of such parameters that define the individual characteristics of the objects being studied to be estimated. The estimation of such parameters is carried out by including a dummy variable for each object, which are fixed effects that are constant for each object, *i*, for the corresponding period.

Table 3. FEM (Robust standard errors) using observations 1–130

Variable	Coefficient	Standard error	*z*	*p*-value	Significance by *t*-statistics
const	6.08097	1.56272	3.891	9.97e-05	***
RDI	−3.10908	0.516056	−6.025	1.69e-09	***
RDI2	1.19868	0.258445	4.638	3.52e-06	***
LEV	1.94665	1.02429	1.900	0.0574	*
l_S	−0.447317	0.174332	−2.566	0.0103	**

Table 4. FEM (Robust standard errors) using observations 1–130

Indicator	Value	Indicator	Value
Mean dependent var.	1.689815	S.D. dependent var.	1.122728
Sum squared resid.	14.03078	S.E. of regression	0.374577
LSDV *R*-squared	0.913713	Within *R*-squared	0.549584

Source: *calculated via Gretl software package*

Based on the regression results of the model, we derived the following equation:
ROA = 6.08097 − 3.10908 RDI + 1.19868 RDI2 + 1.94665 LEV − 0.447317 l_S

The results of regression analysis using FEM (Robust standard errors) (Table 3) indicate that all chosen independent variables for the model are statistically significant, but with different levels (the presence of corresponding asterisks). Multicollinearity between independent variables was not detected, in the presence of which one of the variables would be automatically rejected by the Gretl software. The most significant parameters of the model are Const (*p*-value = 9.97e-05), RDI (*p*-value = 1.69e-09), and RDI2 (*p*-value = 3.52e-06) – i.e., these indicators have the most impact on ROA.

Applying the equation of the model obtained, we found that some variables (const, RDI2, LEV) have a positive relationship with ROA, while others, i.e., RDI, l_S, have a negative one. In particular, the more detailed content of the regression equation coefficients is as follows: 1) if RDI is increased by 1, then ROA decreases by 3.10908; 2) if RDI2 is increased by 1, then ROA increases by 1.19868 relatively; 3) if LEV is increased by 1, then ROA increases by 1.94665; and 4) an increase of l_S by 1 causes a 0.447317 decrease in the ROA ratio.

Table 4 indicates that the coefficient of determination (LSDV *R*-squared) of the model is 0.913713. This means that 91.37% of the variation of the ROA can be explained by the variation of the independent variables (const, RDI, RDI2, LEV, l_S), while the remainder of the impact is caused by other variables that are not the subject of this study. The value of within *R*-squared shows that 54.96% of the variance of ROA within medical device companies is captured by the model.

DISCUSSION

This study examines the role that R&D expenditures play in the profitability of Slovak medical device companies. Rather than arguing that R&D investments have a significant positive or negative impact on the profitability of medical device companies (Luo, Hu & Yu, 2018; Yeom et al., 2021), we show that there is a curvilinear (inverted-U) relationship between the two above-mentioned variables. To be more specific, as a result of panel data regression analysis it has been determined that, while R&D intensity has a significant negative impact on profitability at a 1% level, at the same time R&D intensity squared significantly positively influences profitability at the 1% level. This confirms conclusions regarding the limited role of R&D in ensuring the profitability of the enterprise due to limitations in the process of creating innovations or their

low-quality level (Del Monte & Papagni, 2003; Fortune & Shelton, 2012; Luo, Hu & Yu, 2018). Thus, R&D has a positive effect on the profitability of medical device companies only when a certain critical input volume is achieved. At the same time, taking into consideration the objective factors justifying the impossibility of the constant growth of a company's profitability – e.g., market volumes, production capacity of the company, etc. – there is an initial critical volume of R&D, after which a negative relation with profitability is observed. The gap between the critical input and output volumes of R&D forms a zone of optimal activities, which is characterized by a positive impact on the profitability of the company.

The results of regression analysis enabled it to be established that in order to increase the profitability of Slovak medical device companies, the annual amounts of R&D investments are to be increased. Such suggestions are consistent with the results obtained by Luo, Hu & Yu (2018), which suggest that medical device enterprises with higher R&D expenses present better operational performance. At the same, an important issue is determining the optimal level of R&D investments, which is in the scope of future research. This is because it is this optimal value that should be the starting point for establishing the R&D investment policy of a company by the management. Jen Huang and Ju Liu (2005) defined the optimal level of R&D investments as 6.39% for the top 1,000 Taiwanese companies. Booltink and Helmhout (2018) found the critical threshold for investments in R&D for non-high-tech SMEs to be 2.1%. Knowing the available amount of R&D of the enterprise and the value of the initial critical amount of R&D, it is possible to determine the potential to invest in R&D and bring it into accordance with the general strategy of the company's development.

Based on the actual values obtained, which characterize the non-linear relation between R&D and profitability, two types of such inverted-U relations can be distinguished. In the first case, R&D has a positive significant impact on profitability, and R&D squared has a negative one (Jen Huang & Ju Liu, 2005; Erdogan & Yamaltdinova, 2019; Booltink & Helmhout, 2018; Chou et al., 2022). In the second case, the opposite situation can be observed, i.e., R&D negatively influences profitability, while R&D squared has a positive impact (Fortune & Shelton, 2012; Qi & Deng, 2019). The results of our study support the second scenario. Depending on the type of inverted-U relationship between R&D and profitability, managers are expected to set up the R&D investment policy of a company accordingly. That is, decisions are to be made to increase, decrease or maintain the existing volume of R&D investments in order to achieve the optimal level of profitability.

The results of panel regression analysis also made it possible to identify the presence of a significant positive impact of LEV on ROA at the 10% level, and the presence of a significant negative impact of l_S on ROA at the 5% level. The latter contradicts the results of the study by Archarungroj and Hoshino (1999), which revealed the positive role of larger firm size in ensuring the strength of the relationship between R&D and profitability.

Some limitations should be taken into account when considering the results of our study. Firstly, in our study ROA was chosen as a profitability indicator of medical device companies, which is influenced by the R&D expenditures incurred by a company. Our study results can be expanded and clarified by further studies in which other profitability indicators as dependent variables can be applied. Second, the list of independent variables that characterize the R&D activities of medical device companies can be expanded. In particular, such indicators could in-

clude the number of registered patents, the amount of internally generated intangible assets of the company (patent rights), R&D Investment (internally and externally-sourced), R&D Intensity and Degree of Internationalization, Intangible Asset Intensity, and R&D growth rate, which are widely mentioned by other authors (Danielson & Press, 2005; Fortune & Shelton, 2012; Booltink & Helmhout, 2018; Luo, Hu & Yu, 2018; Qi & Deng, 2019). Third, when carrying out panel data regression analysis, the assumption that annual R&D influences annual profitability was made. However, considering the creative and innovative nature of R&D activities, return on R&D investments may manifest itself not only in the current year, but may have a far more prolonged nature.

In addition, it is necessary to investigate the impact of lagged R&D effects on the profitability of medical device companies in future research.

CONCLUSION

The present study was performed to analyze the relation between R&D activities and the profitability of Slovak medical device companies using the panel data of 26 companies over the 2015–2019 period. Carrying out such research is especially relevant under the conditions of the rapid development of the Slovak medical products market and the implementation of the Slovak government's protectionist policy in this area. Research was conducted using panel data regression analysis. The Return on Assets ratio was chosen as the dependent variable characterizing the company's profitability. Four independent variables were chosen to explain it, i.e., Research and Development Intensity, Research and Development Intensity Squared, Leverage, and Size for the period.

Based on the application of the Breusch-Pagan test and the Hausman test, the feasibility of using the fixed effects method as an estimate parameter for the suggested empirical model was substantiated. The diagnosis of the adequacy of this model was carried out on the basis of the Normality test, the Autocorrelation test and the Heteroscedasticity test, applying the Gretl software package. Having revealed its low level of adequacy, the expediency of model estimation with robust standard errors was further substantiated.

Our study makes a significant original contribution to the existing scientific literature by giving empirical evidence of the relationship between R&D and company profitability. The research results obtained in the paper disprove the statement regarding the expediency and effectiveness of any investments in R&D in knowledge-intensive enterprises, despite the active development of the knowledge economy. In order to make effective investments in R&D, the limitations that are imposed on the company by the amount of such investments and that are caused by other factors, i.e, the size of the enterprise and leverage, should be taken into account.

The results of panel regression analysis demonstrated the existence of a curvilinear (inverted-U) relationship between R&D and profitability of medical device companies, which, in turn, confirmed the hypothesis of the study. Apart from this, the independent variable, RDI, has a significant negative impact on ROA at the 1% level, and RDI2 has significant positive impact on ROA at the 1% level. This shows that medical device companies with higher R&D intensity present better financial performance. However, for companies where R&D investments do not exceed the critical input volume, there is a negative relationship between R&D and profitability. Thus, these research results suggest that more investment in R&D is better for profitability, but

only within the zone of optimal R&D activities. Medical device companies with an insufficient amount of R&D investment, which is smaller than their critical input volume, need to improve R&D investment policy towards increasing the quality and effectiveness of R&D activities.

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Appendix A

Sample for Panel Data Regression Model:
Financial Data of 26 Slovak Medical Device Production Companies

No.	Company	No.	Company
1	ALLdent s.r.o.	14	PGdent s.r.o.
2	AMD Zubná technika, s.r.o.	15	PROCORP, spol. s r.o.
3	BET-ROCK s.r.o.	16	PRODATIK, s.r.o.
4	BUFFALO - DENT s.r.o.	17	Profi Dental Design s. r. o.
5	CHIRANA Medical, a.s.	18	Protet, s.r.o.
6	CHIROMEGA s.r.o.	19	ŠAÁRDENT, s.r.o.
7	DENT-ART spoločnosť s ručením obmedzeným	20	SIMBA ZL, s.r.o.
8	DMF - DenTech, s.r.o.	21	VI DENTIA s.r.o., stomatologické laboratórium
9	Estelio, s.r.o.	22	VILADENT, spol. s r.o.
10	F-dent, spol. s.r.o.	23	ViVa Protetik s.r.o.
11	KO - lens, spol. s r.o.	24	ZUB - TECH, s.r.o.
12	PE EM, stomatologické laboratórium, s.r.o.	25	Zubná technika - Halušková, v.o.s.
13	PEGAS DENT, spol. s r.o.	26	Zubná technika Mgr. Peter Blaho, s.r.o.

EMPLOYEE-DRIVEN INNOVATION CAPABILITY: THE ROLE OF KNOWLEDGE, CREATIVITY, AND TIME SUFFICIENCY

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Abstract: *Creativity and innovation are fascinating issues in the current literature because they play an essential role in organizational sustainability. Although previous studies found that knowledge and creativity are prominent predictors of innovation, the existing literature regarding the connection between these concepts remains insufficient. The present study investigates how individual creativity and an employee's innovation capability are influenced by different types of knowledge (i.e., knowledge network, knowledge quality, and knowledge sharing). Furthermore, it attempts to amplify the grasp of the pathways and conditions to improve innovation capability by assessing the mediating role of an individual's creativity and the moderating role of time sufficiency. The present study promoted structural equation modelling and cross-sectional design to test the hypotheses, utilizing data collection from 414 full-time employees at 69 SMEs in Indonesia. The findings revealed that creativity mediates the effects of knowledge quality and knowledge sharing on employees' innovation capability. Furthermore, the influences of different types of knowledge on creativity and innovation capability are not alike – time sufficiency plays the role of moderating the relationship between knowledge quality and employees' innovation capability. The present study contributes significantly to helping define how knowledge, creativity, and innovation capability are*

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intertwined by highlighting the vital role of knowledge quality, knowledge sharing stimulation, and time sufficiency enhancement.

Keywords: *knowledge network; knowledge quality; individual creativity; employee's innovation capability; time sufficiency.*

JEL Codes: *D23, D83, M12, O31, O34*

1. Introduction

Massive technological alterations shape today's economic environment and, along with globalization, give birth to innovation as a salient solution for improving performance and achieving sustainable competitive advantage (Haseeb et al., 2019; Hossain et al., 2021; Trachenko et al., 2021). Innovation capability is critical for an organization to succeed in a fast-changing business environment (Arsawan et al., 2022; Ode & Ayavoo, 2020) as it allows companies to be more adaptable and flexible to face changes (Denicolai et al., 2021; Leckel et al., 2020). In addition, innovation enables companies to accommodate consumer needs, stay ahead of their competitors, and consolidate their power by taking advantage of market opportunities (Gavrila Gavrila & de Lucas Ancillo, 2021). Furthermore, innovation is a crucial and decisive factor in national and organizational competition as the principal generator of economic growth (Bodlaj et al., 2020; Westman et al., 2021).

However, most companies in developing nations are categorized as SMEs, with small capital and resources for promoting innovation (Filipishyna et al., 2020). This has prompted researchers and practitioners to explore practical methods to improve the capability of companies in these countries in terms of innovation (Le & Lei, 2019; Parwita et al., 2021).

Knowledge and creativity are unique resources in innovation that serve as important predictors. Organizations may magnify their creativity and transform resources into dynamic competencies through knowledge networks, knowledge quality, and knowledge-sharing processes (Areed et al., 2021; Zhao et al., 2020). Prior research has shown that knowledge has a broad influence on innovation at both the individual and organizational levels (Arsawan et al., 2022; Parwita et al., 2021) or indirectly by fostering an environment that encourages employees' creativity and innovation capability (Ferreira et al., 2020; Lei et al., 2019). Therefore, to offer a solid grasp of the correlation between the type of knowledge, creativity, and innovation, this study investigates how knowledge is associated with innovation capability through mediating and moderating roles. The present study is the latest investigation to contribute significantly to innovation initiatives as follows.

First, creativity and innovation are fascinating issues in recent literature (Jin & Shao, 2022; Le & Lei, 2019; Tsouri et al., 2021; Zhao et al., 2020) because managing and improving innovation capability is increasingly crucial in the knowledge-based economy era (Bhatti et al., 2020; Chaubey et al., 2022; Ferreira et al., 2020). Creativity and innovation play an essential role in organizational sustainability by building a strong culture and climate (Aboramadan et al., 2020; Dabic et al., 2019) and a dynamic capability for competitive advantage (Ferreira et al., 2020; Mady et al., 2022). Although previous studies found that knowledge and creativity are prominent predictors of innovation (Ganguly et al., 2019; Singh et al., 2021), the existing literature regarding the

connection between these concepts remains insufficient (Zhao et al., 2020). In addition, Parwita et al. (2021) argue that creativity is a defining component in modelling innovative companies, but what nurtures or prevents it remains poorly understood and investigated. As a result, we believe that investigating the creative mediation mechanism between knowledge quality, knowledge network, knowledge sharing, and innovation capability is essential. Thus, this study aims to bridge the gap mentioned above and provide a more in-depth understanding of the mediating function of creativity in the relationship between knowledge type and innovation capability.

Second, Migdadi (2020) emphasizes the need to identify the antecedents of the innovation aspect by asking the following question: *Q1. How does the type of knowledge as a driver of organizational resources impact employees' innovation capability?*

Knowledge quality, knowledge network, and knowledge sharing are valuable organizational resources (Phelps et al., 2012; Shi et al., 2019; Wang & Hu, 2020). Therefore, exploring the effects of knowledge quality, knowledge network, and knowledge sharing on creativity will significantly contribute to providing valuable solutions or appropriate pathways to achieve employees' innovation capability. Third, according to De Clercq and Pereira (2020), previous studies have no consensus about the positive influence of type of knowledge on employees' innovation capability. They believe that future studies should confirm the nexus between knowledge quality, knowledge network, knowledge sharing, and innovation, and uncover the moderating role of time sufficiency. Organizations with different climates and support can produce multiple impacts on knowledge sharing and innovation because of their differences in making resources, opportunities, and motivation available for these endeavors. Thus, this effect might inhibit or stimulate the positive influence of knowledge quality, knowledge network, and knowledge sharing on creativity and innovation capability. Therefore, the present study investigated the moderating role of time sufficiency in the interlinkage between creativity and employees' innovation capability, knowledge network and employees' innovation capability, and knowledge sharing and employees' innovation capability to include empirical evidence, a more profound understanding, and an integrated vision of the pathways leading to innovation capability. As a means to bridge the aforementioned theoretical gaps, the current study was designed to answer the subsequent research questions:

RQ1. How do knowledge quality, knowledge network, and knowledge sharing impact creativity and innovation capability?

RQ2. Does creativity mediate the relationship between knowledge quality and innovation capability, knowledge sharing, and innovation?

RQ3. Does time sufficiency moderate the effect of creativity on innovation? What is the relationship between knowledge quality and innovation and between knowledge sharing and innovation?

In order to answer these research questions, the present study developed a series of hypotheses validated by Structural Equation Modelling (SEM) statistical analysis conducted in a series of primary surveys on 414 respondents from 69 export SMEs in Indonesia with three considerations. First, the employee innovation capability of SMEs is not regarded as crucial (Abdul-Halim et al., 2018), even though the findings from Kwarteng et al. (2016) revealed that performance and sustainability are built on creativity and innovation at all levels. Moreover, Indonesia is ranked 87th out of 132 countries in this regard (WIPO, 2021). Consequently, boosting innovation for

competitive advantage at the global level is indispensable (Chang et al., 2017; Tsimoshynska et al., 2021). Second, Indonesia is a developing country with around 64 million SMEs that continue to grow to encourage national economic growth (Arsawan et al., 2022). The general problem of SMEs, mainly export SMEs, is the lack of implementation of employees' knowledge, creativity, and innovation to provide problem-solving in their routine activities. Third, the increase in creativity and innovation capability will strengthen the management process model for small and medium enterprises to strengthen economic growth in Indonesia.

Drawing from job demand resource theory (Bakker & Demerouti, 2007; Demerouti et al., 2001) and the essential role of innovation (Areed et al., 2021; Chaubey et al., 2022; Colclough et al., 2019), the present study is crucial in grasping dynamic scenarios and providing proper examination in explaining employee's innovation capability based on types of knowledge as drivers of creativity.

2. Theoretical background and hypotheses.

2.1. Job demand resource theory.

The theoretical framework underpinning this study is job demands-resources theory (Bakker & Demerouti, 2007; Demerouti et al., 2001), which describes work environments as having respective characteristics and illustrates that wellbeing and efficiency in the workplace could be the result of two types of working situations – job demands and job resources (Bakker & Demerouti, 2017). The interactions between these two components are not merely interactions in welfare development and job performance, but also employee burnout (Signore et al., 2022). Specifically, demands at work involve professional aspects that would result in taxing endeavors if they exceed employees' ability to adapt (Seibert et al., 2017). These endeavors can be physical or cognitive (intense workloads, pressures, emotionally challenging interactions with others), and can lead to physiological and psychological effects (Demerouti et al., 2001).

