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Impact of firms' size, leverage, and net profit margin on firms' profitability in the manufacturing sector of Bangladesh: An empirical analysis using GMM estimation

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ABSTRACT

The study investigated the factors that influence the return on assets (ROA) of manufacturing firms in Bangladesh. The study relied on secondary data sourced from the audited annual reports of 15 leading manufacturing firms in Bangladesh, covering a period of ten years from 2013 to 2022. The sample firms were selected based on their listing on the Dhaka Stock Exchange (DSE)-30 and Chittagong Stock Exchange (CSE)-30 indices and their status as leading firms in the manufacturing sector using the purposeful sampling method. The study employed the one-step generalized method of moments (GMM) estimator to analyze the data, addressing the presence of endogeneity and heteroskedasticity. The results of the study indicated that the natural logarithms of net profit margin (NPM) and total sales (TS) have a significant positive relationship with ROA, while the natural logarithm of total assets (TA) has a significant negative relationship with ROA. However, the study did not find any significant relationship between the leverage ratio (D RATIO) and ROA. The lagged value of the dependent variable (L) was also found to be insignificant. The study's findings suggest that firms can enhance their ROA by improving their profitability and increasing their sales while avoiding excessive growth in their asset base. Additionally, larger firms may face diseconomies of scale that reduce their profitability. However, the lack of a significant relationship between leverage and ROA is somewhat surprising, and further research is needed to better understand the relationship between leverage and ROA in different contexts. Overall, the study utilized a rigorous data collection approach to ensure the reliability and validity of the data used for analysis, providing accurate results that can be relied upon for making informed decisions.

I. Introduction

A firm is an entity that refers to a business or organization that has attained stability, financial security, and a strong foothold in the market. The term "manufacturing firm" is used to denote an enterprise that transforms raw materials, components, and parts into finished goods that are suitable for consumer use. The primary objective of a firm is to maximize profits, and the remaining amount after deducting all relevant expenses from earnings constitutes the profit. A firm's viability and longevity hinge on its ability to generate a substantial amount of profit. According to Hakim et al. (2023), profitability is a crucial indicator of managerial success, shareholder satisfaction, investor attraction, and business sustainability. There is a positive relationship between profitability and firm performance, as noted by Olugbode et al. (2008). The profitability of a firm is influenced by several factors, including firm size and leverage. Evaluating firm size is primarily based on total assets, number of employees, and sales. Abeyrathna & Priyadarshana (2019) have measured firm size using both total assets and sales. Total assets include cash and cash equivalents, receivables, inventory, property, plant, and equipment, as well as intangible assets, while sales represent a company's total revenue from goods and services sold. A larger total asset and sales indicate a larger firm. In contrast, the firm's leverage is the ratio of its total debt to total assets, which measures the company's financial risk and its ability to meet its obligations with its own capital. Companies with high leverage ratios tend to have high debt levels in their capital structure. This high level of debt can prevent a company from distributing dividends to shareholders because it must use its profits to pay off its debt. Therefore, companies must balance taking on and paying off debt.

Previous research has examined how firm size and leverage affect firm profitability, with varying results depending on the country and industry. For instance, Babalola (2013) and Ozcan et al. (2017) found that firm size, measured in terms of total sales or total assets, has a positive impact on profitability. Similarly, Rahman et al. (2020) and Afolabi et al. (2019) found that leverage influences profitability.

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However, Abeyrathna & Priyadarshana (2019) found that firm size has no significant impact on profitability. Bangladesh is an emerging economy in South Asia with a GDP of $460.8 billion and is ranked as the 35th largest economy in the world (Bintara, 2020). As a developing country, it is attracting local and foreign investors, with increasing foreign direct investment flows. Bangladesh has diverse industries that contribute to its economic development and play a vital role in achieving sustainable development goals (SDGs). The manufacturing industry is one of the industries that is playing a vital role in growing the economy. Manufacturing firms in Bangladesh have been essential to the country's economic growth and development over the last two decades. Bangladesh has a highly diversified manufacturing sector, producing a wide range of products. The sector has grown significantly, driven by increased demand for locally produced goods, a growing population, and improvements in infrastructure. The sector currently accounts for just under a quarter of the country's GDP and employs millions of people. The industry is dominated by small and medium-sized firms, with the majority of the workforce employed in the informal sector. In recent years, the industry has seen increasing investment from both local and foreign companies, creating new opportunities for growth and job creation. As Bangladesh continues to modernize and develop, the manufacturing sector is expected to remain a key contributor to economic growth. Researchers have made several attempts to examine the impact of leverage and firm size on firm profitability. However, the results of the previous examination differed across nations and industries. The study of the impact of leverage and firm size (TA and TS) on profitability (ROA and NIM) in emerging countries, including Bangladesh, is limited. Therefore, we address the research gap by investigating an empirical study of the impact in the context of manufacturing industries in Bangladesh.

The objective of this research paper is to investigate the relationship between the size and leverage of firms and their profitability. More specifically, we aim to analyze the impact of four key variables, namely net profit margin (NPM), leverage (measured by the debt ratio), total assets (TA), and total sales (TS), on return on assets (ROA), a significant performance indicator for firms. Our study seeks to provide a more in-depth understanding of how these variables relate to firms' profitability and to explore the potential differences in their effects across different industries and countries. The findings of this research will help managers and investors make more informed decisions regarding firm performance and financial stability.

The study is divided into several sections. The literature review and the formulation of hypotheses are presented in the next section. Section 3 covers the variable selection and conceptual framework. Section 4 covers the data and methodology used in the study. Section 5 provides the results of the analysis (descriptive and correlational, endogeneity and heteroscedasticity), the Generalized Method of Moments (GMM) estimator, as well as a summary of the hypothesis testing. In Section 6, the findings are discussed. The conclusions are presented in Section 7. Finally, Section 8 covers the policy implications.

2. Literature Review

The manufacturing sector plays a crucial role in the economic growth and development of countries worldwide, including Bangladesh. Studies have shown that the return on assets (ROA) of manufacturing firms is a key indicator of their financial performance and overall success. Several factors have been identified in the literature as determinants of ROA, including profitability, sales, leverage, and asset efficiency (Ullah et al., 2019). Net profit margin (NPM) has been identified as a key determinant of ROA, as it reflects a firm's ability to generate profits from its sales. Total sales (TS) have also been found to have a significant positive relationship with ROA, indicating that firms with higher sales tend to generate higher returns. On the other hand, the total assets (TA) of a firm may have a negative impact on its ROA, as larger firms may face diseconomies of scale that reduce their profitability. However, leverage, as measured by the debt ratio (D ratio), has been found to have mixed results in the literature, with some studies showing a negative relationship with ROA and others finding no significant relationship (Ullah et al., 2019). Overall, the literature suggests that ROA is influenced by several factors in the manufacturing sector of Bangladesh, including profitability, sales, leverage, and asset efficiency. However, there is still a need for further research to better understand the determinants of ROA in this context, particularly in light of the unique challenges faced by firms operating in the Bangladesh manufacturing sector. Several research studies have been carried out to investigate the causal relationships between economic growth, financial development, international trade, and expenditure. Notable among these studies are the works of Işık, et al. (2017), which explored these relationships and the study by Işık (2011) on the competitive advantage of investing in information technology for modern economies. Furthermore, Işık, et al. (2019) conducted research on the effectiveness of the economic policy uncertainty index and its potential impact on the performance of the tourism industry and the overall economy of a country. In the following sections, we present our arguments regarding the association between firms' size, net profit margin, leverage, and return on assets.

2.1. Net Profit Margin and Return on Assets

Net profit margin (NPM) and return on assets (ROA) are two widely used financial metrics for evaluating a company's financial performance. NPM measures the profitability of a company by calculating the percentage of profit earned on each dollar of revenue, while ROA measures how efficiently a company uses its assets to generate profit. The literature on NPM and ROA is extensive, with numerous studies focusing on the relationship between these metrics and a company's financial performance. Putry (2013) conducted an investigation into the impact of three variables—current ratio (CR), total assets turnover (TATO), and net profit margin (NPM)—on return on assets (ROA) for companies listed on the Indonesia Stock Exchange (IDX) from 2009 to 2011. The study revealed that net profit margin (NPM) had a significant effect on return on assets (ROA). Similarly, Pranata (2014) conducted research into the relationship between total asset turnover, non-performing loans, net profit margin, and return on assets, either simultaneously or partially, and found that the variable of net profit margin had an effect on return on assets, whether analyzed simultaneously or partially.

H1: There is a significant positive association between net profit margin (NPM) and return on assets (ROA).

2.2.Leverage and Return on Assets

Leverage and return on assets (ROA) are two important financial metrics that are commonly used to evaluate a company's financial performance. Leverage, measured by the debt-to-assets ratio (D Ratio), reflects the amount of debt a company uses to finance its operations, while ROA measures how efficiently a company uses its assets to generate profit. The literature on leverage and ROA is extensive, with numerous

studies examining the relationship between these metrics and a company's financial performance. AlGhusin (2015) conducted a study to examine the relationship between financial leverage, Company's Growth, noncurrent/total assets ratio, firm's Size as independent variables and profitability in Proxy of Return on Assets ratio (ROA) as the dependent variable. The study found a significant positive effect of leverage on profitability. Nugraha et al. (2020) also investigated the effect of leverage and liquidity on the financial performance of companies in the property and real estate subsector in Indonesia and found that leverage, specifically the debt-to-assets ratio, had a partially influential effect on company financial performance, i.e., return on assets and liquidity financial performance. Kartikasari & Merianti (2016) focused on investigating the impact of leverage and firm size on the profitability of public manufacturing companies in Indonesia and found that the debt ratio had a significant positive effect on profitability, i.e., return on assets. Furthermore, Ullah (2019) examined the impact of financial leverage on the profitability of fertilizer companies in Pakistan and found that financial leverage had a significant negative impact on the profitability of fertilizer companies in Pakistan.

H2: There is a significant positive association between leverage (D ratio) and return on assets (ROA).