Demands at work do not necessarily adversely impact employees; however, high demands placed on employees at work can lead to a bottleneck. Consequently, demands at work are conceived as physical, psychological, social, and organizational aspects that entail substantial physical and psychological endeavors and are thus linked with specified costs (Demerouti et al., 2001). The second factor in the JD-R model concerns job resources. These are physical, psychological, social, and organizational features that can be instrumental in achieving goals, reduce physiological and psychological costs that are associated with demands at work, and enhance learning and development abilities (Bakker & Demerouti, 2017). In the existing literature (Bakker & Demerouti, 2007; Burdiuzha et al., 2020), job resources entail social support, job autonomy, supervision, performance feedback, coaching, and time control. Job resources are intrinsically and extrinsically motivating because they enable the fulfilment of human needs and the pursuit of growth and autonomy in the workplace (Joo et al., 2014; Llopis & Foss, 2016).

2.2. Knowledge network, knowledge quality, and individual creativity.

Turbulence and challenges in the business environment have forced employees to seek

knowledge from external parties (e.g., consumers, sellers, government, suppliers, or competitors) for novel insights (Nonaka & Takeuchi, 1995). Some employees may not master the skills necessary for job success; thus, an effective knowledge network is crucial. Knowledge networks enable employees to receive valuable contacts, information, and insights from both within and outside the organization (Baldé et al., 2018). Other employees can act as knowledge intermediaries related to their mastery, and can acquire core competencies (Yoo et al., 2011).

Knowledge networks increase the efficiency of employees' roles because they can seek external expertise to cope with the complex and uncertain nature of work. This enables employees and groups to access a more comprehensive external source of knowledge. In addition, the promotion and development of intra- and extra-organizational knowledge networks will promote the communication of essential ideas, views, and points of view to increase employees' creativity (Valaei & Rezaei, 2017). Combining internal and external resources enables employees to obtain helpful knowledge and supplementary skills. Thus, they may improve their knowledge quality through convenient integration, utilizing knowledge networks and enhancing creativity. With increased knowledge, employees have the opportunity to learn to the greatest extent and to develop their own potential (Bakker & Demerouti, 2017). Given the arguments above, we proposed the following hypotheses:

H1. Knowledge networks significantly affect knowledge quality.
H2. Knowledge networks significantly affect individual creativity.

2.3. Knowledge quality, knowledge sharing, creativity, and innovation capability.

Knowledge quality is defined as the acquisition of valuable and solution-oriented knowledge in completing activities (Ganguly et al., 2019), and can be a new alternative for system development, achieving organizational goals or creating innovations (Waheed et al., 2021). The knowledge quality possessed by employees will influence the knowledge quality of the group, unite the common goals and interests of team members, and highlight the importance of sharing knowledge among them, which successively improves the value of knowledge sharing. In addition, knowledge that is of good quality will encourage an increase in the sharing of quality knowledge so that it is truly beneficial at all employee levels (Valaei & Rezaei, 2017; Y. Zhang et al., 2019). Simultaneously, knowledge quality will stimulate dynamic capability (Sabetzadeh & Tsui, 2015) in building employees' creativity because knowledge can be the basis for developing ideas to help complete work (Yoo, 2014).

Furthermore, Yoo et al. (2011) claimed that higher levels of knowledge quality help organizations to be more productive, reduce costs, increase efficiency in their processes, and influence innovation. Therefore, quality knowledge not only has significant meaning to the personal quality of employees, but also provides support for knowledge management in the long term and is a source of innovative ideas (Sabetzadeh & Tsui, 2015). As a result, excellent knowledge provides several opportunities for employees to raise their level of innovation, whether it is connected to process innovation, product innovation, or technique, because the quality of ideas significantly impacts innovation (Migdadi, 2020). Thus, it can increase professional interaction in improving performance (Signore et al., 2022). The use of knowledge quality provides a multi-layered effect on the knowledge-sharing process and stimulates employees' creativity and innovation capability

(Alassaf et al., 2020; Nguyen et al., 2019). Therefore, knowledge quality can prominently impact the decision-making chain and subsequent movements in innovation practice, which may manifest into improvements or development in the organization's innovation capability (Ganguly et al., 2019). In reference to the arguments above, the authors proposed the following hypotheses:

H3. Knowledge quality significantly affects knowledge sharing.

H4. Knowledge quality significantly affects individual creativity.

H5. Knowledge quality significantly affects innovation capability.

2.4. Knowledge sharing, individual creativity, and innovation capability.

Various researchers have examined the notion that facilitating access to the knowledge of colleagues in organizations has encouraged the creative and innovative behavior of individuals (Bhatti et al., 2020; de Clercq & Pereira, 2020; Rese et al., 2020; Zeb et al., 2019; Zhao et al., 2020) and organizational innovation capability (Meyer, in press; Parwita et al., 2021). Employees with a more robust knowledge bond will be more versatile and receptive to new ideas and concepts, allowing them to reunify and reconstruct information to generate more innovative ideas (Bhatti et al., 2020) that progressively improve employees' performance while also benefiting companies. Employee knowledge sharing is critical for developing particular knowledge in the organizational realm (Soda et al., 2019).

Knowledge exchange between employees at various levels results in employees becoming more aware of and motivated by the organization's strategic goals and processes that assist them in increasing capability (Wang & Zatzick, 2019). Employees with access to knowledge will stimulate the emergence of the latest innovative viewpoints and have a high tendency to take advantage of these ideas (Valaei & Rezaei, 2017). A new perspective is the trigger in stimulating responses to think creatively and take advantage of creatives ideas to innovate (Akram et al., 2020). Given the arguments above, the authors proposed the following hypotheses:

H6. Knowledge sharing significantly affects individual creativity.

H7. Knowledge sharing significantly affects innovation capability.

2.5. Individual creativity and innovation capability.

Creativity is generally viewed as the capacity to produce new and valuable work in a particular domain (Ferreira et al., 2020; Phelps et al., 2012). Accordingly, creativity obliges opportunities for new, original, and practical ideas because it is considered an essential element of innovation. For this reason, organizations need a set of processes, methods, and structures that enable timely and efficient performance to achieve innovation. Although creativity and innovation are commonly interchangeable, they are not synonymous (Bhatti et al., 2020). The definition of innovation is described as the deliberate introduction and use of the concept (idea), method (process), products, or procedures that are novel to the job, work team, or organization and are meant to benefit those entities in their work, teamwork, or organization (Ba et al., 2021). Innovation capability permits organizations to attain long-term performance because it can be interpreted as successfully implementing creative concepts where creativity acts as the foundation. Creativity is fundamental to successful innovation (Migdadi, 2020) because it involves complex

processes, such as new product/service development, improvisation, and competence (Ganguly et al., 2019). Based upon the arguments above, the authors proposed the following hypothesis:

H8. Individual creativity significantly affects employee's innovation capability.

2.6. The mediating role of individual creativity.

Creativity is "a novel and appropriate, useful, correct, or valuable response approach to the task at hand, and the task is heuristic rather than algorithmic" (Amabile, 1983). Therefore, creativity is essential for organizations to increase competitiveness in national and global markets. Organizations with excellent innovation capability are generated by creative employees or individuals (Ferreira et al., 2020; Soda et al., 2019), with an emphasis on the notion that research on creativity in large organizations and SMEs is a starting point in building innovation capability. One of the drivers of this is the role of knowledge quality, which may stimulate the emergence of creativity and become the basis for developing ideas to assist in completing tasks and assisting employees to be more productive. This, in turn, increases their level of innovation (Sabetzadeh & Tsui, 2015), whether related to process innovation, product innovation, or methodology, because the quality of ideas has a significant influence on the success of innovation (Migdadi, 2020). Nevertheless, knowledge sharing between employees is critical to developing knowledge (Soda et al., 2019), thereby increasing awareness and motivation, which contributes to capacity building (Wang & Zatzick, 2019). This stimulates the emergence of novel and innovative concepts and encourages the high tendency to take advantage of these ideas (Valaei & Rezaei, 2017) to be more creative. Consequently, employees have a broad horizon for generating concepts, ideas, and creativity, increasing their innovation capability. Based upon the arguments above, the authors proposed the following hypotheses:

H9. Creativity mediates the interlinkage between knowledge quality and innovation capability.

H10. Creativity mediates the interlinkage between knowledge sharing and innovation capability.

2.7. The moderating role of time sufficiency.

Drawing from the theory of resource conservation (Hobfoll, 1989; Hobfoll & Shirom, 2000), the effectiveness of knowledge in promoting positive work behavior depends on the degree to which employees can apply the lessons learned from ancillary resources that create the improvement of practicable activity (de Clercq & Pereira, 2020). When employees have a realistic workload, they will be able to encounter and meet deadlines, and the cognitive ability to assign the knowledge obtained from mutual exchanges to work accomplishments increases because of the incorporation of the expansion of novel concepts (Pooja et al., 2016). Perceived time adequacy can stimulate knowledge-based relational resource application to encourage creative behavior since employees have extra time to advance and preserve their novel concepts (Chen et al., 2015) and generate motivation to become involved in the knowledge-sharing process (Ba et al., 2021).

Furthermore, when employees are not troubled by impractical workloads and have adequate time to complete their tasks, they can expect more support for professionality and capability enhancement (Migdadi, 2020). This can force the motivation to dedicate knowledge-sharing

to creativity so that the organization can benefit from it (Rese et al., 2020; Zeb et al., 2019). In contrast, when employees are under time constraints, the benefits of employing relational resources to engage in creative tasks may appear minimal because individuals fear failure (Avery et al., 2010). Employees who are under extreme time pressure may lack the incentive to actively seek out novel organizational problem-solving strategies using their knowledge-based relational resources because such knowledge application looks less desirable (de Clercq & Pereira, 2020). Founded on the arguments above, the authors proposed the following hypotheses:

H11. Time sufficiency moderates the relationship between knowledge sharing and innovative capability.

H12. Time sufficiency moderates the relationship between knowledge quality and innovation capability.

H13. Time sufficiency moderates the relationship between employees' creativity and innovation capability.

Therefore, this research examines and explains the direct relationship between knowledge network, knowledge quality, knowledge sharing, individual creativity and employee innovation capability. Furthermore, individual creativity was tested as a mediating variable and time sufficiency as a moderating mechanism among the constructs. The research framework is shown in Figure 1.
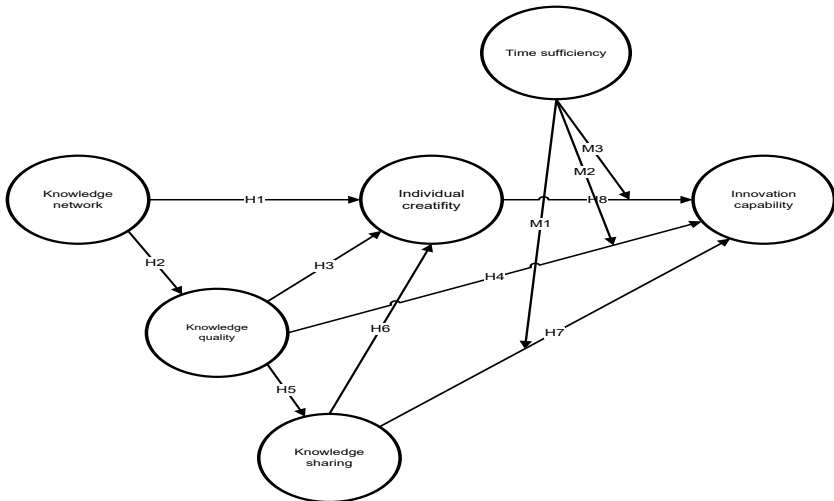

Figure 1. Theoretical framework

3. Methodology.

3.1. Population and sampling procedure.

The population of this study consisted of 8,967 export SMEs in Indonesia registered under the Business and Export Development Organization (BEDO). Within the constraints of costs and the scope of the coverage area of the study, the selected samples were taken only in Bali province using purposive sampling following three criteria. First, export SMEs in Bali covering all of the nine province regencies in the BEDO database. Second, SMEs that were actively conducting export in the past 5 years (2016–2020) and recorded at the department of industry and trade of the regency. Third, the international market requires products and services that have added value, quality, and international standards. Therefore, the operational activities of SMEs require the ability to adapt to market fluctuations and environmental uncertainty by carrying out continuous innovation. Because innovation is based on knowledge and creativity, export SMEs must have had a strategic policy regarding this matter in order to qualify for this study.

The number of samples in this study is 150 export SMEs. Furthermore, to achieve the research objectives, we made phone calls, emails and in-person visits to 150 SME representatives in August–October 2021 to explain the research objectives and request cooperation in filling out the questionnaire. Based on direct visits, emails, and phone calls, we established 69 SMEs who were willing to be subjects of this research. Of the 69 willing SMEs, we distributed a total of 450 questionnaires to respondents from three levels (low, middle and top management), and received 428 responses. Of these responses, 414 were valid, giving a validity level of 96.73 percent. Respondents in this study were vital employees who held leadership positions in teams in their HR, administration, accounting, operations, marketing/sales, and finance departments. This step was taken to ensure that all participants understood and regularly shared strategic information within the organization.

3.2. Measurements.

Variables were measured using items adopted from the existing literature. To measure each construct, a seven-point Likert scale was used – with 1 representing *strongly disagree* and 7 – *strongly agree*. Knowledge network was measured by 5 indicators adapted from (Yoo et al., 2011); knowledge quality was measured by 3 dimensions and 19 indicators adapted from (Yoo et al., 2011); knowledge sharing was adapted from (Bhatti et al., 2020) and (Wu et al., 2007) and included 10 indicators; individual creativity was measured by 4 indicators from (Zhao et al., 2020a); innovation capability was measured by 4 dimensions and 16 indicators from (Migdadi, 2020); and time sufficiency was measured by 3 indicators from (de Clercq & Pereira, 2020).

The Partial Least Square (PLS) is a suitable method for testing research models that validate a theory (Hair et al., 2016). For this reason, this study uses PLS-SEM utilizing SmartPLS 3.2.9 software to test the hypothesized relationships in the research model suggested in this study based on data from 414 respondents in 69 Export SMEs in Indonesia. This method was also used to assess the validity and reliability of the construct by inspecting the measurement model (Hair Jr et al., 2017). As Hair Jr et al. (2017) suggest, PLS-SEM is a powerful method for predicting small samples and there is no assumption of distribution of the collected data (Hair et al., 2016). Furthermore, the PLS-SEM rule-of-thumb for detecting the minimum sample size is to remove

twenty to thirty times the maximum number of arrows pointing to a construct, or independent variable (Hair Jr et al., 2017). Our research sample fully meets these criteria. Finally, this method was also used to assess the moderating role of experience by testing multi-group analysis (Hair Jr et al., 2016). A descriptive analysis was first carried out using the SPSS software before the data were examined using PLS-SEM.

4. Results.

4.1. Respondent profile

This study involved 414 respondents from 69 Export SMEs in 9 districts in Bali, Indonesia. We handed questionnaires to employees to gather data for our research on strategic policies regarding creativity, innovation, and types of knowledge. Export SMEs in Indonesia grow and develop into the backbone of the economy because they create jobs and increase gross domestic product (GDP) and economic growth (Arsawan et al., 2021). Table 1 explains that the most common amount of experience among employees is 11–15 years (30.5%), indicating that employees have a lot of time to absorb knowledge, with the dominant age being 31–40 years (Abualqumboz et al., 2020; Jordão et al., 2019). With an average education level equivalent to a bachelor's degree (92%), the employee's ability to absorb knowledge (Arsawan et al., 2018) and integrate knowledge networks and turn them into knowledge quality is crucial (Abualqumboz et al., 2020; Zhang, 2019). Finally, the dominant level of employees involved in this study was low management (59.67%) because they have routine activities that are directly related to creativity and innovation capability to complete their work.

Table 1. Respondent profiles

Characteristics	Frequency	Percentage
Years of work experience		
<5	41	9.9
6–10	112	27.1
11–15	126	30.5
16–20	103	24.8
>20	32	7.7
Age		
21–30	27	6.50
31–40	194	47.00
41–50	167	40.30
51–60	26	6.20
Educational Level		
Bachelor	381	92.00
Master	29	7.00

Doctor	4	1.00
Gender		
Male	314	75.85
Female	100	24.15
Level of positions		
Top management	70	16.90
Middle management	97	23.43
Low management	247	59.67

4.2. Measurement model

The current research model was founded on 57 items from six variables, as shown in Table 2. The VIF test was used to evaluate the variance of the general method prior to evaluating the model (Kock & Lynn, 2012). The findings revealed that the full collinearity VIF has a value of 2.726, indicating no issue with the common method variance. Therefore, a two-stage check was utilized to evaluate the suggested model. The assessment of construct reliability and validity were the initial step. The average variance extract (AVE), outer loadings, composite reliability (CR), and Cronbach's Alpha were all examined in this study to achieve the goal. According to the findings, all factor loadings were greater than 0.6. Additionally, all CR values were greater than 0.7, and AVE values were more than 0.5, meeting the reliability and validity requirements (Hair et al., 2016).

Table 2. Measurement model of indicators

Variables	Dimensions	Indicators	Loading	CA	CR	AVE
Knowledge network				0.865	0.902	0.649
		Individual-external knowledge	0.784			
		Individual-external resources	0.824			
		Useful contacts outside	0.825			
		Coordinates individual-external	0.766			
		Seeks feedback	0.828			

Knowledge quality	Intrinsic knowledge quality			0.906	0.926	0.645
		Knowledge accurate	0.871			
		Knowledge reliable	0.864			
		Knowledge objective	0.867			
		Knowledge unbiased	0.615			
		Knowledge believable	0.786			
		Knowledge current	0.802			
		Knowledge updated	0.786			
	Contextual knowledge quality			0.928	0.943	0.735
		Knowledge of decision making	0.808			
		Knowledge of personal operations	0.882			
		Knowledge of competitive advantage	0.834			
		Knowledge of my tasks	0.821			
		Knowledge of our jobs	0.898			
		Knowledge context-specific	0.897			
	Actionable knowledge quality			0.935	0.949	0.758
		Knowledge actionable	0.931			
		Knowledge adaptable	0.919			
		Knowledge expandable	0.911			
		Knowledge applicable	0.815			
		Knowledge effective	0.809			
		Knowledge capacity	0.828			
Knowledge sharing				0.940	0.949	0.654
		Discussing work-related	0.783			
		Willing to share	0.620			
		Willing to answer	0.788			
		Record a document	0.870			
		Demonstration	0.841			
		Opportunities to perform	0.824			
		Offer information	0.849			
		Look for assistance	0.830			
		I encourage colleagues	0.861			
		Express ideas	0.794			

Individual creativity				0.934	0.953	0.836
		Finding solutions	0.944			
		New ideas for products	0.907			
		Analytical thinking	0.948			
		Creating new procedures	0.856			
Innovation capability	Product inno-vation			0.894	0.926	0.757
		Introduces innovative products	0.873			
		Capability for new knowledge	0.831			
		Develop new products	0.909			
		Capability to use new materials	0.866			
	Process innova-tion			0.919	0.943	0.807
		Pioneer disposition	0.804			
		Capability to adjust the processes at all levels	0.924			
		Displays clever responses	0.926			
		Improves existing machinery and equipment	0.934			
	Marketing inno-vation			0.917	0.942	0.802
		Close relationship management customers	0.826			
		Good knowledge of different market segments	0.903			
		Highly efficient sales-force	0.923			
		Product distribution is efficient	0.925			
	Organizational innovation			0.857	0.904	0.702
		Coordination and cooperation	0.904			
		Integration and control	0.879			
		Developing and gaining access	0.789			
		The capability of innovative strategy	0.772			

Time suffi- ciency				0.704	0.834	0.627
		Work too fast	0.788			
		Work under time pressure	0.820			
		Deal with a backlog at work	0.765			

Additionally, we employed the HTMT criteria to examine the discriminant validity; the HTMT ratio value should be <0.85 (Hair Jr et al., 2016). Table 3 showed that all HTMT ratios <0.85, confirming that the criteria for discriminant validity in this research model have been met.