2.3. Total Assets and Return on Assets

Total assets (TA) is an important financial metric that measures the total value of a company's assets, while return on assets (ROA) measures how efficiently a company utilizes its assets to generate profits. The relationship between the logarithm of total assets (LnTA) and ROA has been extensively researched in the financial literature. In a study conducted by Irman & Purwati (2020), the impact of the current ratio, debt-to-equity ratio, and total asset turnover on return on assets was examined for automotive and component companies listed on the Indonesia Stock Exchange for the period 2011–2017. The study found that total assets had a significant positive effect on return on assets. Diaz & Pandey, (2019), investigated the factors affecting the return on assets of US technology and financial corporations and reported that total assets had a positive relationship with return on assets. Kartikasari & Merianti (2016) also explored the effect of leverage and firm size on the profitability of public manufacturing companies in Indonesia and found that total assets had a significant negative impact. Additionally, Babalola (2013) conducted a study on the effect of firm size on firm's profitability in Nigeria and found that firm size, in terms of total sales, had a positive impact on the profitability in terms of return on assets of manufacturing companies in Nigeria.

H3: There is a significant positive association between the log of total assets (TA) and return on assets (ROA).

2.4.Total Sales and Return on Assets

Total sales (TS) is an important financial metric that measures the total revenue generated by a company, while return on assets (ROA) measures how efficiently a company utilizes its assets to generate profits. The relationship between the logarithm of total sales (LnTS) and ROA has been examined in the financial literature. Babalola (2013) conducted a study on the impact of firm size on the profitability of manufacturing companies in Nigeria and concluded that firm size, measured in terms of total sales, has a positive effect on profitability, as measured by return on assets. Similarly, Ozcan et al. (2017) investigated the relationship between firm size and profitability and found that total sales had a positive impact on firm profitability. In another study, Sritharan (2015) examined the relationship between firm size and profitability in Sri Lankan hotel and travel sector firms listed on the stock exchange and reported a positive association between firm size and profitability, as measured by return on assets.

H4: There is a significant positive association between the log of total sales (TS) and return on assets (ROA).

3. Variable Selection and Conceptual Framework

3.1.Dependent Variable

3.1.1.Return on Assets

Return on assets (ROA) is a financial ratio that measures a company's profitability by calculating the amount of profit generated per dollar of assets. It is calculated by dividing net income by total assets (Helfert, 2001). ROA is a commonly used measure of a company's financial performance, as it reflects the efficiency with which a company is utilizing its assets to generate profits (Hill & Jones, 2014). Several studies have used ROA as a dependent variable to examine the impact of various independent variables on a firm's profitability. For instance, Rahman et al. (2020) investigated the relationship between leverage and ROA at Bangladeshi manufacturing firms. They found that leverage has a significant negative impact on ROA. Similarly, Niresh & Thirunavukkarasu (2014) examined the impact of firm size and leverage on the financial performance of Sri Lankan manufacturing firms, using ROA as the dependent variable. They found that firm size has a positive impact on ROA, while leverage has a negative impact. Therefore, in this research paper, ROA is selected as the dependent variable to examine the impact of independent variables, such as net profit margin (NPM), leverage (D Ratio), total assets (TA), and total sales (TS), on a firm's profitability. The selection of ROA as a dependent variable is based on its importance in measuring a company's financial performance and its previous use in similar research studies.

3.2. Independent Variables

3.2.1.Net Profit Margin, Leverage, Total Assets, Total Sales

Net profit margin (NPM) is the ratio of net profit to total revenue and measures a company's profitability on a per-dollar-of-revenue basis (Petty et al., 2015). Leverage (D Ratio) measures the extent to which a company's operations are financed by debt and is calculated as the ratio of total debt to total assets. Total assets (TA) are the sum of a company's current and non-current assets, representing the total value of assets owned by a company. Total sales (TS) represent the total revenue generated by a company from its business operations. These independent variables are commonly used in research studies to analyze their impact on a firm's financial performance. For instance, Nguyen & Nguyen (2020) examined the impact of NPM, D Ratio, TA, and TS on the financial performance of Vietnamese listed firms. They found that NPM, TA, and

TS have a positive impact on a firm's financial performance, while D Ratio has a negative impact. Similarly, Ongore & Kusa (2013) analyzed the impact of NPM, D Ratio, and TA on the financial performance of Kenyan commercial banks. They found that NPM and TA have a positive impact, while D Ratio has a negative impact.

Therefore, in this research paper, NPM, D Ratio, TA, and TS are selected as the independent variables to examine their impact on a firm's profitability, as they are commonly used in similar research studies and have been found to have a significant impact on financial performance in previous studies.

3.3. Conceptual Framework

The development of a conceptual framework is based on a thorough review of the existing literature, and the hypotheses formulated in the literature review section are deemed to be consistent with the underlying principles of the conceptual framework.

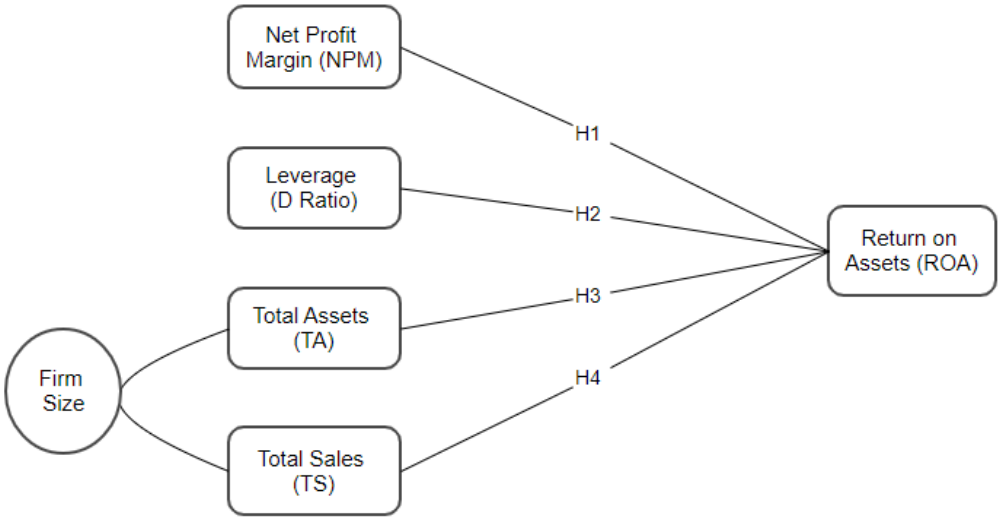

Figure 1: Conceptual Framework

4. Methodology

4.1 .Data

For this study, we relied on secondary data sourced from the audited annual reports of 15 manufacturing firms operating in Bangladesh. These firms were selected based on their listing on the Dhaka Stock Exchange (DSE)-30 and Chittagong Stock Exchange (CSE)-30 indices and their status as leading firms in the manufacturing sector. The selection of these companies was carried out using a purposive sampling method to ensure representativeness and avoid selection bias. The firms were chosen due to their prominence in the manufacturing sector and the availability of reliable data on their financial performance.

The data were collected for a period of ten years, covering the years from 2013 to 2022. The long-term data collection period allowed for the identification of patterns and trends in the financial performance of the sample firms over time. To ensure the accuracy and completeness of the data, we relied on audited financial reports as the primary source of data. This helped to minimize errors and discrepancies in the data and ensure that the data was of high quality. Overall, the study utilized a rigorous data collection approach to ensure the reliability and validity of the data used for analysis. This helped to ensure that the results obtained from the analysis were accurate and could be relied upon for making informed decisions.

To achieve the objective of the study, we aim to examine the effects of key financial performance indicators, specifically net profit margin, leverage, total assets, and total sales, on return on assets. Furthermore, this study seeks to determine the extent to which firm size and leverage impact profitability in the context of the manufacturing industry in Bangladesh. By analyzing the relationship between these variables, we aim to provide insight into the factors that contribute to firm profitability in this industry. Ultimately, the findings of this study will help inform managers, investors, and policymakers in the manufacturing industry in Bangladesh about the key drivers of firm profitability, which can inform strategic decision-making and promote the sustainable growth of businesses in the country.

4.2. Model Specification

The presence of endogeneity and heteroskedasticity in the data requires the use of an appropriate statistical model for analysis. In this study, we employed the Generalized Method of Moments (GMM) estimator to address these issues. Specifically, we utilized the one-step GMM estimator due to its computational efficiency and robustness to misspecification of the moment conditions (Arellano & Bover, 1995; Roodman, 2009). The model specification for our analysis is as follows:

$$ROA_{it} = \beta_0 + \beta_1 \ln NPM_{it} + \beta_2 \ln TS_{it} + \beta_3 \ln TA_{it} + \beta_4 D_{it} + \varepsilon_{it}$$

Where:

- ROA_{it} represents the return on assets for firm i at time t.

- $lnNPM_{it}$ represents the natural logarithm of the net profit margin for firm i at time t.
- $lnTS_{it}$ represents the natural logarithm of the total sales for firm i at time t.
- $lnTA_{it}$ represents the natural logarithm of the total assets for firm i at time t.
- D_{it} represents the leverage ratio (debt to total assets) for firm i at time t.
- $\beta_0, \beta_1, \beta_2, \beta_3$, and β_4 are the regression coefficients to be estimated.
- ε_{it} is the error term for firm i at time t.

5. Analysis and Findings

5.1.Descriptive and Correlation Analysis

Table 1: Descriptive and Correlation Analysis

	Mean	Std. Deviation	ROA	NPM	Log of TA	Log of TS
ROA	.0785	.0829	1			
NPM	.1258	.1202	.359**			
D RATIO	.5266	.3540	.104	-.460**		
Log of TA	10.6519	2.6195	.044	0.135	-.256**	
Log of TS	10.0604	2.6659	.221**	.035	-.133	.930

**Correlation is significant at the 0.01 level (2-tailed). (ROA = Return on Assets; NPM = Net Profit Margin; D RATIO = Debt Ratio/ Leverage; Log of TA = Logarithm of Total Assets; Log of TS = Logarithm of Total Sales)