Table 3. HTMT Heterotrait-Monotrait Ratio (HTMT)

Constructs	Knowledge Net- work	Knowledge Quality	Knowledge Sharing	Individual Creativity
Knowledge network				
Knowledge quality	0.698			
Knowledge sharing	0.676	0.741		
Individual creativity	0.612	0.673	0.697	
Innovation capability	0.687	0.831	0.779	0.739

4.3. Structural Model

The second stage of the investigation was to evaluate the structural model and hypotheses. A 5000-iteration bootstrap approach was used to evaluate the path coefficients following scientific advice from Chin et al. (2008). These results indicated a goodness of fit value of 0.488, which Tenenhaus et al. (2005) deem adequate for the suggested model. Next, knowledge network, knowledge quality and knowledge sharing were evaluated for their ability to explain variation in creativity, which was 74.8% of the variation in innovation capability ($R^2 = 0.748$). According to Chin et al. (2008), the percentage value of R^2 suggested that the independent variable's explanatory power on employees' innovation capability was reasonable. Finally, the structural model was further evaluated, revealing a mean path coefficient of 0.427 ($p < 0.01$), AVIF 4.335 – below the maximum recommended level of 5 (Hair et al., 2016). These findings indicated that the tested model was fit, had a rational explanatory power, and a path coefficient and variance inflation within acceptable limits.

4.4. Hypothesis testing

As recommended, the present study evaluated the path coefficients using 5,000 bootstrap samples (Hair et al., 2016). As a result, the direct effects of knowledge network and individual creativity ($\beta = 0.168$) and knowledge quality ($\beta = 0.698$) were significant ($p < 0.01$) according to Table 4, supporting hypothesis 1 and hypothesis 2. In addition, hypothesis 3 was supported by the direct impact between knowledge quality and individual creativity ($\beta = 0.402$), which was also

significant ($p < 0.01$). Further, the nexuses between knowledge quality and innovation capability ($\beta = 0.327$) and knowledge quality and knowledge sharing ($\beta = 0.753$) were similarly significant ($p < 0.01$), which supported hypothesis 4 and hypothesis 5.

Table 4. Hypotheses testing

	β	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/ST-DEV|)	p-value	Decision
KN → Individual creativity (H1)	0.168	0.170	0.060	2.778	0.006	Supported
KN → KQ (H2)	0.698	0.699	0.029	24.349	0.000	Supported
KQ → Individual creativity (H3)	0.402	0.398	0.062	6.505	0.000	Supported
KQ → Innovation capability (H4)	0.327	0.324	0.056	5.876	0.000	Supported
KQ → KS (H5)	0.753	0.753	0.025	30.461	0.000	Supported
KS → Individual creativity (H6)	0.242	0.241	0.063	3.853	0.000	Supported
KS → Innovation capability (H7)	0.193	0.191	0.053	3.610	0.000	Supported
Individual creativity → Innovation cap. (H8)	0.327	0.325	0.048	6.787	0.000	Supported

The next stage was to test the mediation mechanism once the direct relationship between variables had been established. In the context of the present study, two mediation pathways were examined. Non-parametric bootstrap analysis was performed for evaluation (Hair et al., 2016) using Variance Accounted For (VAF), which classifies data into three categories: no mediation (VAF < 0.20), partial mediation (VAF range 0.20–0.80), and full mediation (VAF > 0.80).

Table 5. Mediation testing

Link*	Mediator*	Independent Variable→ Mediator	Mediator → Dependent Variable	Direct	Indirect	Total effect	VAF (%)	Data interpretations
Knowledge quality → innovation capability (H9)	Creativity	0.402	0.327	0.327	0.131	0.458	0.286	Partial mediation
Knowledge sharing → innovation capability (H10)	Creativity	0.242	0.327	0.193	0.079	0.272	0.290	Partial mediation

Table 5 presents information suggesting that, with a VAF value of 0.286 (28.6%), individual creativity mediated the interlinkage between knowledge quality and innovation capability, supporting hypothesis 9. Moreover, with a VAF value of 0.290 (29%), individual creativity mediated the interlinkage between knowledge sharing and innovation capability; hence, hypothesis 10 was accepted.

Furthermore, the present study also tested the moderating variable (see Table 6). The moderating role of time sufficiency was examined by using multigroup analysis using PLS (Henseler & Fassott, 2010). Initially, determining whether time sufficiency functions as a moderator variable in the nexus between individual creativity and innovation capability ($\beta = 0.098$, STDEV 0.060, T Statistics $1.621 < 1.96$, PV 0.106) was not proven; thus, hypothesis 11 was rejected. Next, hypothesis 12 was accepted since time sufficiency was a moderator in knowledge quality and innovation capability ($\beta = 0.117$, STDEV 0.051, T Statistics $2.285 > 1.96$, PV 0.023). Finally, evaluating time sufficiency in the nexus between knowledge sharing and innovation capability ($\beta = 0.015$, STDEV 0.061, T Statistics $0.247 < 1.96$, PV 0.805) indicated that it did not act as a moderator, and thus hypothesis 13 was rejected.

Table 6. Moderation testing

	β	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	p-value	Decisions
Creativity *TS Innovation capability (H11)	0.098	0.093	0.060	1.621	0.106	No Moderation
KQ*TS Innovation capability (H12)	0.117	0.117	0.051	2.285	0.023	Moderation
KS*TS Innovation capability (H13)	0.015	0.014	0.061	0.247	0.805	No Moderation
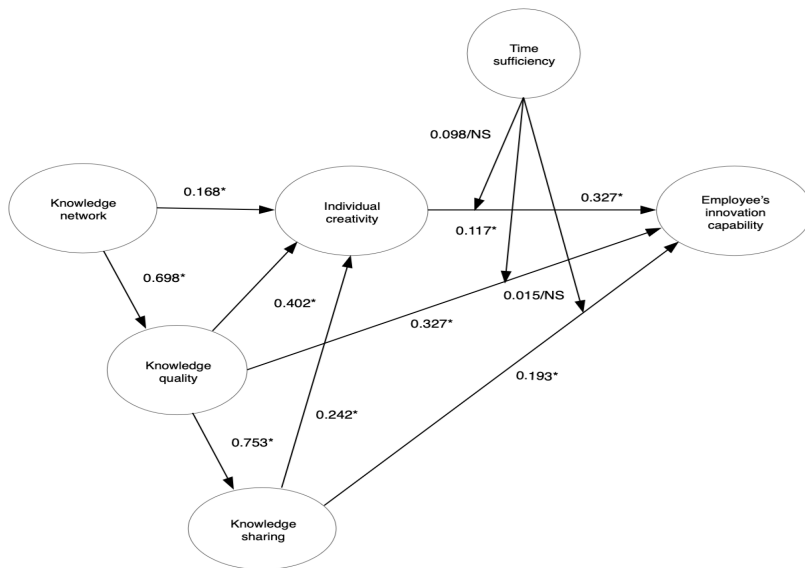
Notes: *$p < 0.05$; **$p < 0.01$; *NS: Non-significant*
Figure 2. Full model analysis

5. Discussion.

Strengthening innovation capability has been considered a key predictor of organizational success. According to the results of the present study, knowledge network, knowledge quality, and knowledge sharing positively impact creativity, which increases employees' capability for innovation. A significant contribution to theoretical and practical endeavors in the field of innovation and knowledge management was produced in this study. The present study investigated the elements influencing employees' innovation capability, with time sufficiency as a moderating variable. Using PLS-SEM analysis, it discovered that employees' creativity significantly influences innovation capability, followed by knowledge quality and knowledge sharing. These findings support previous studies in the context of SMEs (Ganguly et al., 2019; Le & Lei, 2019; Singh et al., 2021), which discovered the importance of knowledge sharing and knowledge quality in developing innovative capability. These results suggest that knowledge sharing and quality are essential triggers in maximizing knowledge, leading to innovation capability that enhances the company's performance even further. This study supports previous findings on organizations' efforts to improve their innovation (Ferreira et al., 2020; Le & Lei, 2019; Migdadi, 2020). In addition, these results indicate that knowledge quality influences employees' creativity, followed by knowledge networks and knowledge sharing. These findings demonstrate that knowledge quality would support the growth of knowledge networks (Abualqumboz et al., 2020; Shi et al., 2019). These networks would eventually be shared to benefit employees at all levels.

Furthermore, the findings of this study investigate creativity as a mediating variable. Although both mediation relationships evaluated were significant, the relationship between knowledge sharing, creativity, and innovation capability was more significant. These findings show that SMEs prioritize the process of information sharing that is utilized to improve creativity (Cegarra-Navarro & Martelo-Landroguez, 2020; Haider & Kayani, 2021) and innovation capability (Ganguly et al., 2019). They also imply that knowledge sharing is the primary catalyst for SMEs to produce high-quality knowledge (Mao et al., 2015; Ode and Ayavoo, 2020), which then serves as the foundation for how employees become more creative, allowing them to innovate in their regular work (Ko & Choi, 2019; Liu et al., 2017; Nguyen et al., 2019).

Moreover, within this study's three moderation tests, time sufficiency merely modified the relationship between knowledge quality and innovation capability. These results suggest that time sufficiency enhances the quality of knowledge and innovation capabilities. Employees with a realistic workload will be able to meet deadlines and cognitively apply their newly gained information to improve productivity (Pooja et al., 2016). In addition, perceived sufficiency of time would stimulate knowledge-based resources to encourage creative behavior as employees have extra time to enhance their new ideas (Liao & Chen, 2018), motivating them to engage in the knowledge-sharing process (Ba et al., 2021).

This study presented significantly advances theories of innovation and knowledge management in three areas. First, despite knowledge being a crucial organizational resource, researchers have not paid it much attention (Ganguly et al., 2019; Parwita et al., 2021; Singh et al., 2021; Zhao et al., 2020). The present study suggests a research model that connects type of knowledge (knowledge network, knowledge quality, and knowledge sharing) with creativity and innovation capability to close the research gap. Evidence supports the substantial impact of knowledge network, knowledge quality, and knowledge sharing on employees' creativity and innovation capability. The present study suggests that while the type of knowledge enables companies to foster employees' creativity, it is also a powerful approach to promoting innovation capability.

Secondly, research by Anderson et al. (2014) revealed that knowledge is a core component of creativity, but very few empirical studies have examined how this aspect influences creativity and innovation capability in the workplace. Therefore, it was recommended by Parwita et al. (2021) to investigate the individual creativity mechanisms that mediate knowledge sharing and innovation behavior. The present study has established a nexus between knowledge sharing and innovation capability based on the mediating role of creativity in response to this urge. Empirical research has verified that creativity, as a strategic and intangible resource, significantly and positively affects an individual's capacity for innovation. Additionally, creativity serves as a potent mediator between knowledge quality and innovation capability. This provides a definitive answer to Ganguly et al. (2019) and Anderson et al. (2014) regarding the interlinkage between organizational resources and innovation capability. The present study demonstrates the integrative theory of the relationship between knowledge quality and innovation capability through the mediating role of creativity, and highlights the significant direct or indirect effects of knowledge quality and knowledge sharing on innovation capability through their positive effects on creativity. These findings reveal that knowledge quality motivates employees to be more creative and increases innovation capability. Creativity boosts employees' innovation capability by enabling knowledge quality to allow them to rapidly respond to new information and the external environment, com-

plete jobs effectively, and address current problems (Le & Lei, 2019).

Finally, this paper responds to the academic urge for more precise time sufficiency mechanisms to moderate the nexus between knowledge sharing and innovation capability (de Clercq & Pereira, 2020). The three effects of time sufficiency on knowledge quality/innovation, knowledge sharing/innovation, and creativity/innovation were examined in this study. The empirical findings reveal that time sufficiency positively moderates the nexus between knowledge quality and innovation capability. This finding considerably advances knowledge quality by incorporating time sufficiency as a situational variable interacting with knowledge quality to influence innovation capability positively. Furthermore, these results reveal that, according to the degree of employees' time sufficiency, the influence of knowledge quality on creativity and innovation capability might have different effectiveness and outcomes. These results suggest, more particularly, that if knowledge quality was taken into account then creativity would be enhanced and would actively contribute to help improve knowledge quality, competence, and personal competitive advantages (PCAs), thereby increasing the ability for innovation.

5.1. Theoretical implications.

First, this study expands the model of employees' innovation capability in the context of SMEs through knowledge types (i.e., knowledge network, knowledge quality and knowledge sharing). The integration of the knowledge type and innovation capability models based on creativity helps understand SMEs in building performance at the individual level to improve team and organizational performance. The theoretical contribution of this study can be seen in the suitability of the proposed model, where knowledge network, knowledge quality and knowledge sharing are integrated as drivers of employee creativity and innovation ability. From the innovation capability-based creativity model, the suitability of the proposed integrated model offers a significant contribution – something that has never been tested in previous research.

Second, from the perspective of conservation of resource theory (Hobfoll, 1989; Hobfoll & Shirom, 2000), knowledge-based relational resources provide insights into innovative work behavior. When employees have an achievable workload, they will be able to meet work-related deadlines and their cognitive ability will be utilized to allocate insights gained into routine activities. The perception of time sufficiency can stimulate creative behavior because employees have more time to develop and sustain new ideas that trigger motivation to engage in the knowledge sharing process (Ba et al., 2021). Conversely, employees feel burdened when they are burdened by time pressures, and this has an impact on decreasing motivation and creativity. For this reason, the role of communication is very important to reduce social fatigue due to work demands (Signore et al., 2022). Communication can be the foundation in increasing collaboration, building shared knowledge and strengthening social capital (Arsawan et al., 2022).

Third, in the context of the effect of time sufficiency on the relationship between knowledge quality and employees' innovation capability, this study also succeeds in enhancing job resource demand theory (Bakker & Demerouti, 2007, 2017). The moderating role that supports the relationship between these constructs offers support for the time sufficiency proposition, which we believe is a challenge to be explored further in the future. That is, by providing sufficient time to complete work, the knowledge quality that is absorbed can be transformed into a higher innovation capability which ultimately increases innovative work behavior (Kmieciak, 2020; Miller &

Miller, 2020; Phung et al., 2019), productivity and performance (Arsawan et al., 2018). Providing sufficient time for employees to complete work will improve learning abilities and employee self-development processes (Bakker & Demerouti, 2017).

5.2. Managerial implications.

The present study offers a more thorough understanding of the causal nexus between types of knowledge, individual creativity, and employees' innovation capability in terms of empirical analysis and theoretical contributions. As a result, the present study can be utilized by managers of small and medium-sized companies in Indonesia to help them practice organizational support, encourage creativity, and improve innovation capability, especially at the individual level for organizational performance. The specific managerial implications are as follows.

First, the results indicate that information quality is the primary means of encouraging individual creativity, which in turn promotes the capability for innovation. High-quality knowledge is probably the best way to stimulate creativity (Ganguly et al., 2019) by building intense communication (Zhang et al., 2019). This will help cultivate creativity for innovation capability (Ferreira et al., 2020; Liao & Chen, 2018). The present study provides significant implications, practical advice, and an apparent path toward enhancing employees' innovation capability.

Second, the empirical research findings demonstrate the importance of knowledge quality in encouraging employees to share ideas, knowledge and innovation. The impact of knowledge sharing and innovation can be enhanced by high knowledge quality. Our findings add to the body of knowledge by demonstrating how knowledge quality magnifies the impact of knowledge sharing on innovation capability. This result supports the notion that employees' behavior in knowledge sharing and innovation is a long-term task and needs external assistance to be successful (Le & Lei, 2019). We are aware that knowledge quality places a high value on encouraging employees to perform knowledge sharing and actively develop their innovation capability.

Third, Griese et al. (2012) asserted that knowledge activities could generate strategic resources and competencies that enable companies to outperform their competitors and achieve higher innovation outcomes. This finding highlights the importance of knowledge sharing as the catalyst for innovation and the centrality of employees in the knowledge-sharing process. In order to encourage staff to participate positively and actively in the innovation process, managers must focus on identifying efficient pathways and sensible strategies.

5.3. Limitations and further study.

Although the present study has significantly aided the comprehension and value of the existing literature, it has some limitations. First, the cross-sectional approach does not rule out the potential that long-term causal association could develop due to alterations in one's psychology and beliefs. In this study, employees' beliefs about innovation capability are strengthened by time sufficiency, which is very sensitive to employee morale, work demands and self-motivation. This can be addressed by conducting a longitudinal study and consolidating the results into encouraging findings.

Second, although knowledge is universally acknowledged as a fundamental and durable resource that enables companies to innovate and sustain a competitive advantage, the present study solely centers on examining how the type of knowledge affects creativity and innovation

capability. Future research must look at the relationship between psychological change, individual beliefs, and specific characteristics of innovation capability in order to fully comprehend the significant impact that knowledge has on employees' innovation capability. Eventually, further studies should examine the relationship between latent variables in greater detail by evaluating the moderating role that could influence the transformation of knowledge sharing into better innovation. This will assist directors and managers in understanding the factors, processes, and mechanisms influencing innovation.

Third, this study was conducted in Bali, Indonesia, which means that the research results cannot be generalized to other geographic contexts by only involving export SMEs. For this reason, future research can adopt this model in other countries and in other industrial sectors such as hospitality, information technology or innovation-based organizations.

Finally, this study solely uses the SEM-PLS approach to predict the model proposed in the hypothesis. Future research might use a stronger approach in explaining and interpreting research results to produce more realistic theoretical and managerial recommendations.

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CAUSALITY BETWEEN FDI IN REAL ESTATE AND TOURISM GROWTH: COUNTY-LEVEL DATA FROM CROATIA

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Abstract. Croatia is a developed tourist destination that is overly dependent on tourism. Looking at the Croatian economy, the first thing that catches one's eye is the role that tourism plays in its structure. It is a frightening fact that tourism generates almost a quarter of Croatia's GDP. Tourism in Croatia has been growing steadily for years, and before the COVID-19 pandemic, Croatia began to face the problem of over-tourism. The real estate market in Croatia is also recording continuous rates of price growth, especially with regard to the attractive coastal region. Foreign direct investment (FDI) in real estate in Croatia became significant during the second decade of the 21st century, and today real estate is in second place if one looks at the structure of FDI in Croatia according to the National Qualification of Activities. In the last 10 years, real estate has accounted for 17.8% of all FDI in Croatia. Given the attractiveness of Croatia as a tourist destination, it is not surprising that its real estate market draws attention. The main goal of this paper is to determine the causal link between FDI in real estate and tourism at the level of Croatian counties in the period from 2007 to 2020. The research results found the existence of a one-way causal relationship running from international tourist arrivals to FDI in real estate at the 5% level of significance.

Keywords: FDI in real estate, tourism growth, Croatia, panel Dumitres & Hurlin.