The above Table 1 presents the descriptive statistics and correlation coefficients for the variables ROA, NPM, D RATIO, Log of TA, and Log of TS. ROA refers to Return on Assets, which has a mean of 0.0785 and a standard deviation of 0.0829. NPM represents net profit margin, with a mean of 0.1258 and a standard deviation of 0.1202. D RATIO indicates the debt ratio, with a mean of 0.5266 and a standard deviation of 0.3540. The log of TA denotes the logarithm of total assets, with a mean of 10.6519 and a standard deviation of 2.6195. Finally, the log of TS represents the logarithm of total sales, with a mean of 10.0604 and a standard deviation of 2.6659. The correlation coefficients suggest that there are significant relationships between the variables. There is a positive and significant correlation between ROA and the log of TA (r = 0.044, p 0.01) and between the log of TS and ROA (r = 0.221, p 0.01). On the other hand, there is a negative and significant correlation between D RATIO and NPM (r = -0.460, p 0.01) and between Log of TA and NPM (r = -0.256, p 0.01). These findings suggest that firms with higher total assets tend to have a higher return on assets, and those with higher total sales tend to have a higher return on assets as well. In contrast, firms with a higher debt ratio tend to have a lower net profit margin, and those with higher total assets tend to have a lower net profit margin. These results may provide insights for investors and managers in making decisions related to financial performance and risk management.

5.2. Endogeneity

5.2.1.Tests of endogeneity

Ho: variables are exogenous
Durbin (score) chi2 (1) = 56.9082 (p = 0.0000)
Wu-Hausman F(1,145) = 88.6402 (p = 0.0000)

The results suggest that the exogeneity assumption of the variables in the panel data may not hold, as indicated by the statistically significant Durbin (score) chi2 (1) test (56.9082, p = 0.0000) and Wu-Hausman F (1,145) test (88.6402, p = 0.0000). The Durbin (score) test, also known as the Lagrange multiplier test, is a test for serial correlation in panel data models. The null hypothesis of the test is that there is no serial correlation, which implies that the variables are exogenous. However, a significant result indicates the presence of serial correlation and suggests that the variables may be endogenous. The Wu-Hausman test is another commonly used test for endogeneity in panel data models. The test compares the estimates of a regression model using two different methods: ordinary least squares (OLS) and instrumental variable (IV) estimation. The null hypothesis of the test is that the variables are exogenous, which implies that the OLS estimates are consistent and efficient. However, a significant result indicates that the OLS estimates are inconsistent and suggests that the variables may be endogenous. These results are consistent with prior research on endogeneity in panel data models. For example, Bai & Ng (2002) note that endogeneity is a common problem in panel data analysis and suggest using various tests, including the Durbin (score) and Wu-Hausman tests, to diagnose endogeneity. Similarly, Wooldridge (2010) notes that the Durbin (score) and Wu-Hausman tests are among the most commonly used tests for endogeneity in panel data models. In conclusion, the results of the Durbin (score) and Wu-Hausman tests suggest that the exogeneity assumption of the variables in the panel data may not hold and that the variables may be endogenous. This finding has important implications for the interpretation and estimation of the panel data model and suggests the need for further analysis using appropriate methods to address endogeneity.

5.3.Heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of ROA
chi2(1) = 5.69
Prob > chi2 = 0.0170

The result of the Breusch-Pagan/Cook-Weisberg test indicates that the variance of the errors in the model is not constant (heteroskedasticity), as the p-value of the test is 0.0170, which is statistically significant at conventional levels.

When heteroskedasticity is present, the Ordinary Least Squares (OLS) estimator is still unbiased but inefficient, which means that the standard errors of the estimates are biased and the estimates may not be as precise as they could be. To address this issue, several methods can be used, such as robust standard errors, weighted least squares (WLS), or the generalized method of moments (GMM). In this case, since the Breusch-Pagan/Cook-Weisberg test indicates the presence of heteroskedasticity and the OLS estimator is inefficient, using a GMM model would be more appropriate to estimate the coefficients of the model. GMM is a flexible estimation method that can handle various types of data and is robust to heteroskedasticity, autocorrelation, and other types of misspecification. This finding is consistent with prior research on heteroskedasticity and GMM estimation. For instance, Arellano & Bover (1995) highlight the advantages of GMM estimation in panel data models, where heteroskedasticity and other forms of misspecification are common. Similarly, Hansen (1982) shows that GMM is a powerful method for estimating models with heteroskedasticity, especially when the heteroskedasticity is not easily correctable. In conclusion, since the Breusch-Pagan/Cook-Weisberg test indicates the presence of heteroskedasticity, using a GMM model would be more appropriate to estimate the coefficients of the model.

5.4. One-Step Generalized Method of Moments Regression results

Table 2: Regression Analysis

lnROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
L	-.02	.014	-1.41	.159	-.048	.008	
lnNPM	1.074	.047	22.61	0	.981	1.167	***
lnDRATIO	.078	.061	1.27	.204	-.042	.198	
lnLogofTA	-10.102	.529	-19.08	0	-11.14	-9.065	***
lnLogofTS	9.762	.455	21.45	0	8.87	10.654	***
Constant	.97	.415	2.34	.019	.157	1.783	**

Mean dependent var	-2.843	SD dependent var	1.104
Number of obs	128	Chi-square	881.095

*** p<.01, ** p<.05, * p<.1;* (ROA= Return on Assets, NPM represents Net Profit Margin, D RATIO = Debt Ratio/ Leverage, Log of TA= Logarithm of Total Assets, Log of TS = Logarithm of Total Sales)

The one-step generalized method of moments (GMM) regression analysis (Table 2) was conducted to examine the factors that influence return on assets (ROA) in firms. The results of the study indicate that the natural logarithms of net profit margin (NPM) and total sales (TS) have a significant positive relationship with ROA, while the natural logarithm of total assets (TA) has a significant negative relationship with ROA. However, the study did not find any significant relationship between the leverage ratio (D RATIO) and ROA. The lagged value of the dependent variable (L) was also found to be insignificant.

These findings are consistent with previous research (Isik et al., 2017), which found that profitability and sales growth are important drivers of ROA. Additionally, the negative relationship between TA and ROA is consistent with the notion that larger firms may face diseconomies of scale that reduce their profitability (Chen et al., 2017). Overall, the results suggest that firms can enhance their ROA by improving their profitability and increasing their sales while avoiding excessive growth in their asset base.

However, the lack of a significant relationship between D RATIO and ROA is somewhat surprising, as prior studies have suggested that leverage can have both positive and negative effects on firm performance (Bradley et al., 1984; Kalantonis et al., 2021). One possible explanation for this discrepancy is that the sample used in this study consisted of firms from a specific industry or geographic region, which may have different financial characteristics than those examined in previous research. Further research is needed to better understand the relationship between leverage and ROA in different contexts.

5.5.Test of Hypothesis

Table 3: Hypothesis Testing

Hypothesis	Coefficient	P value	Remarks
H1: There is a significant positive association between Net profit margin (NPM) and return on assets (ROA)	1.074	0	Supported
H2: There is a significant positive association between Leverage (D Ratio) and return on assets (ROA)	.078	.204	Not Supported
H3: There is a significant positive association between Log of Total Assets (TA) and return on assets (ROA)	-10.102	0	Not Supported
H4: There is a significant positive association between Log of Total Sales (TS) and return on assets (ROA)	9.762	0	Supported

Table 3 shows the results of the hypothesis tests conducted on the coefficients of the GMM model you presented earlier. The table presents the null hypothesis, the estimated coefficient, the p-value, and the remarks on whether the null hypothesis is supported or not.

6. Discussion

The present study aimed to investigate the factors that influence the return on assets (ROA) of manufacturing firms in Bangladesh. The results of the study indicate that there is a significant positive relationship between net profit margin (NPM) and ROA, as well as a significant positive relationship between total sales (TS) and ROA. These findings are consistent with prior research (Işık et al., 2017), which has found that profitability and sales growth are important drivers of ROA.

The negative relationship between the log of total assets (TA) and ROA is also noteworthy. This finding is consistent with the notion that larger firms may face diseconomies of scale that reduce their profitability (Chen et al., 2017). The lack of a significant relationship between leverage (D ratio) and ROA is somewhat surprising, as prior studies have suggested that leverage can have both positive and negative effects on firm performance (Bradley et al., 1984; Kalantonis et al., 2021). One possible explanation for this discrepancy is that the sample used in this study consisted of firms from a specific industry or geographic region, which may have different financial characteristics than those examined in previous research.

The finding that the log of total sales (TS) has a significant positive relationship with ROA suggests that firms can enhance their performance by increasing their sales. This finding is consistent with prior research that has found that sales growth is an important driver of firm performance (Işık et al., 2017).

The present study contributes to the literature by providing insights into the financial performance of manufacturing firms in Bangladesh. However, the study is not without limitations. One limitation of the study is that the sample size is relatively small, consisting of only 15 firms. Future research could expand the sample size and include firms from other industries and regions to provide a more comprehensive understanding of the factors that influence firm performance in Bangladesh. In conclusion, the present study provides evidence that the net profit margin (NPM) and total sales (TS) have a significant positive relationship with the return on assets (ROA) in manufacturing firms in Bangladesh. The study also found that larger firms may face diseconomies of scale that reduce their profitability. However, the lack of a significant relationship between leverage and ROA requires further investigation. The findings of this study provide insights into the financial performance of manufacturing firms in Bangladesh and can be used to inform decision-making in this sector.

7. Policy Implication

The findings of this study have several policy implications for firms, investors, and policymakers. Firstly, firms can use the results of this study to identify key determinants of ROA and take steps to improve their financial performance. Specifically, they can focus on improving their net profit margin, increasing their total sales, and managing their leverage ratio effectively. Firms can also use these findings to benchmark their financial performance against their competitors in the manufacturing sector in Bangladesh. By identifying areas for improvement, firms can enhance their competitiveness and profitability. Secondly, investors can use the results of this study to make informed investment decisions in the manufacturing sector in Bangladesh. They can identify firms with a high ROA that are likely to provide higher returns on investment. They can also use these findings to evaluate the financial health of firms in the sector and assess their long-term sustainability. Thirdly, policymakers can use the results of this study to develop policies that support the growth and development of the manufacturing sector in Bangladesh. For example, policies that encourage firms to improve their net profit margin and increase their total sales can help to enhance their financial performance and competitiveness. Similarly, policies that promote responsible borrowing and effective debt management can help reduce the risks associated with leverage. Overall, the findings of this study provide insights into the factors that influence the financial performance of firms in the manufacturing sector in Bangladesh. These findings have important implications for firms, investors, and policymakers and can be used to support the growth and development of the manufacturing sector in Bangladesh.