JEL Classification: *F21, Z32, C33*

1. Introduction

FDI in services has become more significant over the last two decades following the privatization and liberalization policies of numerous countries (UNCTAD, 2009). Real estate is a special type of service according to its fundamental characteristics such as heterogeneity, location connectivity and high transaction costs. As He and Zou (2010) stated, the lack of international real estate trade is offset by increased FDI in real estate, international development projects and multinational real estate.

FDI in real estate includes inflows from both individuals and foreign companies (Boers,

2017). As far as FDI in real estate is concerned, it is expected to grow globally (Topintzi et al., 2008). The main reason for this is real estate market liberalization in many countries (UNCTAD, 2017). FDI in real estate has been one of the fastest growing sectors in recent years (Hui & Chan, 2014). This is supported by the fact that, after the onset of the global financial crisis in 2008, it increased worldwide (Gök & Akseki, 2020). According to Myles (2022), cross-border investments in European real estate are expected to reach record values this year. The statement of PwC (2022) could further support this: "From the investment perspective, the real estate market as a whole has proved to be resilient in times of a large economic crisis, which will lead to larger capital inflows in the next three to five years".

In the conditions of globalization, tourism has become the backbone of the global economy and all analyses indicate the further growth of its strength. According to the UNWTO (2020) and data from before the beginning of the COVID-19 pandemic, international tourist arrivals rose globally by 4% in 2019 and reached the level of 1.5 billion individuals. It is also interesting to point out the pre-pandemic economic strength of tourism, which according to the WTTC (2020) amounted to 10.3% of global GDP, 10.4% of total global employment, and one in four newly created jobs.

The link amongst FDI in real estate and the development of tourism is a modestly explored research topic (Fereidouni & Al-mulali, 2014; Ramdhany et al., 2021). The fact is that the tourism and real estate sectors are two components of the economy with high benefits and strong correlations in the tertiary sector (Sun & Fu, 2018). According to Tsai et al. (2015), the real estate and tourism sectors can have a synergistic effect of improving the image of the destination. The real estate sector can increase real estate values through tourism and surrounding facilities, while real estate development can result in a better tourist environment (Zhu, 2005). By engaging in international tourism, potential investors gain direct experience and information about potential investment opportunities (Gholipour & Al-mulali, 2014). Research to date has identified tourism as a very important factor influencing FDI in real estate (Gholipour & Masron, 2011; Gholipour, 2013; Hui & Chan, 2014; Rodríguez & Bustillo, 2010). Most research dealing with the causality issue found a causal relationship running from tourism to FDI in real estate (Gholipour et al., 2010), or a two-way causal relationship between these variables (Gholipour & Al-mulali, 2014; Gopy-Ramdhany et al., 2021). All of this mentioned research mainly focuses on the potential positive consequences of the causal relationship between tourism and FDI in real estate, ignoring negative aspects.

Both FDI in real estate and tourism itself have a very important place in the Croatian economy. Croatian tourism has been growing continuously for many years and has recorded a current growth rate of 9%, approaching the figure of 11 million tourist arrivals. It is a most propulsive area of the Croatian economy. Bearing in mind the attractiveness of Croatia as a tourist destination, it is not surprising that from 2007 to the present, FDI in real estate in Croatia has recorded a continuous growth rate of 26.4% (Croatian National Bank, 2022). FDI in real estate is currently in second place in the overall structure of FDI in Croatia. For comparison's sake, FDI in tourism ranks 7th (Croatian National Bank, 2022). Consequently, the main goal of this research is to explore the causal relationship between FDI in real estate and tourism using panel analysis at the level of 20 Croatian counties in the period from 2007 to 2021. To the author's knowledge, no scientific research has addressed the issue of causality amongst FDI in real estate and tourism

in Croatia. At the same time, no research so far has interpreted the direction of causality between tourism and FDI in real estate from a potential negative point of view. Instead, such results have automatically been considered excellent indicators of the need to further develop tourism in order to attract FDI in real estate. Here, the author recognizes the research gap that this paper will try to bridge, because FDI in real estate can also have negative consequences which should be kept in mind when interpreting the causal relationship. This is the first contribution of this research.

Moreover, and as a second contribution of this paper, it is necessary to highlight how previous research on the relationship between FDI in real estate and tourism has not included cross-sectional dependence testing and slope homogeneity issues in the panel model, which is crucial for the reliability of research results. According to Andreß (2017), with panel data, the chronological order of the possible causes of a particular effect is known through repeated measurements at the individual level, meaning that cause-and-effect conclusions and the political implications arising from them are much better grounded. Moreover, panel data allows testing a number of important economic questions to which time series or cross-sectional data cannot provide answers (Chuang & Wang, 2009).

To the author's knowledge, there is no research on the topic in question that has dealt with data at the county level, and this is the third contribution of this paper. In the case of Croatia, this is particularly significant as there are large differences between counties in terms of tourism development. In the end, considering the dynamics of the growth rate of FDI in real estate in Croatia and the strong growth rate of tourism, which is presenting Croatia with the problems of over-tourism, these research results have significant and broad socioeconomic and ecological implications. This is the fourth contribution of this work, because the obtained research results require a quick response from the holders of political power. It is certain that there is a serious threat of excessive tourism development in Croatia, and a threat to the standards of living of the local population due to the high level of FDI in real estate.

Research activity aimed at questioning the relationship between tourism and FDI in real estate is more than modest, but often ignores the potential negative aspects of research results finding causality between tourism and FDI in real estate. Such research has also not been carried out on the example of Croatia, all of which justifies the purpose of this research.

The subsequent section provides a literature review of the relationship between FDI in real estate and tourism. Section 3 describes importance of tourism and FDI in real estate for the Croatian economy. The data, empirical approach, and results and discussion of the empirical study are elaborated in Section 4. Lastly, concluding remarks as well as policy implications can be found in Section 5.

2. The state of the art: the relationship between FDI in real estate and tourism

The power of FDI in the development of the economy is a thoroughly investigated scientific topic to which decades of research have been devoted. Interestingly, regardless of the power that tourism has in the global economy, the links amongst FDI and tourism have been explored to a lesser extent (Sanford & Dong, 2000; Endo, 2006; Tang et al., 2007; Craigwell & Moore, 2008; Bezić et al., 2010; Salleh et al., 2011; Zhang et al., 2011; Katircioglu, 2011; Othman et al., 2012; Selvanathan et al., 2012; Samimi et al., 2013; Fereidouni & Al-mulali, 2014; Perić & Nikšić Radić,

2016; Bezić & Nikšić Radić, 2017). The importance of FDI in tourism is of particular importance for developing and less developed countries (Chen & Devereux, 1999; Shehadi, 2017). However, the connection between FDI in tourism and tourism itself is still relatively poorly researched (Bezić & Nikšić Radić, 2017). The beginnings of research on this topic can be found in the work of Dunning and McQueen (1982), which investigated the effects of foreign-owned hotels. The results of their research showed that these effects are closely related to numerous factors of tourism in the host country, but also to the very nature of the corporation's operations. During the 1990s, the unexplored nature of the subject started to be emphasized (Sinclair & Stabler, 1991; Zhang, 1999; UNWTO, 1999). Research that followed mostly related to the testing of the causal relationship between tourism and FDI in tourism (Salleh, Othman, & Sarmidi, 201; Bezić & Nikšić Radić, 2017). Consequently, the connection amongst FDI in real estate and tourism, as noted earlier, is an even scarcer area of research.

Economic research points to the undoubted fact that FDI in real estate, like any other form of FDI, may add to the economic progress of the host country by stimulating the inflow of additional financial resources, transferring knowledge, skills and technology, creating jobs, etc. An analysis of the potential effects of FDI in real estate on the host country indicate a very wide range of both positive and negative effects (Swarbrooke & Horner; 2004; Wei et al., 2006; Basu & Yao, 2009; Fung et al., 2006; French, 2015; Rodríguez & Bustillo, 2010; Gholipour & Masron, 2013; Kim et al., 2015; Wortman et al., 2016; Paris, 2017; Li et al., 2021). It seems most important to point out that, on the one hand, FDI in real estate contributes to the revitalization of especially rural areas and affects the growth of tourism, because tourism is the next step after acquiring real estate in a foreign country. On the other hand, it brings the marginalization of the local population and an increase in real estate prices. Worsening housing affordability for domestic residents and high demand for real estate has led to overdevelopment in some parts of the Mediterranean.

Regarding the mere observation of the connectivity amongst FDI in real estate and tourism development, it is interesting to note that, to the author's knowledge, such research can only be traced back to the early 21st century, as shown in Table 1.

Table 1. *Empirical evidence on FDI in real estate and tourism development*

AUTHORS	SAMPLE/PERIOD	METHODOLOGY	RESULTS
Jiménez, 2002	Spain, 1967–1998	Three Stage Least Squares	Simultaneous and direct interdependence of revenues from tourism and FDI in real estate.
Rodriguez & Bustillo, 2008	Spain, 1990–2077	Engle and Granger cointegration regression	Tourist agglomeration in the host country is a significant and important determinant of FDI in real estate.
He et al., 2009	Chinese provinces, 1997–2007	Tobit model and spatial econometric analysis	Tourism has a positive impact on FDI in real estate.

He & Zhu, 2010	35 major Chinese cities, 2002–2008	Fixed effects panel model	Tourism is an important determinant of FDI in real estate.
Gholipour et al., 2010	Dubai	Vector Error Correction Model	Tourism has a long-term impact on FDI in real estate.
Gholipour & Masron, 2011	19 OECD countries, 1999–2008	Fixed effects panel model	There is a positive and significant connection between tourist agglomeration and FDI in real estate.
Gholipour & Al-mulali, 2014	24 OECD countries, 1995–2009	Panel Granger causality test	There is a long-term and two-way causal link between FDI in real estate and international tourism.
Gholipour, 2013	Panel of 14 Malaysian states, 2004–2010	System Generalized Method of Moments (GMM)	Tourist agglomeration is an important determinant of FDI in real estate.
Hui & Chan, 2014	Chinese provinces, 2005–2010	Fixed effects panel model	Tourism is not an important determinant of FDI in real estate.
Poon, 2017	UK (London), 1987–2015	Fixed effects panel model	The impact of tourism on FDI in real estate has been recognised as statistically insignificant, but has a high negative value.
ÅžÄˇT, 2019	Turkey, 2003–2018	DOLS-FMOLS estimator model	Tourism has a negative impact on FDI in real estate.
Wong et al., 2019	Australia, 2002–2013	Predictive quantitative design	Wealthy Asia-Pacific investors, both foreigners and tourists, invest heavily in the Australian residential real estate market due to Australia's well-known favourable living conditions and education standards.
Baguisi, 2020	Philippines, 1991–2018	Vector Error Correction Model	Tourist agglomeration leads to higher levels of FDI in real estate.
Gök & Akseki, 2020	Turkey, 2003–2016	Vector Error Correction Model	The number of one-year lagged tourist arrivals is one of the most important and statistically significant determinants of FDI in real estate in Turkey.
Go-py-Ramdhany et al., 2021	33 countries, 2000–2016	Panel Vector Error Correction Model	FDI in real estate has a generally positive impact on tourism growth. Tourism has a positive impact on FDI in real estate (at least in the long run).

Source: *Author's research*

An overview of existing research points to two main approaches to the theme of the connection between FDI in real estate and tourism. One stream of research looks at tourism as a potential determinant of attracting FDI in real estate (for example, Rodriguez & Bustillo, 2008; He and Zhu, 2010; Gholipour et al., 2010; Baguisi, 2020). Another stream of research approaches the problem in a manner similar to this paper – i.e., observes the causal relationship between FDI in real estate and tourism (Gholipour et al., 2010; Gholipour & Al-mulali, 2014; Gopy-Ramdhany et al., 2021).

A review of previous research makes it quite certain that FDI in real estate is influenced by tourism. According to Karadag (2021), when a foreign investor is considering the decision to invest in real estate, they usually invest on the coast of a country with a mild climate, affordable transportation, and natural, historical, and cultural beauty. The direction of causality between these two observed variables can be perceived as an open question (Gholipour et al., 2010). Most existing research points to the fact that tourism causes FDI in real estate (Rodriguez & Bustillo, 2008; Gholipour et al., 2010; Gholipour, 2013; Baguisi, 2020; Gök & Akseki, 2020), but a number of studies have demonstrated the existence of a two-way relationship amongst the observed variables (Jimenez, 2002; Gholipour et al., 2010; Gholipour & Al-mulali, 2014; Gopy-Ramdhany et al, 2021).

Existing research dealing with causality has not provided an unambiguous answer, so the question of the direction of this causality is one that requires further study. What is more certain in the specific country that is the subject of research – FDI in real estate-led tourism, or tourism-led FDI in real estate? Reflecting on the results of previous research, it is quite certain that in countries where tourism is still developing, FDI in real estate provides a positive impetus and can play a significant role in the further development of tourism. FDI in real estate has the potential to ensure the infrastructural development of tourism, which consequently results in the development of tourism (Gopy-Ramdhany, N. et al., 2021). However, is this the case for countries such as Croatia, which already have highly developed tourism? Is it good that tourism attracts FDI in real estate? Countries that are already developed as tourism destinations very often face the problem of over-tourism, and it is not in their interest to excessively attract FDI in real estate. FDI in real estate has a large impact on the environment, and is incompatible with the model of sustainable development (Barrantes-Reynolds, 2011) which every serious tourist destination strives to achieve in their long-term development. Tourism-developed countries are also very often faced with an enormous increase in real estate prices, which puts the local population in a perilous situation. FDI in real estate is associated with higher real estate prices in most capital-importing countries (Calvo et al., 1996), providing one more reason why it is not in their interest to excessively attract FDI in real estate. The very limited amount of research, paired with these arguments, clearly points to the need for further research into the causal relationship between FDI in real estate and tourism. Such research results have exceptional political implications and have wider socio-economic and ecological effects in the case of Croatia, which is the focus of this research.

3. The importance of tourism and FDI in real estate for the Croatian economy

Croatia is a country whose heritage of tourist activity dates back to the time of the Habsburg

Monarchy. Today, tourism is the backbone of the Croatian economy. The strength with which it dominates the Croatian economy is truly frightening, as confirmed by the data in Table 2.

Table 2. *The strength of tourism in the Croatian economy*

	2019			2020		
	Croatia	**EU**	**World**	**Croatia**	**EU**	**World**
Contribution of travel & tourism to GDP	24.3% of total economy	9.5% of total economy	10.4% of total economy	10.2% of total economy	4.9% of total economy	5.5% of total economy
Contribution of travel & tourism to employment	22.2% of total employment	10.1% of total employment	1 in 10 jobs globally	19% of total employment	9.3% of total employment	1 in 11 jobs globally
International visitor impact	37.7% of total exports	6.2% of total exports	6.8% of total exports	18.1% of total exports	2.6% of total exports	6.8% of total exports

Source: *World Travel & Tourism Council (2021)*

Table 2 shows parallel data from 2019 and 2020 in order to highlight the importance of tourism more realistically, given the exceptional situation that affected the world globally during 2020. During 2019, the overall contribution of tourism to Croatia's GDP was 24.3%, while at the EU level it was 9.5%, and at the global level 10.4%. In the same year, tourism accounted for 22.2% of total employment in Croatia, while at the European and world level it accounted for around 10%. The situation is even more compelling when it is pointed out that in 2019 tourism accounted for 37.7% of total Croatian exports, while at the EU level it accounted for 6.2%, and at the global level 6.8% of total exports. During 2020, Croatia, like the rest of the world, recorded poorer tourism results, but regardless of this decrease tourism remained the dominant force in Croatia's economy.

It is interesting to note the trend of international tourist arrivals. Croatia, as a member of Yugoslavia at the time, recorded a record 10 million international tourist arrivals in 1985 (Gosar, 1989). After the disintegration of Yugoslavia and the Homeland War, it took a number of years for Croatian tourism to regain its former contours, and in 2000 it came somewhere close to pre-war levels. Croatia only re-achieved this record level of 10 million international tourist arrivals in 2009, as can be seen from Figure 1.

Figure 1. Croatian international tourist arrivals (in thousands), 2007–2021
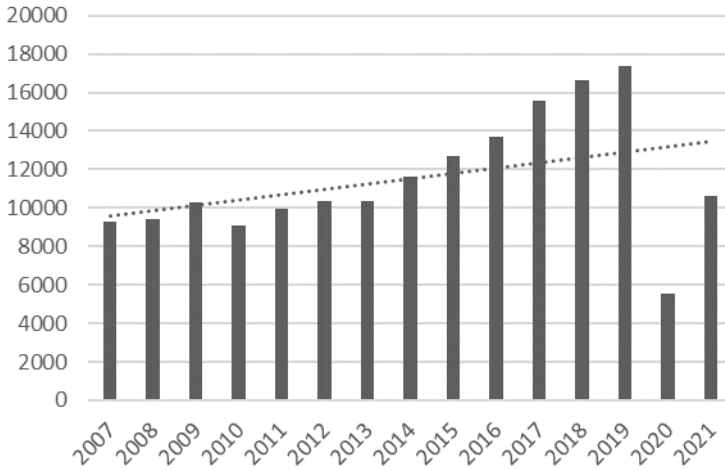
The Global Financial Crisis caused turbulence in the intensity of tourism activity in 2008, but after that Croatian tourism continued to grow. In 2019, Croatia began to seriously deal with the issue of over-tourism when it achieved a record 17.4 million total tourist arrivals (Nikšić Radić, 2022). During the 2020 COVID-19 pandemic, Croatian tourism experienced a sharp decline, and 2021 ended with 10.7 million international tourist arrivals. In the observed period from 2007 to 2021, the average growth rate of international tourist arrivals was 9%.

It is also interesting to observe the trend in FDI in the Croatian economy. The official statistics of the Croatian National Bank have been monitoring the first inflows of foreign capital since 1993, and a significant growth trend can be traced back to 1995, when the Homeland War ended. The trend of FDI in the Croatian economy in the period from 2007 to 2021 reflects the situation of the global market, which can be seen in Figure 2.

Figure 2. *FDI and FDI in real estate in Croatia, 2007–2021 (in million EUR)*
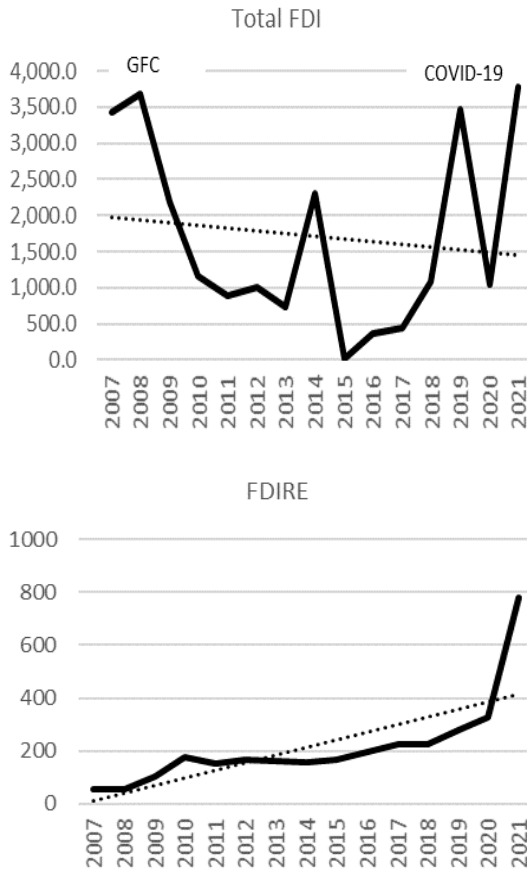
Source: *Author's calculation according to data from the Croatian National Bank (2021)*

It is possible to see how Croatia managed to achieve a record level of FDI just before it faced the consequences of the Global financial crisis, and the next strong blow was dealt to it by the COVID-19 crisis in 2020. At the end of 2021, Croatia again attracted a record amount of FDI that can be compared to levels before the onset of the Global financial crisis.