8. Conclusion

In conclusion, this study aimed to identify the determinants of return on assets (ROA) in the manufacturing firms of Bangladesh. The study utilized secondary data sourced from the audited annual reports of 15 prominent manufacturing firms operating in Bangladesh. The data were collected for a period of ten years, covering the years from 2013 to 2022. The study employed the one-step generalized method of moments (GMM) estimator to address the presence of endogeneity and heteroskedasticity in the data. The results indicate that the natural logarithm of net profit margin (NPM) and the natural logarithm of total sales (TS) have significant positive relationships with ROA. Conversely, the natural logarithm of total assets (TA) has a significant negative relationship with ROA. There is no significant relationship between the leverage ratio (D ratio) and ROA.

The findings of this study provide valuable insights for managers and investors interested in improving firm performance and profitability. Specifically, the results suggest that firms can improve their ROA by focusing on increasing their NPM and TS while reducing their TA. And there is no increase or decrease by the change of leverage or D ratio. The study's findings are consistent with previous research that has reported significant relationships between NPM, leverage, and firm size with ROA. However, some studies have reported inconsistent results regarding the relationship between firm size and ROA. This study's findings contribute to the existing literature on the determinants of firm performance and provide further evidence on the importance of NPM, D RATIO, TA, and TS in influencing ROA.

It is important to note that this study has some limitations. First, the study only considered 15 manufacturing firms, which may limit the generalizability of the results. Future studies can expand the sample size to increase the study's external validity. Second, the study focused on ROA as the dependent variable and did not consider other performance measures such as return on equity (ROE) and earnings per share (EPS). Future studies can examine other performance measures to provide a more comprehensive understanding of firm performance. Finally, this study utilized secondary data, which may be subject to measurement errors and other limitations.

In summary, this study provides valuable insights into the determinants of ROA in manufacturing firms in Bangladesh. The results indicate that NPM, TA, and TS are important factors that influence ROA. The study's findings can inform managers and investors' decisions about improving firm performance and profitability. Further research can build on this study's findings to provide a more comprehensive understanding of firm performance in Bangladesh and other emerging economies.

Data availability: The datasets generated and analyzed during the current study are available in the World Bank Indicator, Materialflows.net, World Intellectual Property Organization repository.
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An assessment on rational expectations and perception engineering in the cyber-capitalist age

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ABSTRACT

In recent years, studies in economics have revealed that analyses in psychology, sociology, religion, and ethics have begun to describe trends in the markets, household preferences, entrepreneurships, and investor decisions. These studies are referred to be results of the critical dynamics put forward by the "Rational Expectations Theory." Although conditional rationality is widely assumed in economic analysis, the assumptions of rational expectations as a unique approach allow for new perspectives of bias on the perception engineering which is being realised through social media for both political or economic operations. Percepion engineering has become easy and widespread in this new age of cyber-capitalism in which artificilal intelligence (AI) based Management Information Systems (MIS) and IoT tend to dominate pervasively for economic, political or religious reasons. This study asserts that investment decisions, political tendencies and economic preferences may not be rational due to exposure to perception engineering through innovative technology of algorithms and social media. Therefore, in today's cyber-capitalist ecosystems, the generation of manipulated social consent has been incredibly enhanced by hacking, collecting, accumulating, changing, controlling, and disseminating information for propaganda and marketing purposes over social media. In this multidiscipinary study, perception engineering that has become a part of artificial intelligence-assisted social engineering processes, is concluded to be the key spoiler of rational expectations of economic agents. In this context, possible measures are developed and suggested.

1. Introduction

Neoliberal policies have brought the flexible labor market approach to cost reduction through wage reductions and depleting of real wages. Low wages of Syrian refugees in Türkiye since 2011 allows the goods and services to be produced relatively cheaply. The decrease in incomes of the producers' goods that will be imported at a lower cost by restricting their production has been a fundamental reason for the disintegration of the developing countries like Türkiye, especially in the agricultural field. However, it is a problem for developing countries to meet the foreign exchange requirement needed for the goods to be imported cheaply. The current foreign account deficit problem is also an indicator of the difficulty in financing imports and is an essential item in terms of short-term capital financing. The high-interest rates used to attract short-term capital, and the foreign currency needed to import the exported goods in this way is costly for the country's economy (Işık, 2013).

The concepts and models studied in behavioral economics have many reflections and echoes in daily life. The causes and consequences of irrational behavior can become much more understandable when examined by including sociological, ethical and psychological factors in the framework. Therefore, making an investment decision solely based on the information herein may not produce results in line with expectations.

It is assumed that social media is effective in perception engineering of masses. We have asserted the existence of a close relationship between rational theory and behavioral economics in setting a framework for policymakers' and entrepreneurs' financial and economic decisions (Künü & Duran, 2021; Serttaş et al., 2022). We try to answer the following questions:

- Is there a relationship between rational expectation theory and perception engineering methodologies?
- If perceptions of both producers and consumers can be shaped and redirected towards less-profitable or less-functional areas or products, can we claim that there is no rational expectations anymore in this cyber-capitalist era?

This study aims to assess the validity of rational expectations with perception engineering in the cyber-capitalist age. To achieve this goal, the study uses literature survey, conceptual and theoretical reasoning methodologies alongside content analysis of sectoral reports. The study is divided into six sections that examine various aspects of the relationship between rational expectations and perception engineering in the cyber-capitalist age.