FDI in real estate in Croatia can be monitored only since 2007. It is evident that FDI in real estate in Croatia in the observed period continuously grew at an average rate of 26.4%. An extremely high growth trend was recorded in the last observed year. Such a trend is in line with

global market trends (see more in PwC, 2022).

## 4. Research methodology

4.1 Data

This research will use annual data related to the inflow of FDI in real estate and the number of international tourist arrivals. The data panel includes 20 counties and the capital of the Republic of Croatia: Zagreb, Krapina-Zagorje, Sisak-Moslavina, Karlovac, Varaždin, Koprivnica-Križevci, Bjelovar-Bilogora, Primorje-Gorski Kotar, Lika-Senj, Virovitica-Podravina, Požega-Slavonia, Brod-Posavska, Zadarska, Osječko-Baranjska, Šibenik-Knin, Vukovarsko-Srijemska, Splitsko-Dalmatinska, Istarska, Dubrovačko-Neretvanska, Međimurska, and the City of Zagreb. The advantage of panel data is that they provide more explanatory data, greater variability, less collinearity between variables, a greater degree of freedom, and greater efficiency (Baltagi & Pesaran, 2007; Farzanegan & Gholipour, 2014). The data cover the period from 2007 to 2021. Table 3 shows the variables used in the study.

Table 3. *Variables and sources*

Variable	Definition	Source
LOGFDIRE	Inflow of FDI in real estate investments (in million EUR)	Croatian National Bank
LOGIN-TARR	Number of international tourist arrivals (in millions)	Croatian Bureau of Statistics

The statistical program EViews 12 will be used to conduct the panel analysis. The cross-sectional dimension ($N = 21$) includes data for 21 counties, while the time dimension ($T = 15$) covers 15 years. A scatter plot between these two variables is shown in Figure 3.

Figure 3. The relationship between international tourist arrivals and FDI in real estate
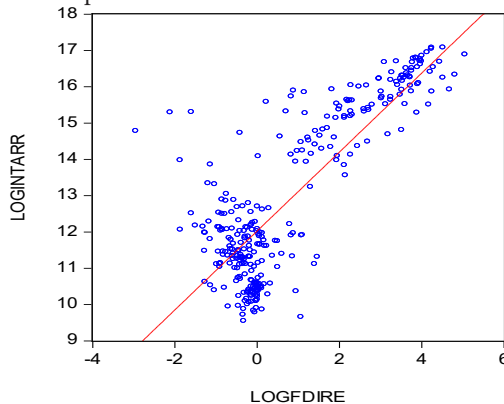
Source*: Author's calculations*

The scatter plot of international tourist arrivals and FDI in real estate shows the positive slope of the trend line.

4.2 Empirical approach

According to Lin (2008), testing causality among variables is both the most important and the most difficult issue in economics. Simply put, Granger causality analyses the flow of information between time series. More specifically, by investigating the causality between FDI in real estate and tourism, the author could potentially prove the following: FDI in real estate affects tourism; tourism affects FDI in real estate; there is no relationship between the variables; or there is a mutual relationship between FDI in real estate and tourism. The author employed the Dumitrescu and Hurlin causality test as a crucial test for making political decisions (Ahmed et al., 2022). At its core, this test examines whether there is a cause and effect bond between two observed variables (Yunusova, 2021). It is possible to highlight three advantages that it offers compared to existing methods: it takes into account cross-sectional dependence; the time dimension and relativity size of the cross-section is insignificant; and it achieves proficient results in an unbalanced panel (Lawal et al., 2022).

To the author's knowledge, previous research examining the causal link between FDI in real estate and tourism has not analysed cross-sectional dependence and slope homogeneity issues in panel analysis.

Cross-sectional dependence can be a serious issue in panel data, and its neglect can lead to misinterpretations (Grossman & Krueger, 1995). Cross-sectional dependence and slope homogeneity issues need to be tested before testing causality in panel models. These are two key steps in investigating the causal relationship in panel analysis (Dogru & Bulut, 2017). Cross-sectional dependence is described as the interaction between cross-sectional units. Due to spatial effects or spill over effects, cross-sectional dependence may occur or may be due to unnoticed (or inconspicuous) common factors (Baltagi & Pesaran, 2007).

In addition, before testing the unit root test and causality, this research starts with cross-sectional dependence testing. Establishing the occurrence or absence of cross-sectional dependence is essential to determining which unit root test will apply. The occurrence of cross-sectional dependence amongst counties will be assessed through the following tests: Breusch–Pagan (1980) LM; Pesaran (2004) CD; Pesaran (2004) scaled LM (LMS); and Baltagi, Feng and Kao (2012) bias-adjusted scaled LM (LMBC). The cross-sectional test hypotheses are as follows:

H_0 = *There is no reliance on the horizontal section.*
H_1 = *There is a dependency on horizontal section.*

Another important step is to examine slope homogeneity issues, which will be carried out through the Hsiao (1986) test. The homogeneity test is applied through panel analysis in order to decide whether other counties are equally affected by changes to one of the selected counties. The Hsiao (1986) test hypotheses are as follows:

H_1 = *Null hypothesis: panel is homogeneous vs alternative hypothesis: H_2*
H_2 = *Null hypothesis: H_3 vs alternative hypothesis panel is heterogeneous*
H_3 = Null hypothesis: panel is homogeneous vs alternative hypothesis: panel is partially

homogeneous.

The further research procedure requires stationarity testing. In panels where cross section-al dependence has been proven, it is appropriate to use some of the second generation unit root tests such as MADF (Taylor & Sarno, 1998), SURADF (Breuer et al., 2002), Bootstrap (Smith et al., 2004), PANIC (Bai & Ng, 2004), CADF and CIPS (Pesaran, 2007), and HK tests (Hadri & Kurozumi, 2012). This study will use the CADF test developed by Pesaran (2007). CADF testing is based on the contemporary modification of ADF regression with the first differences of indi-vidual series and average latency level cross-sections. In the test, individual results are obtained for each section with CADF statistics, and CIPS (Cross Sectionally Im-Pesaran-Shin) statistics are extended by taking the average of the section. Results are thus obtained for the entire panel. CADF panel unit root tests have substantial size and power even if N and T are relatively small (Dogru & Bulut, 2018). The CADF hypotheses are as follows (Pesaran, 2007):

H_0: *The variable is not stationary.*

H_1: *The variable is stationary.*

The presence of a causal relationship will be observed by the Dumitrescu and Hurlin (2012) panel causality test. Dumitrescu and Hurlin (2012) developed a panel causality test, the main features of which are: pondering both cross-sectional dependence and heterogeneity; giving ho-mogeneous results in Eviews; giving effective results in unbalanced panel data sets when time is greater than horizontal dimensions ($T > N$); and the ability to be used regardless of whether there is cointegration or not (Degerli, 2021).

The basic equation of the Dumitrescu and Hurlin causality test is as follows:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{L} y_i^k y_{it-k} + \sum_{k=1}^{L} \beta_i^k x_{it-k} + \varepsilon_{it}, i = 1,2,\ldots,N: t = 1,2,\ldots,T$$

where $\alpha_i \alpha_i$ denotes individual effects, $y_i^k y_i^k$ stands for the autoregressive parameters for each county, $\beta_i^k \beta_i^k$ denotes the regression coefficients for each county, and $y_{it} y_{it}$ and $x_{it} x_{it}$ indicate observables.

The null hypothesis versus the alternative hypothesis can be stated as follows:

$H_0: \beta_i = 0 H_0: \beta_i = 0$

$H_1: \begin{cases} \beta_i = 0 \\ \beta_i \neq 0 \end{cases} \forall_1 = 1,2 \ldots N \text{ and } \forall_1 = N+1, N+2 \ldots N$

4.3 Research results

The first step of the analysis was cross-sectional dependence testing, which plays a vital role in identifying and testing all phases for panel data. The existence or nonexistence of cross-sec-tional dependence is essential in deciding which unit root tests to apply. The test results are re-vealed in Table 4.

Table 4. The results of the cross-section dependence test

| Variables | Breusch-Pagan LM | Pesaran scaled LM | Bias-corrected scaled LM | Pesaran CD |

logfdire	613.2367 (0.00)	19.67594 (0.00)	18.92594 (0.00)	7.421865 (0.00)
logintarr	1817.064 (0.00)	78.41667 (0.00)	77.66667 (0.00)	40.36628 (0.00)

Note: Figures in the parentheses are the probability values

The results of the cross-section dependence test show that the null hypothesis of no cross-sectional dependence was rejected at the 1% significance level. In other words, it is possible to conclude that there is cross-sectional dependence among the counties of the Republic of Croatia.

The next step was to examine the heterogeneity of the panels. When the economic forms of the considered counties differ, the coefficients in the model are expected to be heterogeneous. When their economic forms are similar, the coefficients will be homogeneous. The test results are presented in Table 5.

Table 5. The results of the Hsiao (1986) test

Hypotheses	F-stat	p-value
H1	159.9289	1.8E-166
H2	1.958107	0.009417
H3	298.3853	1.2E-181

H_0: slope coefficients are homogenous

The results of the Hsiao homogeneity test show that it is possible to accept the assumption of heterogeneity by rejecting the homogeneity condition at the 5% significance level in all three hypotheses.

Given the proven cross-sectional dependency, it is appropriate to use second-generation unit root tests in further analysis. One such test is the CADF panel unit root test developed by Pesaran (2007).

Table 6. The results of the CADF panel unit root test (Pesaran CIPS Test Results)

	CIPS test results	p-value
logfdire	−0.95	>0.10
logintarr	−2.73	<0.01
dlogfdire	−3.59	<0.01
dlogintarr	−2.70	<0.01

The CADF panel unit root test results in Table 6 show that the null hypothesis of a root unit can be rejected when both variables are level. Both variables achieve stationarity after differentiation, I (1). Consequently, when conducting the Dumitrescu and Hurlin (2012) panel causality test, the first differentiation of the subject variables will be used. The results of the Dumitrescu and Hurlin (2012) causality test are shown in Table 7.

Table 7. The results of the Dumitres and Hurlin (2012) causality test

Null hypothesis:	W-stat	p-value
H_0: dlogintarr does not homogeneously cause dlogfdire	4.68	0.04*
H_0: dlogfdire does not homogeneously cause dlogintarr	3.36	0.55

Note: *Illustrates 5% statistical significance

The results of the Dumitres and Hurlin (2012) causality test show that the null hypothesis – no causality running from international tourism to FDI in real estate – can be rejected at the level of 5% significance. Furthermore, the results related to the null hypothesis – no causality running from FDI in real estate to international tourism arrivals –are not significant. In other words, it is possible to conclude that there is a one-way causality running from international tourist arrivals to FDI in real estate in the Republic of Croatia, observing the panel of its counties.

These research results are consistent with those of Rodriguez and Bustillo (2008), Gholipour and Masron (2011), Gholipour (2013), Baguisi (2020), and Gök and Akseki (2020). The development of Croatian tourism and its natural beauty, which make it attractive, influence the attraction of FDI in real estate. Nevertheless, while the mentioned previous research, the results of which are consistent with the results of this research, positively perceives the direction of causality from tourism to FDI in real estate, countries such as Croatia have to think about such trends in a different way. This is precisely why it is necessary to intensify research efforts in destinations whose enviable tourism results strongly attract FDI in real estate, which leads to negative effects in the country. For example, the research of Gholipour et al. (2010) focused on Dubai, where such results have a stimulating effect on the holders of political power who should recognize the opportunity and intensify efforts to attract additional numbers of tourists and thereby ensure the further attraction of FDI in real estate. However, these measures are not in the national interest in Croatia. On the contrary, such results send a signal to the holders of political power in Croatia to seriously deal with the issue of the strong growth of FDI in real estate. Large inflows of FDI in real estate are often associated with growing imbalances, such as rising real estate prices (Guerra de Luna, 1997; Brooks, 2017) and the increasing cost of land and housing (Copeland, 1991). Large amounts of FDI in real estate in Costa Rica (around 25% of total FDI inflows) contributed to the development of real estate prices (Cordero & Paus, 2008). For comparison, in 2021 FDI in real estate in Croatia amounted to 20.6% of total FDI inflows. According to Thomas (2021), real estate prices in Croatia have grown by more than 26% in the past 10 years or so.

Contrary to the results of this research, Poon (2017), using the example of England through the analysis of panel data, proved a negative connection between the number of tourists and FDI in real estate, but the reason for this is perhaps because these investments had the purpose of achieving financial profit. As far as FDI in real estate is concerned, Croatia is primarily attractive for other reasons. For instance, Croatia is proclaimed to be the eighth best country in the world to retire to, according to a survey from 2022 (Thomas, 2022). While the standard of living Croatian citizens is below the European average and the cost of living in their own country is extremely high for them, Croatia is, citing McMahon (2021) "insanely cheap for just about everything" for citizens of developed Western countries. The phenomenon of buying real estate in one's favourite

tourist destination is particularly visible in Europe (Swarbrooke & Horner, 2004). This is a direct consequence of large differences in the standards of living of individual member states. Real estate has become both global and local: global because it is of interest to global corporations; and local in terms of micro location factors that have a profound impact on values (Norges Bank, 2015; Reiss, 2002; Bardhan & Kroll, 2007). The link between the global real estate industry and a country is "a state-building force in some respects and a state-destroying force in others" (Harrington, 2016; Rogers & Koh, 2017).

Finally, such research results should also be considered from the aspect of sustainability in Croatia's case, because Croatia is a country facing the serious problem of over-tourism. Similar previous research has not considered these results from this very important aspect. Real estate affects the accomplishment of sustainability goals (Kabil et al., 2022), and it should be strongly pointed out that these research results represent a severe threat to the sustainability of Croatian tourism, which is already seriously damaged.

5. Conclusion

It is quite certain that the phenomenon of buying real estate abroad is a trend that will continue to grow around the world in the future (Swarbrook & Horner, 2004). This is a consequence of the increasing growth of international tourist arrival numbers, which very often results in the purchase of real estate in a foreign country – a country previously visited for tourist reasons. In addition, some investors consider real estate investments to be a safe haven in times of great uncertainty (European Systemic Risk Board, 2022). As Rogers and Koh (2017) stated, FDI in real estate is once again becoming a key issue in political, scientific and public debates.

The Croatian economy and tourism, unlike many of Croatia's competing tourist destinations, are two extremely dependent concepts. Tourism accounts for approximately 25% of Croatia's GDP, and the country has a serious problem with over-tourism. Croatia is an attractive tourist destination and of course draws global attention with its real estate market. In the last 10 years, FDI in real estate accounted for 17.8% of all FDI in Croatia, and today FDI in real estate is in second place if one looks at the total structure of FDI in Croatia.

The research results in this paper unequivocally indicate the existence of a one-way causality running from international tourist arrivals to FDI in real estate at the 5% level of significance. Given the continuing strong growth rate of international tourist arrivals of 9%, such results are in line with previous research results that clearly point out that tourist visits often result in later investments in the visited destination (Rodriguez & Bustillo, 2010; Gholipour & Masron, 2011).

Although previous research suggests that when tourism affects FDI in real estate policymakers should pay special attention to their tourism sectors and try to attract additional international tourists to advance their real estate sectors (Gholipour & Masron, 2011), it is very questionable whether there is a need to attract additional international tourists to Croatia. Given that Croatia is a country facing a major over-tourism problem due to its extreme seasonality, which is a direct consequence of the specific structure of Croatian accommodation, (Nikšić Radić, 2022) the additional attraction of FDI in private accommodation would put an even heavier burden on Croatian tourism and would remove it even further from the aspiration of sustainable tourism development. In Croatia, if the representative year 2019 is observed, significantly reduced seasonality can be noticed only in hotel accommodation (Nikšić Radić, 2022). Croatia can benefit

only if it successfully corrects its extremely seasonal tourist image.

Countries that rely heavily on tourism, and especially on international tourist arrivals, are usually small, have a GDP per capita in the middle- and high-income range, and are mostly net debtors (Milesi Ferretti, 2021). It is interesting to note that there are actually studies that have proven that small countries specializing in tourism are more successful than other small countries (Brau et al., 2007). However, in the case of Croatia, previous experiences show that any global instability that directly reflects on tourism activity throws the Croatian economy, to which tourism contributes 25%, to its knees. According to Lee and Chien (2008), countries or areas that target tourism as a development strategy to secure domestic investment depend on foreign investment to ensure the success of the tourism sector. Nevertheless, warnings of the appropriate degree of connection between the two aspects have been heard for decades. In this vein, Davis (1967) pointed out how "Tourism, like other economic activities, flourishes best when it fits into a context of general economic policies and programs designed to lead to the optimum growth of the economy as a whole. For this, some sort of national planning – at least in setting priorities and seeing that they are emphasized – is required to create a climate for productive investment in all suitable fields. The adoption of a national tourism plan is probably the only most important step that each country can take to ensure a balanced investment program in tourism development". It is quite certain that the current Croatian tourism plan, and consequently the development of Croatian tourism, is inconsistent with the rest of the economy. On the contrary, looking at the strength of Croatian tourism in relation to its overall economy, it is evident that tourism has been the only pillar holding up the Croatian economy for decades.

Although residential tourists contribute to the inflow of FDI in real estate and are expected to be more committed to a particular destination, large numbers of foreign investors and a high level of foreign control can also jeopardize the sustainability of the residential tourism sector (Wortman et al., 2016). Excessive development can lead to a decline in tourism, and a direct consequence of this may be the transfer of investors to other opportunities, leaving the local population with an overdeveloped and declining industry. Mihaljek (2005) pointed out that this potential problem could befall Croatia in 2005. Today, Croatian tourism is already facing a strong growth rate of international tourist arrivals, FDI in real estate, and the excessive development of tourism. Consequently, the long-term sustainability of its development is becoming more and more questionable. The holders of political power need to take very seriously such messages in the existing scientific literature, especially after the proven causal link that, in the Croatian example, proceeds from international tourist arrivals to FDI in real estate. Croatia's long-term goal should be to provide its citizens with the opportunity to acquire real estate in their own country and to ensure the sustainability of tourism, on which the entire economy rests. The current strong growth trends of FDI in real estate, stimulated by intensive tourism growth, put the possibility of realizing the necessary stated long-term goals into question.

These research results certainly indicate the importance of further research on the subject. It would be interesting to see which other determinants of the Croatian economy, in addition to tourism, affect the attraction of FDI in real estate. It should also be noted that the real estate market, due to the huge interest of foreigners in Croatia, is recording continuous growth rates in prices, especially in the attractive coastal area. This has far-reaching consequences for the local population. The effect of FDI in real estate on house prices is unquestionable, and is an area

requiring further research. Looking at the direction of causality running from tourism to FDI in real estate from a potential negative point of view is an imperative for the Croatian economy. Thus, the question must be asked: what is the ultimate limit of this need to attract FDI in real estate in each individual country?

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AN EMPIRICAL ANALYSIS OF LUXEMBOURG'S POST-COLD WAR DEFENCE EXPENDITURE

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Abstract. *The latest shift in the global balance of power (i.e., Russia invading Ukraine) has reinforced the role of NATO and breathed new life into the discussion on defence expenditure, particularly in respect to NATO's two percent GDP guideline. This paper is interested in the defence expenditure of one of the smallest NATO nations, Luxembourg. The author investigates Luxembourg's post-Cold War military spending via two different methods (graphical analysis and econometric modelling) and in relation to a selection of endogenous and exogenous influence factors. Graphical analysis allows for an explanation of the dichotomy of Luxembourg being, on the one hand, NATO's smallest contributor in terms of defence expenditure as a share of GDP, and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure. In turn, the econometric analysis in this paper proposes an OLS model which explains Luxembourg's defence expenditure as a share of GDP in relation to two endogenous variables (GDP per capita and military personnel) and one exogenous variable (US defence expenditure as a share of GDP). This model has two merits. First, it offers a science-based indication as to how many staff the Luxembourg Armed Forces need to recruit in the future. Second, it exposes the limits of defence expenditure as a share of GDP for evaluating the military effort of a nation. Finally, the limitations of the paper are that the developed model is only applicable to Luxembourg. The author tested it against an updated version of Verlaine's (2022, in press-a, in press-b) small NATO nations, but it failed to produce convincing results.*

Key words. *Defence expenditure, Luxembourg, small NATO nations, OLS model.*

JEL Codes. *H:56, C:11*

1. Introduction

The end of the Cold War introduced a new era in the defence spending of NATO nations. The collapse of the Soviet Union and the dissolution of the Warsaw Pact in 1991 implied that NATO's main rival had suddenly disappeared. NATO countries were eager to profit from the newly gained "peace dividend", and gradually reduced their defence spending in favour of other investments (e.g., public health, education, infrastructure) (Bishop, 2017). This trend has been further accelerated by a neoliberal method of reform in public management (New Public Management), which has redefined the role of the government and introduced (a) greater reliance on markets and private services and (b) new pressures and incentives for efficiency and effectiveness (Cadell, 2007).

However, faced with shrinking budgets on the one hand and new responsibilities (e.g., peacekeeping and stabilisation missions) on the other, the NATO nations agreed at the 2006 Riga Summit to commit a minimum of two per cent of their gross national product (GDP) to defence spending in order to continue to guarantee the Alliance's military readiness (NATO, 2022a). This decision was also made against the backdrop of the rise to power of the Russian Federation and a change in President Putin's rhetoric, particularly in relation to NATO's enlargement process in the East. At the 2014 Wales Summit, as a reaction to the illegal annexation of Crimea by the Russian Federation, the NATO nations reiterated their commitment to the two percent guideline and further agreed to spend twenty percent of their annual defence expenditure on major new equipment (Techau, 2015). Finally, at the 2022 Madrid Summit, following the Russian invasion of Ukraine, the NATO nations issued a membership invitation to Sweden and Finland and reconfirmed the importance of military spending and the two percent GDP baseline (The White House, 2022).

In spite of the commitments undertaken at the Riga, Wales and Madrid Summits, the majority of the NATO nations have not spent two per cent of their GDP on defence in 2022 (see Figure 1). However, most NATO nations do match the twenty percent guideline on equipment expenditure (see Figure 2).
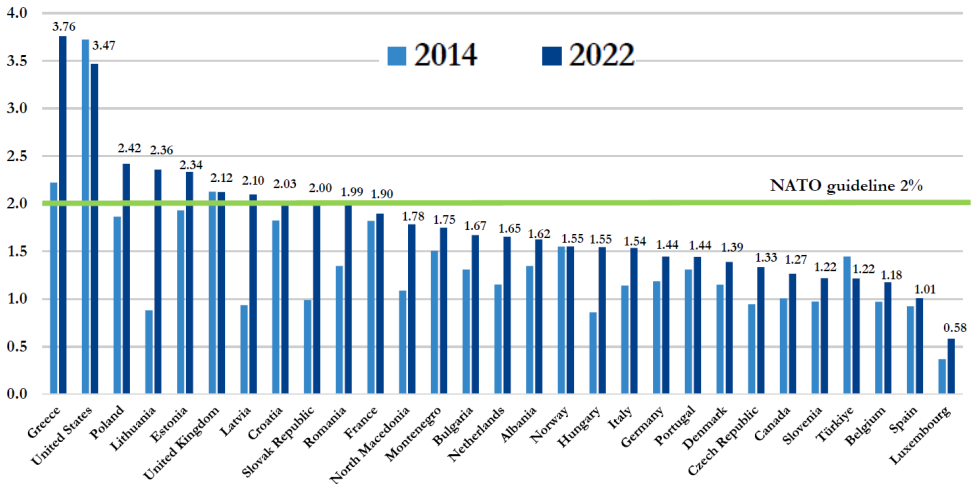
Figure 1: Defence expenditure as a share of GDP (in percentages) (Source: NATO, 2022b)
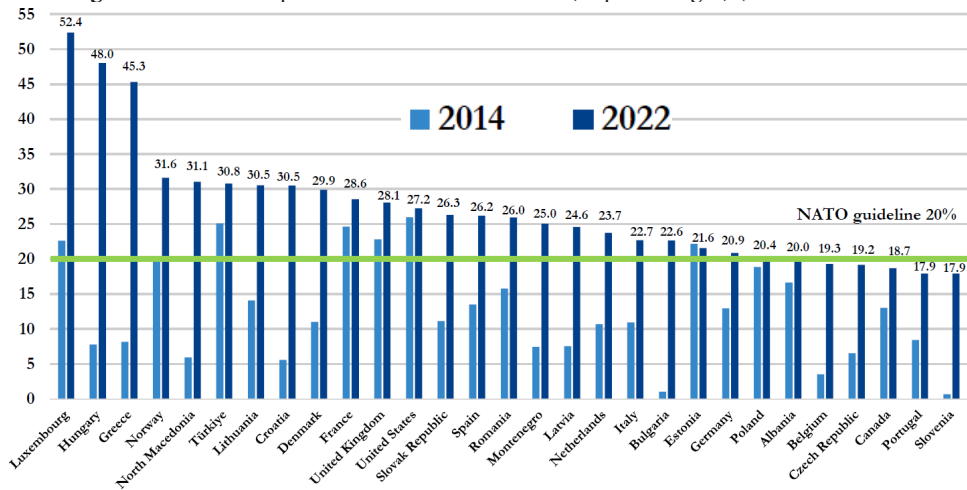
Figure 2: Military equipment as a share of defence expenditure (in percentages) (Source: NATO, 2022b)

2. Research Objective

This paper is specifically interested in the defence expenditure of one of the smallest NATO nations, Luxembourg. Figure 1 shows that Luxembourg spends by far the smallest share of GDP on defence of all NATO nations (0.58% in 2022 and 0.38% in 2014). However, Figure 2 shows that Luxembourg is NATO's top spender in terms of military equipment by share of defence expenditure (52.4% in 2022 and 22.6% in 2014). This discrepancy is intriguing and deserves an

explanation.

The main research question is as follows: What factors influence Luxembourg's defence expenditure, and is it possible to develop a model that can accommodate these factors? The period of interest is the post-Cold War era, from 1989 to 2021. The unit of analysis is Luxembourg's defence expenditure as a share of GDP.

This paper is furthermore interested in whether the developed model holds true for Luxembourg only, or if it is applicable to other similar small NATO member countries. In order to answer this question, the model is tested against an updated version of Verlaine's (2022, in press-a, in press-b) small NATO nations. The author's hypothesis is that Luxembourg occupies a unique position with NATO as result of its socio-economic and geopolitical profile, and that the developed model is too specific to be applied elsewhere.

Finally, the paper tackles the question of why Luxembourg is, on the one hand, NATO's smallest contributor in terms of defence expenditure as a share of GDP, and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure. Table 1 summarises the research questions and hypothesis.

Table 1: Research questions and hypothesis

Main Questions	What factors influence Luxembourg's defence expenditure, and is it possible to develop a model that can accommodate these factors?
	Will the developed model hold true for Luxembourg only, or is it also applicable to other similar smaller NATO member countries?
Sub Question	Why is Luxembourg on the one hand NATO's smallest contributor in terms of defence expenditure as a share of GDP, and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure?
Hypothesis	Luxembourg occupies a unique position within NATO as result of its socio-economic and geopolitical profile, and the developed model is too specific to be applied elsewhere.

3. Literature Review

The author conducted a literature review on the determinants of military spending in general, and on the socio-economic and geopolitical situation of Luxembourg in particular, in view of identifying potentially relevant influence factors for explaining the defence expenditure of Luxembourg.

In terms of the former, a series of contemporary and classical publications caught the attention of the author. Looney and Frederiksen (1990) analysed the impact of expected and unexpected gross national income (GNI) on defence expenditure in six East Asian Countries and concluded that economic strength is a key factor. In a similar vein, Pan et al. (2015) investigated the causal relationship between military spending and economic growth in ten countries in the Middle East. They found that causality was either unidirectional, bidirectional or non-existent depending on the economic and political profile of the country. Desli et al. (2016) came to a similar conclusion when investigating developed, developing and least-developed countries. They found evidence of a positive long-term causality from military spending to economic growth in

the case of developing countries, and from economic growth to military spending in the case of developing and developed countries.

By contrast, Jari (2005) took a more multifactorial perspective and proposed to model defence expenditure in relation to the price of military goods, a state's income, the impact of friendly states' military spending, the impact of hostile states' military spending, and the constraints imposed by changes in the overall strategic parameters of a nation. In fact, Jari (2005) sides with Smith (1977, 1978, 1980, 1989, 1995), who established early on that a host of factors determine military spending, including internal and external security considerations, economic power, geopolitical aspirations, and the ideological orientation of the incumbent government. Wang (2013) also adhered to a multidimensional approach when examining Southeast Asia, and discovered that military spending in this region has been jointly determined by economic, strategic and socio-political factors. He identified surging foreign debt and the rise of China as key forces.

Finally, Odehnal and Neubauer (2020) used a host of economic variables (budget balance, foreign debt, inflation, GDP per capita, growth and current account as a percentage of GDP), security variables (terrorism, cross border conflict, ethnic tension and foreign pressures) and political variables (democratic accountability and a government stability) when assessing military spending within NATO. Their results showed serious inconsistencies in factors affecting the defence expenditure of both old and new NATO nations. In a similar study, Odehnal et al. (2021) investigated military expenditure in relation to a series of socio-economic variables (average military burden, GDP, non-military government expenditure, share of trade balance of GDP and population) in order to identify the potential following behaviour of NATO nations. They found that new NATO nations in particular honour the commitment to spend two percent of GDP on defence.

As to Luxembourg's socio-economic and geopolitical profile, the latest OECD economic forecast on Luxembourg and government reports on Luxembourg's defence strategy offer valuable reference points (OECD, 2019, 2022; DOD, 2017, 2022a, 2022b). Furthermore, as a member of the Luxembourg Armed Forces, the author has access to internal documents such as the five-year road map and the recruitment strategy of the Armed Forces. Naturally, the information contained in the latter documents needs to be treated with some discretion. A short socio-economic and geopolitical profile of Luxembourg is presented below.

Luxembourg is a small and stable high-income economy featuring solid growth, low inflation rates (until 2022) and low unemployment. Its political orientation is neoliberal, with a strong conservationist tendency. The economy proved relatively sheltered from direct negative consequences of the war in Ukraine or the sanctions imposed on Russia, although energy supply (oil and natural gas) is likely to become more of a concern in the future. Luxembourg has a dominant service sector which accounts for a substantial share of its GDP. It has a total population of 645,000 inhabitants, and only a small Armed Force of 900 soldiers. Despite a lurking global recession, the Luxembourg Directorate of Defence (DOD) plans to increase defence expenditure substantially, from $523 million in 2022 to $992 million in 2028. This increase is necessary in order to fulfil the latest NATO capability targets that Luxembourg accepted in 2021, most notably the establishment of a Belgian-Luxembourg reconnaissance battalion and the reinforcement of its stock of war ammunition.

Based on the conducted literature review, the author identified 10 potentially relevant en-

dogenous influence factors and 15 potentially relevant exogenous influence factors for explaining Luxembourg's military spending (see Appendix A and Appendix B). Endogenous factors were selected with reference to the socio-economic information they contain about Luxembourg's economy (GDP in real terms, GDP per capita, inflation and growth rates) and defence apparatus (military personnel, defence expenditure in real terms, defence expenditure per capita, and defence expenditure per category). In turn, exogenous factors were selected based on global economic crises (dotcom bubble, subprime mortgage crisis, COVID-19 pandemic), key NATO decisions (Riga Summit, Wales Summit and Madrid Summit) and international political/armed conflicts in which the Luxembourg Armed Forces intervened with a detachment of soldiers (see Table 2). Furthermore, NATO and US defence expenditure as a share of GDP were included as reference points. All data was retrieved from official sources, including: NATO press releases (NATO, 1992, 1994, 1996, 2001, 2005, 2011, 2015, 2017, 2022b); working documents from the Luxembourg Armed Forces (Armée luxembourgeoise, 2021, 2022); and the databases of the World Bank (2022) and the Luxembourg Institute for Statistics and Economic Studies (STATEC, 2022).

Table 2: Political and armed conflicts in which the Luxembourg Armed Forces intervened

Mission	Period
IFOR	1996
KFOR	2000–2017
ISAF	2003–2012
VJTF	2018 / 2022
eFP	2017–2022
EUTM Mali	2019–2023

4. Methodology

The data from Appendix A and Appendix B was analysed via two different methods: graphical analysis and econometric modelling. The author first conducted a graphical investigation of the selected variables and drew assumptions based on historical facts and socio-economic and geopolitical reasoning. This process was important because data does not speak for itself, but must be interpreted within its context (Mukherjee & Wuyts, 2007). Moreover, graphical analysis helped to visually confirm the choice of endogenous and exogenous influence factors.

Second, the author reverted to econometric modelling in order to test the statistical relevance of the selected endogenous and exogenous influence factors for military spending in the case of Luxembourg. However, there is no consensus among researchers as to what constitutes the best technique for analysing military spending. Some researchers such as Solar (2022) and Kollias et al. (2018) refer to quantile regression analysis and contend that classical regression is likely to underestimate or overestimate the association between economic growth and military expenditure. Others, such as Chairil et al. (2013) and Dunne et al. (2005), put faith in the augmented Solow model and argue that it is less flawed than the often-used Feder-Ram model. More still, such as Odehnal et al. (2021) and Nikolaidou (2008), favour autoregressive distributed lag

(ARDL) models, stressing that these models do not omit important structural changes, as is usually the case with cross-sectional studies of large groups of countries. Yet more authors, such as Dizaji and Farzanegan (2021) and Gomez-Trueba et al. (2020), believe in vector autoregression (VAR), claiming that VAR treats all variables as endogenous and is thus better for revealing the dynamic interactions between the variables.

The author, however, sides with Aziz and Asadullah (2016), Esener and Ipek (2015), Fu et al. (2013) and Albalate et al. (2012), who reverted to ordinary least squares (OLS) regression to analyse the determinants of military spending. Since these studies used similar influence factors to those in this study and produced convincing results, the author sees no reason to reject the OLS technique. In an OLS model, a linear relationship is established between a dependent variable (here: defence expenditure as a share of GDP of Luxembourg) and a selection of independent variables (here: the socio-economic and geopolitical variables Appendix A and Appendix B). Importantly, in order for the model to be conclusive, it is necessary that the independent variables have appropriate theoretical explanatory power in relation to the dependent variable (Frost, 2020; Wooldridge, 2019). The literature review and graphical analysis presented at the front of this paper work in that direction.

The OLS model used is written as follows:

$$y_t = \beta_0 + \beta_n x_{tn} + u_t$$

where t is the year, n the number of independent variables, β_0 the constant, y the dependent variable, x the independent variables, β the coefficient of the independent variables, and u the residual.

The author followed an incremental approach similar to the Bayesian inference method for building the model, and added step-by-step influence factors (see Clyde et al., 2021). Starting with modelling a simple relationship between defence expenditure as share of GDP (dependent variable) and GDP per capita and military personnel (independent variables), the author gradually added endogenous and exogenous variables over the process. However, the adding order was important. Since endogenous variables contain basic economic information such as capital and labour (which are arguably prerequisites for military spending), they were added first. Exogenous variables were added only once a model based on endogenous variables had been built. In order to interpret the results in percentages, the author used natural logarithms (the log-log model). All computing operations were conducted with the help of the STATA software.

In the final step, the author applied the model to an updated version of Verlaine's (2022, in press-a, in press-b) small NATO nations in order to test whether the model holds true for other similar smaller NATO member countries. Verlaine's (2022, in press-a, in press-b) differentiation between big, middle and small NATO powers appears particularly pertinent for this study because it defines "similarity" in terms of the size of the military apparatus (based on military personnel), and not in terms of country size (area or population), geographical location or GDP, as most defence studies do (see Solar, 2022; Dunne et al., 2019; Neubauer & Odehnal, 2018; Kollias et al., 2018; Aziz & Asadullah, 2016; Esener & Ipek, 2015, Fu et al., 2013). Indeed, in view of the peculiar socio-economic and geopolitical profile of Luxembourg, conventional definitions may be ill-placed. Hence, the model was tested on the following NATO nations: Latvia, Estonia, Slovenia, Albania, Montenegro and North Macedonia.

Importantly, the period of investigation had to be adapted for the selected nations because

they only joined NATO in the twenty-first century. Furthermore, finding reliable data for their "pre-NATO" period was an issue. Consequently, the period of investigation was adapted as follows: from 2004 to 2022 for Latvia, Estonia and Slovenia; from 2009 to 2022 for Albania; and from 2014 to 2022 for Montenegro and North Macedonia.

5. Analysis

5.1 Graphical Analysis

Figure 3 shows the evolution of Luxembourg's defence expenditure as a share of GDP from 1989 to 2022. The overall trend is of a decreasing nature. However, within the overall trend, the author identifies four sub-trends. The first is from 1989 to 1995 and is decreasing. The second is from 1996 and 2001 and is increasing. The third is from 2002 to 2008 and is decreasing. The fourth is from 2009 to 2022 and is increasing. Importantly, each sub-trend is likely to have a different origin and thus requires a separate explanation.
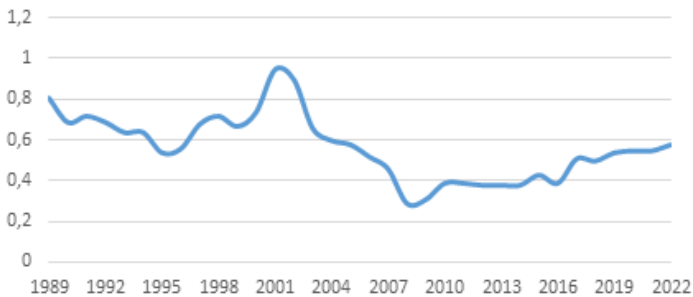
Figure 3: Evolution of the defence expenditure of Luxembourg as a share of GDP (in percentages)

The first sub-trend reflects the effects of both the end of the Cold War and the New Public Management reform in the public sector (see the introduction of this paper). The second sub-trend reflects the rise in violent intrastate conflicts in the 1990s (e.g., Somalia in 1992, Rwanda in 1994, Bosnia in 1995 and Kosovo in 1999) and the subsequent shift in NATO's role towards peace enforcement and peacekeeping missions (Hanlon, 2013). In 1996, Luxembourg contributed to ISAF with a contingent of 22 soldiers, which represented a significant effort for the Luxembourg Armed Forces, especially after prolonged years of austerity (Armée luxembourgeoise, 2022). In fact, ISAF marked a turning point in the strategic orientation of the Luxembourg Armed Forces. As a NATO member, Luxembourg had to contribute its share to NATO's new peace enforcement and peacekeeping role. However, the ISAF experience showed that Luxembourg was ill-prepared to take on such missions and needed to upgrade its military capabilities. This upgrade translated into both a rise in defence expenditure and a rise in military personnel (see Figure 3 and Figure 4). Once the necessary capabilities were built, Luxembourg took on two more NATO peace-

keeping/stabilisation missions: KFOR (2000–2017) and ISAF (2003–2012).
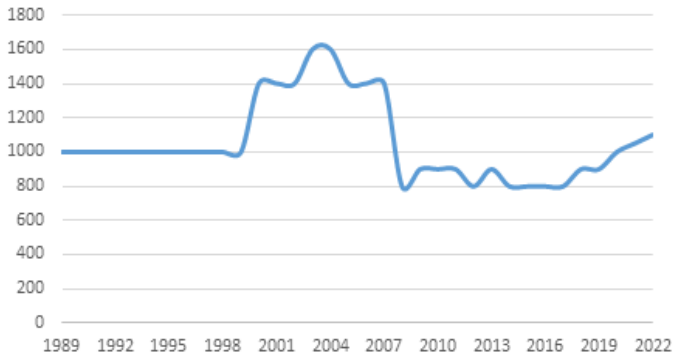
Figure 4: Evolution of the headcount of the Luxembourg military (in real numbers*)*

The third sub-trend is more of a mystery. The author assumes that the stark cut in defence expenditure is linked to an overinvestment in defence expenditure in order to quickly build up the capability for taking on NATO peacekeeping and stabilisation missions. The fact that a substantial share of Luxembourg's KFOR and ISAF contribution was conducted under a decreasing defence budget (viewed as a share of GDP) supports this rationale. However, it must be noted that the defence budget only shrank when viewed as a share of GDP. In real terms, Luxembourg's defence budget actually increased from 1989 to 2022 (see Figure 5). From this perspective, the overinvestment theory changes to a narrative of maintaining newly built capabilities based on a budget of roughly \$200 million during the period from 2002 to 2008.
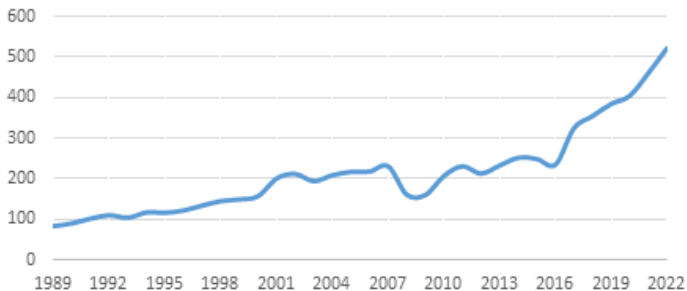
Figure 5: The evolution of Luxembourg's defence expenditure (in million USD)

However, neither the overinvestment theory nor the maintenance narrative can account for the stark drop in military personnel from 2004 to 2008 (see Figure 4). Rather, the opposite. Why were staff that had been recruited in order to take on NATO peacekeeping and stabilisation missions reduced? A more inward perspective is needed to explain the drop in military personnel.

The Luxembourg Armed Forces are composed of professional soldiers (officers and NCOs) and volunteers (privates), with a ratio of roughly one to two-and-a-half (1:2.5). Although conscription was abolished in 1967, for some careers such as the police, the customs or the postal service, a compulsory military service of three years was maintained. This ensured that the Luxembourg Armed Forces recruited enough volunteers (privates) to fulfil their national and international duties. However, political reforms in the late 1990s and early 2000s succinctly abolished compulsory military service for those careers. This decision had an important effect on the personnel strength of the Luxembourg Armed Forces, as recruiting enough volunteers (privates) was no longer guaranteed. Thanks to opening up the volunteer (private) career to EU citizens with their residence in Luxembourg in 2003, it was possible to address a growing sector of the Luxembourg population (young EU citizens) and stabilize military headcount around a baseline of 900 soldiers. More recently, expanding the civilian career within the Luxembourg Armed Forces has allowed the country to break the frontier of 1,100 employees.

Finally, the fourth sub-trend reflects the effects of the illegal annexation of Crimea by the Russian Federation in 2014 and the subsequent reaction by NATO. In contrast to the 2006 appeal to raise defence spending to two percent of GDP, which was paid only little attention by Luxembourg, it appears as if NATO's 2014 appeal had a stronger effect. Luxembourg's military spending almost doubled from 2014 to 2022 (in terms of both real expenditure and as a share of GDP) (see Figure 3 and Figure 5). Moreover, following the latest press brief of the DOD, Luxembourg is planning to reach a one percent GDP baseline by 2028 (DOD, 2022b). Although this is still far away from the two percent GDP baseline requested by NATO, it does confirm a positive sub-trend. In terms of international commitments, Luxembourg has taken on both a NATO commitment (VJTF and eFP) and an EU commitment (EUTM Mali). However, operating on two fronts represents a big effort for the Luxembourg Armed Forces because military headcount has not increased since 2008, as opposed to the military budget, which has more than doubled in the same period (see Figure 4 and Figure 5).

Comparing Luxembourg's defence expenditure with NATO's defence expenditure allows the author's reasoning to be crosschecked. However, since there are important differences between the defence spending of European countries and the US, it is useful to use three variables when investigating NATO's defence expenditure: NATO Europe, NATO Total and the US. Figure 6 shows that NATO Total defence expenditure is embedded between US defence expenditure and NATO Europe defence expenditure. Although all three variables have an overall decreasing trend, there is an important increasing sub-trend in US and NATO Total defence expenditure from 2001 to 2009. This sub-trend can be explained by the 9/11 attacks on the World Trade Centre in 2001 and the subsequent US War on Terror. Crucially, NATO Europe did not follow the increasing sub-trend and continued its decreasing path, dropping below the two percent benchmark from 2005 onwards. The reason that NATO Total defence expenditure followed the US trend is explained by the stark discrepancy between NATO Europe and US military spending.
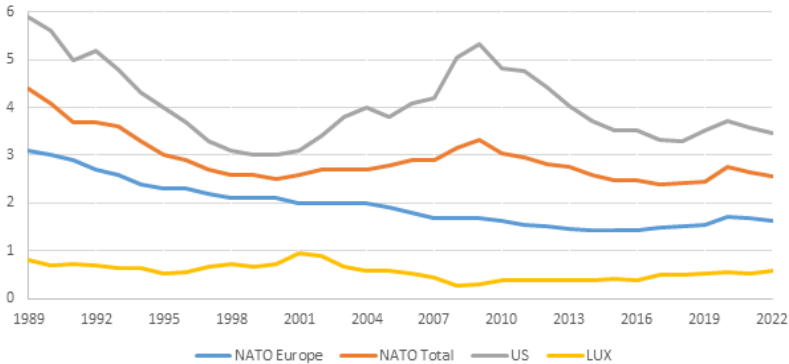
Figure 6: The evolution of defence expenditure as a share of GDP (in percentages)

However, the important question for this study is: Which trend does Luxembourg follow? Based on Figure 6, it appears that Luxembourg neither follows the NATO Europe trend nor the NATO Total and US trend. One possible explanation for this is that Luxembourg has a unique socio-economic and geopolitical profile that significantly differs from the profiles of most NATO nations. Indeed, with a territory of only 2,586 km^2, a population of 645,000, a military apparatus of 1,100 employees (military and civilian) and a GDP of $72,500 million in 2022, Luxembourg is one of the smallest NATO nations (OECD, 2022; STATEC, 2022; Thull, 2022). Moreover, lacking essential defence assets such as combat aircrafts, battleships and tanks, Luxembourg must be considered a no-capability NATO nation (see Verlaine, in press-a, in press-b). The crucial point is that as a no-capability NATO nation, Luxembourg does not have the ability to protect its national territory and relies entirely on the protection of NATO. However, following military theory, the ability to effectively protect national territory is an indispensable prerequisite for the proper functioning of a defence alliance (Odehnal et al., 2021; Wukki & Sandler, 2019). In fact, Luxembourg is a typical NATO free rider – that is, a member nation that underinvests in defence but profits from the collective protection of the Alliance (see George and Sandler, 2022; Jakobsen, 2018).

Finally, the question of why Luxembourg is on the one hand NATO's smallest contributor in terms of defence expenditure as a share of GDP and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure can be explored by breaking down Luxembourg's defence expenditure by category (see Figure 7). Figure 7 shows that expenditure on military personnel in Luxembourg has an overall negative trend, whereas expenditure on military equipment in Luxembourg has an overall positive trend. Moreover, 2008 appears to have been a pivotal year, as expenditure on military personnel significantly dropped while expenditure on military equipment significantly increased. This indicates a strategic shift in Luxembourg's defence orientation towards more capital-intensive and labour-saving military capabilities

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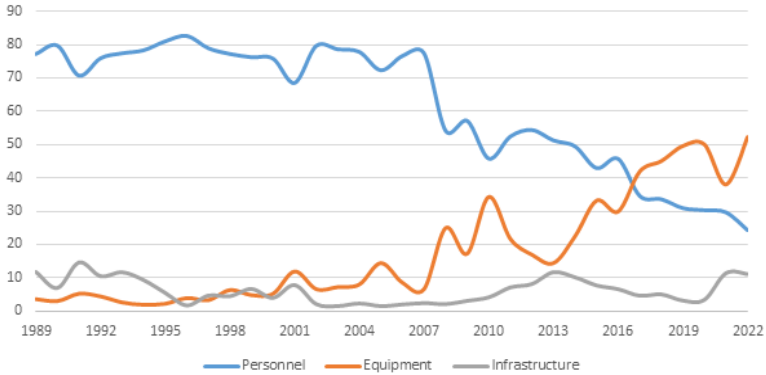
Figure 7: Luxembourg's defence expenditure by category (in percentages)

The fact that expenditure for military personnel has progressively been dropping since 2008 while military headcount has actually stagnated since 2008 can be explained by the stark growth in real terms defence expenditure from 2009 to 2022 (see Figure 5). A rising defence budget and a stagnating military headcount allowed new investments into equipment and infrastructure. Importantly, military headcount from 2008 to 2022 was similar to military headcount from 1989 to 1999 (see Figure 4). However, real terms defence expenditure did not grow as starkly from 1989 to 1999 as it did from 2008 to 2022 (see Figure 5). This explains why Luxembourg dedicated 80% of its defence budget to military personnel in 1989 and only 25% in 2022.

In order for this analysis to be complete, the important growth in real terms of defence expenditure needs to be explained. Comparing real terms defence expenditure with real terms GDP shows that both experienced important growth from 1989 to 2022 (see Figure 5 and Figure 8). A similar picture can be drawn when comparing defence expenditure per capita and GDP per capita from 1989 to 2022 (see Figure 10 and Figure 9). The value of using a per capita indicator (as opposed to a real terms indicator) is that it is able to take into account the variance of the population. From 1989 to 2022, Luxembourg's population almost doubled, growing from 377,000 inhabitants in 1989 to 645,000 inhabitants in 2022. However, over the same period, its GDP multiplied by a factor of seven (rising from $10,392 million in 1989 to $73,000 million in 2022) and its GDP per capita by a factor of four (rising from $27,500 in 1989 to $115,000 in 2022) (see Figure 8 and Figure 9).
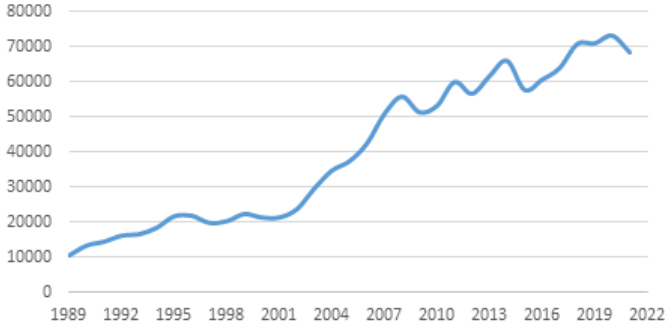
Figure 8: The evolution of Luxembourg's GDP (in million USD)
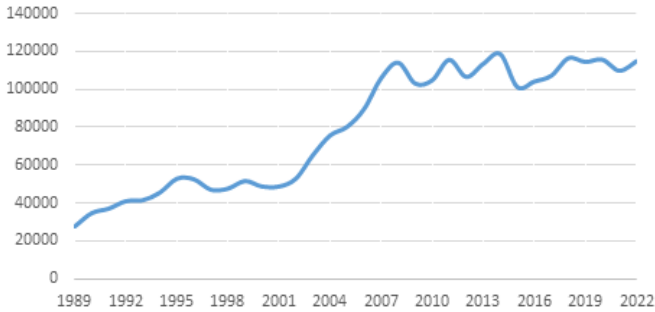
Figure 9: The evolution of Luxembourg's GDP per capita (in USD)

Figure 10: The evolution of Luxembourg's defence expenditure per capita (in USD)

Importantly, when comparing GDP and GDP per capita, a specificity of the Luxembourg economy needs to be taken into account. In Luxembourg, a significant share of employment is occupied by cross-border workers (28% in 1995 and 44% in 2022) (STATEC, 2022). While cross-border workers contribute to Luxembourg's overall wealth (in real terms GDP), they are not accounted for in GDP per capita (as their place of residence is outside of Luxembourg). Thus,

one can make a case for GDP per capita not being the best indicator in the case of Luxembourg.

In conclusion, graphical analysis offers an answer to the question of why Luxembourg is on the one hand NATO's smallest contributor in terms of defence expenditure as a share of GDP and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure. This dichotomy is explained by a strategic (re)orientation towards more capital-intensive and labour-saving military capabilities, induced by recruiting issues. This strategic shift has furthermore been enabled by the stark growth of real terms defence expenditure, which was made possible by a fast-growing economy (in real terms GDP).

5.2 Econometric Modelling

The author started by investigating if the data in Appendix A and Appendix B is stationary or non-stationary. Non-stationary data is a problem for modelling because the estimate of the mean will change through time, which creates biased results (Hamilton, 2020). Based on the graphical analysis, the author suspects that several variables from the dataset are non-stationary and have a unit root trend. Stationarity can be tested against with the Dickey-Fuller test and remedied by using first difference (Hamilton, 2020). The null hypothesis of the Dickey-Fuller test is that there is a trend in the variable. Table 3 shows which variables in the dataset have a unit root problem and thus needed first difference transformation.

In the first step, the author regressed the dependent variable (FD defence expenditure as a share of GDP) on the first set of endogenous variables: GDP per capita and military personnel. GDP per capita was chosen over real terms GDP because it also takes into account the variance of the population. Table 4 shows the key results. *R*-squared is at 51%, which is perfectly acceptable for the model under construction. Furthermore, the *F*-test confirmed that all variables are jointly significant. The null hypothesis of the *F*-test is that at least one of the variables is equal to zero. The null hypothesis must be rejected (*p*-value at 0.0000).

Table 3: Dickey-Fuller test and first difference for variables with a unit root problem

Variable (in ln)	Statistics	p-value
Defence expenditure as a share of GDP	−1.760	0.4003
Defence expenditure in real terms	−0.258	0.9313
Defence expenditure per capita	−1.415	0.5750
GDP per capita	−2.347	0.1574
GDP in real terms	−2.098	0.2453
Military personnel	−1.775	0.3929
Defence expenditure by share of military personnel	0.787	0.9914
Defence expenditure by share of military equipment	−1.023	0.7447
Defence expenditure by share of infrastructure	−2.474	0.1219
US defence expenditure as a share of GDP	−2.112	0.2397
FD* defence expenditure as a share of GDP	−5.094	0.0000
FD defence expenditure in real terms	−5.577	0.0000
FD defence expenditure per capita	−5.649	0.0000

FD GDP per capita	−4.953	0.0000
FD GDP in real terms	−5.005	0.0000
FD military personnel	−6.345	0.0000
FD defence expenditure by share of military personnel	−7.731	0.0000
FD defence expenditure by share of military equipment	−8.123	0.0000
FD defence expenditure by share of infrastructure	−7.069	0.0000
FD US defence expenditure as a share of GDP	−3.415	0.0105

*FD = first difference

Table 4: Test results for the model under construction

FD defence expenditure as a share of GDP (in ln)				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.9350494	0.2127994	−4.39	0.000
FD military personnel	0.9554739	0.3318530	2.88	0.007
_constant	0.0292256	0.0207219	1.41	0.169

R-squared = 0.5034

F-test = 0.0000

Continuing the development of the model, the author added a second set of endogenous variables: defence expenditure by share of military personnel, defence expenditure by share of equipment, and defence expenditure as share of infrastructure. All possible combinations were tested; however, none of the variables worked with the model and added only noise. At this point, it is worth mentioning that defence expenditure per share of military personnel was significant at 10% (*p*-value at 0.084). However, this study adheres strictly to the conventional 5% significance level. As a consequence, the variable of defence expenditure per share of military personnel could not be included into the model.

The author then added the last set of endogenous variables: inflation rates, growth rates, and defence expenditure per capita. Again, all possible combinations were tested. However, as before, none of the variables worked with the model and added only noise.

In a further step, the author added the first set of exogenous variables: NATO Europe defence expenditure as a share of GDP, NATO Total defence expenditure as a share of GDP, and US defence expenditure as a share of GDP. Again, all possible combinations were tested. However, only the variable US defence expenditure as a share of GDP worked with the model (see Table 5). All variables in the model were significant at 5%, and *R*-squared improved to 59%. In addition, the *F*-test confirmed that all variables were jointly relevant (*p*-value at 0.0000).

Finally, the author turned to the last set of exogenous variables, the dummy variables. The dummy variables were organised into three categories – economic crises, military missions and key NATO decisions – and added by category to the model. The economic crises category included the variables subprime mortgage crisis, dotcom bubble and COVID-19 pandemic. The military missions category contained the variables IFOR, KFOR, ISAF, VJTF, eFP and EUTM. The key NATO decisions category included the variables Riga Summit, Wales Summit and Madrid

Summit. For each category, all possible combinations were tested. However, none of the variables worked with the model and added only noise. Consequently, the author stuck with the model as shown in Table 5. This is also the final model.

Table 5: Test results for the final model

FD defence expenditure as a share of GDP (in ln)				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.8152650	0.2024304	−4.03	0.000
FD military personnel	0.7851928	0.3141609	2.50	0.018
FD US def exp as a share of GDP	−0.6196505	0.2498145	−2.48	0.019
_constant	0.0142862	0.0200682	0.71	0.482

R-squared = 0.5904
F-test = 0.0000

The author tested the final model against the following assumptions: autocorrelation, serial correlation, heteroscedasticity and omitted variables. Fist, autocorrelation (or first-order serial correlation) was assessed with the Durbin–Watson test. The result of the Durbin–Watson test was 2.29903, meaning that the variables in the model are negatively autocorrelated. However, since this value is between the acceptable range of 1.5 and 2.5, the autocorrelation is statistically not relevant (SAP, 2016). The alternative Durbin–Watson test confirms the test results of the Durbin–Watson test. The value of chi-squared was 0.716 and the *p*-value for chi-squared was 0.3974. There is thus no reason to reject the null hypothesis (null hypothesis: there is no autocorrelation).

Second, heteroscedasticity was checked with the Breusch–Pagan test. The value of chi-squared was 0.13 and the *p*-value for chi-squared was 0.7175. There is thus no reason to reject the null hypothesis (null hypothesis: there is no heteroscedasticity). Third, higher-order serial correlation was verified with the Breusch–Godfrey test. The author checked for five lags. The choice of five lags is justified on the basis that the government in Luxembourg is elected for five years, and that a policy decision should take (and show) effect within these five years. Table 6 shows the results of the Breusch–Godfrey test. At all five lags, the *p*-value is greater than 0.05. There is thus no reason to reject the null hypothesis (null hypothesis: no serial correlation).

Table 6: Breusch–Godfrey statistics for the final model

Lag	Chi-squared	*p*-value
1	0.823	0.3643
2	5.317	0.0700
3	5.319	0.1499
4	6.034	0.1966
5	6.062	0.3002

Fourth, omitted variables were checked with the Ramsey RESET test and the link-test. In the case of the former, the *p*-value of the *F*-statistics was 0.0689. There is thus no reason to reject

the null hypothesis (null hypothesis: the model has no omitted variables). For the link-test, Table 7 shows the test result. Both hat and hat-squared are statistically significant (*p*-value at 0.000 and 0.044, respectively). Consequently, there is no reason to suspect that the model has omitted variables. Based on the test results, there is no reason to reject the final model.

Table 7: Link-test statistics for the final model

FD defence expenditure as a share of GDP (in ln)				
Variable	Coefficient	Standard deviation	*t* statistics	*p*-value
_hat	0.8498666	0.1589697	5.35	0.000
_hatsq	−1.669718	0.7948175	−2.10	0.044
_constant	0.0191202	0.0182202	1.05	0.302

R-squared = 0.6461

In the last stage, the author applied the final model to an updated version of Verlaine's (2022, in press-a, in press-b) small NATO nations, namely Latvia, Estonia, Slovenia, Albania, Montenegro, and North Macedonia (see Table 8). However, the model did not work with any of the selected countries. Indeed, from the three independent variables (GDP per capita, military personnel and US defence expenditure as a share of GDP), only GDP per capita was significant in the case of Albania (*p*-value at 0.001). As a consequence, the author's final model must be rejected for all small NATO nations except Luxembourg.

Table 8: The final model applied to small NATO nations

LATVIA*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	0.0081402	0.166873	0.49	0.633
FD military personnel	0.3004667	0.5089213	0.59	0.564
FD US def exp as a share of GDP	.1121787	0.488113	0.23	0.822
_constant	0.30339	0.357087	0.85	0.410
ESTONIA*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.0103918	0.0077134	−1.35	0.199
FD military personnel	−0.1031036	0.1272546	−0.81	0.431
FD US def exp as a share of GDP	0.2941843	0.2541789	1.16	0.266
_constant	0.265478	0.195971	1.35	0.197
SLOVENIA*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	0.0052038	0.0105263	0.49	0.629
FD military personnel	0.3651111	0.3449563	1.06	0.308
FD US def exp as a share of GDP	0.959054	0.314861	0.30	0.765

_constant	−0.017361	0.228283	−0.47	0.645

ALBANIA*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.0327055	0.0069455	−4.71	0.001**
FD military personnel	0.2252011	0.1950845	1.15	0.278
FD US def exp as a share of GDP	0.4893332	0.3243806	1.51	0.166
_constant	0.0088981	0.0207482	0.43	0.678

MONTENEGRO*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.0058273	0.0087878	−0.66	0.544
FD military personnel	06863107	0.2617441	2.62	0.059
FD US def exp as a share of GDP	0.4111468	0.674432	0.61	0.575
_constant	0.0260357	0.262624	0.99	0.378

NORTH MACEDONIA*				
Variable (in ln)	Coefficient	Standard deviation	*t* statistics	*p*-value
FD GDP per capita	−0.0208465	0.0140461	−1.48	0.212
FD military personnel	−0.2712295	1.23783	−0.22	0.837
FD US def exp as a share of GDP	1.371667	0.8673085	1.58	0.189
_constant	0.0496502	0.0433769	1.14	0.316

*FD Defence expenditure as a share of GDP (in ln)

**Significant at 1%

6. Discussion

Regression analysis has produced a working model for Luxembourg (see Table 5) which establishes a correlation between defence expenditure as a share of GDP and two endogenous variables, namely GDP per capita and military personnel, and one exogenous variable, namely US defence expenditure as a share of GDP. The results of the model are interpreted below.

First, GDP per capita has a negative effect on defence expenditure as a share of GDP. For any 1% increase in GDP per capita, defence expenditure as a share of GDP is expected to decrease by 0.81% (ceteris paribus). Graphical analysis helps to understand this result. The GDP per capita of Luxembourg has experienced enormous growth over the period from 1989 to 2022, rising from $27,556 in 1989 to $115,000 in 2022 (see Figure 9). In fact, this growth is so important that it "out scales" the growth in real terms defence expenditure (which rose from $84 million in 1989 to $523 million in 2022) when used in a composite index such as defence expenditure as a share of GDP (see Figure 5 and Figure 1). According to the author's model, if the GDP per capita of Luxembourg grows in the future in a way similar to how it did in the past, defence expenditure as a share of GDP will decrease, even if real terms defence expenditure continues to increase.

Second, the number of military personnel has a positive effect on defence expenditure as a share of GDP. For any 1% increase in military personnel, defence expenditure as a share of GDP is

expected to increase by 0.78% (ceteris paribus). In other words, a 100% increase in military personnel (that is, 1,100 employees) is expected to increase defence expenditure as a share of GDP by 78% (that is, from 0.58% to 1.0324%). This information is important, particularly in relation to the latest plan of the DOD to reach a one percent GDP baseline by 2028 (DOD, 2022b). Indeed, following this model, a one percent GDP baseline correlates with recruiting 1,100 new employees (military and civilian) with other factors held constant.

Third, US defence expenditure as a share of GDP has a negative effect on Luxembourg's defence expenditure as a share of GDP. For any 1% increase in US defence expenditure as a share of GDP, Luxembourg's defence expenditure as a share of GDP is expected to decrease by 0.62% (ceteris paribus). At first sight, this appears to be a spurious correlation – that is, a situation in which two variables are correlated but do not have a causal relationship (see Vigen, 2015; Harvard Business Review, 2015). However, there is a logical explanation in this case. The US is a very high capability NATO nation with the biggest defence budget, defence technological and industrial base (DTIB) and military capabilities in the world. By contrast, Luxembourg is a no-capability NATO nation that lacks essential military capabilities such as size, budget, defence industry, etc. (see Hartley and Belin, 2020; Hartley 2020; Verlaine, in press-a, in press-b). In fact, the US and Luxembourg have diametrically opposing defence profiles and military priorities, which is ultimately reflected in their defence expenditure as a share of GDP. On the one hand, the US is the driving force in NATO and stretches its protective umbrella over the other member nations and even beyond; Ukraine and Taiwan being the most recent examples (see Antezza et al., 2022; US Department of State, 2022). On the other hand, Luxembourg is the typical NATO free rider, which does not have the ability to protect its national territory and relies entirely on the protection of the Alliance.

The model is useful in two ways. First, it offers a science-based indication as to how many staff the Luxembourg Armed Forces needs to recruit in the future. This is of particular relevance in the light of the DOD target to reach a one percent GDP baseline by 2028. So far, the Armed Forces have based their estimations on a purely operational needs approach, which is essentially connected to their NATO capability targets. For example, following General Steve Thull (2022), the Luxembourg Armed Forces will need to recruit 100 soldiers in relation to the 2028 Belgian-Luxembourg battalion. Although this method works, it is one-dimensional and cannot account for factors other than overt operational needs. Most importantly, it lacks empirical backing. This study, on the other hand, takes a multidimensional perspective and offers an OLS regression model in which defence expenditure as a share of GDP correlates with GDP per capita, military personnel and US defence expenditure as a share of GDP. Based on this model, a one percent GDP baseline correlates with recruiting 1,100 new employees (military and civilian), with other factors held constant.

Second, this model shows that a composite index such as defence expenditure as a share of GDP is not the best method to evaluate the military effort of a nation. The main reason for this is that it cannot account for the socio-economic and geopolitical peculiarities of a nation. In the case of Luxembourg, the stark growth in GDP per capita combined with an economy that relies heavily on cross border workers to generate its wealth are key influence factors that go unobserved in defence expenditure as a share of GDP. A similar argument has been brought forward by the DOD in order to justify its one percent baseline target (DOD, 2022a). The DOD

argues that Luxembourg's GDP per capita is 2.66 times higher than the EU average, and that this circumstance masks important achievements such as the doubling of its real terms defence expenditure over the past ten years. The DOD further contends that its military investments are high and must be seen in the context of its limited capabilities, highlighting that Luxembourg has only a small air, land and space component and no naval component.

Finally, this model is not useful for other small NATO nations. None of the independent variables (GDP per capita, military personnel and US defence expenditure as a share of GDP) are significant for small NATO nations, except GDP per capita in the case of Albania. This is a strong indication that Luxembourg is an outlier in the small NATO nations group. In fact, Verlaine (in press-a, in press-b) makes a similar argument when investigating the policy and practice of military acquisition within NATO and the EU, holding that Luxembourg is not only a small NATO nation but also a no-capability NATO nation that lacks essential military attributes. The author further claims that Luxembourg faces particular challenges in relation to defence acquisition, which are mainly due to internal factors such as a limited in-house capability, low-volume orders, small budgets, weak review and audit mechanisms, no defence industry and no military school.

7. Conclusion

This paper has proposed a series of endogenous and exogenous influence factors that can potentially explain Luxembourg's defence expenditure in the post-Cold War era (see Appendix A and Appendix B). In the first step, the author investigated the data with the help of graphs and made assumptions based on historical facts and socio-economic and geopolitical reasoning. Importantly, this graphical analysis offered an answer to the question of why Luxembourg is on the one hand NATO's smallest contributor in terms of defence expenditure as a share of GDP and on the other hand NATO's top spender in terms of military equipment by share of defence expenditure. This dichotomy is the result of the strategic reorientation of Luxembourg's defence policy towards more capital-intensive and labour-saving military capabilities, induced by recruiting issues. Furthermore, this policy shift has been enabled by stark growth in real terms defence expenditure, which was made possible by a fast-growing economy (real terms GDP).

In the second step, the author examined the data through regression analysis and developed an OLS model that explains Luxembourg's post-Cold War defence expenditure as a share of GDP in relation to two endogenous factors, namely GDP per capita and military personnel, and one exogenous factor, namely US defence expenditure as a share of GDP. This model has two merits. First, it offers a science-based indication as to how many personnel the Luxembourg Armed Forces need to recruit in the future in view of reaching the set target of a one percent GDP baseline. Second, the model highlights that a composite index such as defence expenditure as a share of GDP is not the best method to evaluate the military effort of a nation. The reason for this is that it cannot account for the socio-economic and geopolitical specificities of a nation.

However, this model also has clear limits: it does not work for other small NATO nations. Even though the model confirms the author's hypothesis that Luxembourg occupies a unique position within NATO as result of its socio-economic and geopolitical profile, further research on small NATO nations is necessary. One potential avenue could be to investigate Verlaine's (2022, in press-a, in press-b) small NATO nations group through a different econometric method such as quantile regression analysis, ARDL or VAR modelling and augmented Solow models. On the

one hand, this would help to confirm the author's research results. On the other hand, and most importantly, it could contribute to generating a better understanding of what influence factors determine the military spending of small NATO nations, and in the process could tackle the lack of consensus among researchers as to what constitutes the best technique to analyse military spending.

Disclaimer

The views represented in the article are those of the author and do not reflect the official position of the Luxembourg Armed Forces.

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APPENDIX A: Endogenous Influence Factors

Year	DE* by share of GDP (%)	DE (million $)	DE per capita ($)	DE by share of personnel (%)	DE by share of equipment (%)	DE by share of infrastructure (%)	Military Personnel	GDP (million $)	GDP per capita ($)	Inflation (%)	Growth (%)
1989	0.81	84	223	77.10	3.80	11.90	1000	10392	27556	3.37	9.8
1990	0.69	91	238	79.60	3.20	7.00	1000	13229	34645	3.25	5.3
1991	0.72	103	266	70.60	5.40	14.80	1000	14322	37007	3.12	8.6
1992	0.69	111	283	75.80	4.60	10.60	1000	16066	40965	3.15	1.8
1993	0.64	105	264	77.30	2.80	11.80	1000	16487	41479	3.59	4.2
1994	0.64	118	293	78.20	2.10	9.40	1000	18326	45481	2.19	3.8
1995	0.54	117	286	80.90	2.40	5.50	1000	21588	52831	1.87	1.4
1996	0.56	123	297	82.50	4.10	1.70	1000	21777	52571	1.18	1.4
1997	0.68	135	322	78.80	3.50	4.70	1000	19732	47042	1.37	5.7
1998	0.72	146	344	77.10	6.50	4.50	1000	20209	47584	0.96	6.0
1999	0.67	150	349	76.10	5.00	6.70	1000	22236	51654	1.03	8.5
2000	0.74	158	362	75.70	5.40	4.00	1400	21264	48735	3.15	8.2
2001	0.95	202	457	68.40	12.10	7.90	1400	21272	48719	2.66	2.5
2002	0.90	213	478	79.50	6.80	2.10	1400	23616	52930	2.07	3.8
2003	0.66	195	432	78.50	7.40	1.50	1600	29557	65455	2.05	1.6
2004	0.60	210	433	77.70	8.20	2.30	1600	34685	75716	2.23	3.6
2005	0.58	218	468	72.20	14.60	1.50	1400	37347	80289	2.49	3.2
2006	0.52	219	462	76.50	8.70	2.00	1400	42414	89739	2.67	5.2
2007	0.46	232	483	77.30	6.80	2.40	1400	50888	106018	2.31	8.4
2008	0.29	162	331	54.00	25.10	2.10	800	55850	114293	3.40	-1.3
2009	0.31	161	323	57.00	17.40	3.10	900	51371	103198	0.37	-4.4
2010	0.39	208	409	45.63	34.45	4.16	900	53212	104965	2.27	4.9
2011	0.39	232	448	52.29	21.86	7.18	900	60005	115761	3.41	2.5
2012	0.38	214	403	54.23	17.11	8.20	800	56678	106749	2.66	-0.4
2013	0.38	234	431	51.10	14.57	11.81	900	61739	113625	1.73	3.7
2014	0.38	253	455	49.31	22.61	10.26	800	66104	118823	0.63	4.3
2015	0.43	250	439	42.77	33.33	7.79	800	57744	101376	0.47	4.3
2016	0.39	236	405	45.56	30.07	6.64	800	60691	104278	0.29	4.6
2017	0.51	326	547	34.40	42.06	4.64	800	64023	107361	1.73	1.8

2018	0.50	356	586	33.42	45.18	5.05	900	70885	116597	1.53	3.1
2019	0.54	386	623	30.76	49.71	3.16	900	71105	114685	1.74	2.3
2020	0.55	406	642	30.13	50.15	3.42	1000**	73264	115873	0.82	-1.3
2021	0.54	403	625	29.48	38.18	11.53	1050**	68500	110000	2.65	6.5
2022	0.58	523	651	24.11	52.37	11.22	1100**	73000	115000	6.60	2.4

*Defence Expenditure
**based on Thull (2022)

(Source: NATO, 1992, 1994, 1996, 2001, 2005, 2011, 2015, 2017, 2022b; World Bank, 2022)

APPENDIX B: Exogenous Influence Factors

Year	DE NATO EU by share of GDP (%)	DE NATO Total by share of GDP (%)	DE US by share of GDP (%)	Sub prime	Dot Com	COVID-19
1989	3.10	4.40	5.90	0	0	0
1990	3.00	4.10	5.60	0	0	0
1991	2.90	3.70	5.00	0	0	0
1992	2.70	3.70	5.20	0	0	0
1993	2.60	3.60	4.80	0	0	0
1994	2.40	3.30	4.30	0	0	0
1995	2.30	3.00	4.00	0	0	0
1996	2.30	2.90	3.70	0	0	0
1997	2.20	2.70	3.30	0	0	0
1998	2.10	2.60	3.10	0	1	0
1999	2.10	2.60	3.00	0	1	0
2000	2.10	2.50	3.00	0	1	0
2001	2.00	2.60	3.10	0	0	0
2002	2.00	2.70	3.40	0	0	0
2003	2.00	2.70	3.80	0	0	0
2004	2.00	2.70	4.00	0	0	0
2005	1.90	2.80	3.80	0	0	0
2006	1.80	2.90	4.10	0	0	0
2007	1.70	2.90	4.20	1	0	0
2008	1.69	3.16	5.04	1	0	0
2009	1.70	3.31	5.32	1	0	0
2010	1.63	3.04	4.81	1	0	0
2011	1.55	2.97	4.77	0	0	0
2012	1.53	2.82	4.42	0	0	0
2013	1.47	2.76	4.03	0	0	0
2014	1.43	2.59	3.73	0	0	0
2015	1.42	2.48	3.52	0	0	0
2016	1.44	2.48	3.52	0	0	0
2017	1.48	2.40	3.31	0	0	0
2018	1.51	2.41	3.29	0	0	0
2019	1.54	2.45	3.52	0	0	0
2020	1.72	2.75	3.72	0	0	1
2021	1.69	2.65	3.57	0	0	1
2022	1.64	2.57	3.47	0	0	1

*Defence Expenditure

(Source: NATO, 1992, 1994, 1996, 2001, 2005, 2011, 2015, 2017, 2022b)

IFOR	KFOR	ISAF	VJTF	eFP	EUTM	Riga06	Wales14	Madrid22
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	1	0	0	0	1	0	0
0	1	0	0	0	0	1	0	0
0	1	0	0	0	0	1	1	0
0	1	0	0	0	0	1	1	0
0	1	0	0	0	0	1	1	0
0	1	0	0	1	0	1	1	0
0	0	0	1	1	0	1	1	0
0	0	0	0	1	1	1	1	0
0	0	0	0	1	1	1	1	0
0	0	0	0	1	1	1	1	0
0	0	0	1	1	1	1	1	1