The first section sets the research problem and establishes the importance of understanding the relationship between rational expectations

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and perception engineering. The second section explores the economic and psychological perspectives of entrepreneurship and how they relate to rational expectations and perception engineering. The third section examines the confusion surrounding rational expectations in the cyber-capitalist age. The fourth section explores the new illusion of cyber capitalism, which is perception engineering of masses. This section looks at how businesses are using perception engineering to shape the way people perceive their products and services. The fifth section examines social capture as a new way of communication, which is being used to shape perceptions in the cyber-capitalist age. The sixth section discusses social media as a new way of perception engineering, which is becoming increasingly more important in the cyber-capitalist age. This section explores the various techniques used by businesses to shape perceptions through social media and the implications of these techniques for rational expectations.

The study concludes by summarizing the key findings and suggesting applicable recommendations to the Turkish government. The study recommends that the Turkish government take prudent measures to promote transparency and accountability in the use of perception engineering techniques by businesses to protect consumers' interests. The study also suggests that policymakers need to stay informed and up-to-date on the latest developments in this area to effectively regulate the market.

2. Research problem setting: validity of rational expectation with perception engineering

Perception engineering activities refer to deliberate efforts by various actors, such as governments, businesses, or media, to shape people's perceptions about economic events, policies, or trends. These efforts can have negative effects on the rational expectations of economic actors, which can in turn have adverse consequences for the economy as a whole. Some of the negative effects of perception engineering activities on the rational expectations of economic actors are:

- Misinformation: Perception engineering activities often involve the dissemination of false or misleading information about economic events or policies. This can lead economic actors to form inaccurate beliefs about the state of the economy, which can in turn lead to suboptimal decisions about investments, consumption, and other economic activities.
- Biases: Perception engineering activities can also be used to exploit cognitive biases and heuristics that are inherent in human decision-making. For example, fear-mongering about economic risks can trigger an emotional response that leads people to make irrational decisions based on short-term considerations rather than long-term benefits.
- Distortion of market signals: Perception engineering activities can also distort market signals by creating artificial demand or supply for particular goods or services. For example, advertising campaigns that promote a particular product can create a perception of scarcity and increase demand beyond what is actually warranted by market conditions. This can lead to price increases and market inefficiencies.
- Undermining confidence: Perception engineering activities can also erode the confidence of economic actors in the transparency and integrity of the economic system. This can lead to reduced trust in financial institutions, regulatory bodies, and other economic actors, which can ultimately undermine the functioning of the economy.
- Inconsistent policies: Perception engineering activities can also be used to justify inconsistent policies, such as changes in economic policies that are not based on sound economic principles. This can lead to confusion and uncertainty among economic actors, who may have difficulty predicting the future course of the economy and making informed decisions.

Therefore, this study is based on the argument that the perception engineering activities can have negative effects on the rational expectations of economic actors breaking of the balance of rational expectation of haoseholds and econmic agents. These negative effects can range from misinformation and cognitive biases to distortions of market signals and reduced confidence in the economic system. To mitigate these negative effects, it is important for economic actors to stay informed and critically evaluate the information they receive from various sources. It is also important for governments, businesses, and media to be transparent and honest in their communication about economic events, policies, and trends.

In line with the problem setting and the research questions the following assumptions are considered as valid:

- Rational expectation theory assumes that individuals make economic decisions based on rational information and that these decisions are consistent with their personal goals. However, with the rise of perception engineering, it is possible that individuals' decisions are influenced by factors that do not align with their rational goals.
- Perception engineering is a relatively new phenomenon that is heavily reliant on technology and social media platforms. As such, it is likely that the effects of perception engineering on rational expectations may not have been fully explored in the literature.
- The use of social media as a tool for perception engineering may have significant implications for the economy, as consumers may be influenced to purchase products or invest in areas that are not necessarily profitable or functional.
- There may be a need for greater regulation of social media platforms to prevent the spread of false information and biases, which could lead to a distorted perception of reality.
- The study assumes that the government and appositon parties have a significant role to play in managing perceptions, as they have access to resources and tools that can be used to shape the narratives. However, the study also acknowledges that civil society organizations, international NGOs, tycoons and bigwig individuals can also play a role in shaping perceptions.
- The study assumes that Turkey is facing challenges with perception engineering and biased rational expectations, and that these challenges may be more acute in the context of the cyber-capitalist age.

3. Economic and Psychological Perspectives of Entrepreneurships

Why are some entrepreneurs like Elon Musk, Jack Ma or Selcuk Bayraktar are so successful than others in starting new bussiness? Growing evidence suggests that the answer involves cognitive, political and social factors. Is there perception engieneering by political or governmental sponsorhip behind these kind of iconic figures? Similarly, successful entrepreneurs appear to be more socially competent and they are interacting effectively with others, and so, they are better at social perception and adapting to new social situations. These results suggest that the principles and assumptions of psychology can be invaluable to researchers in entrepreneurship, providing essential insights into the factors that influence entrepreneurs' success (Baron, 2000). Since the concept of entrepreneurship is a process of creating economic activity it has been

been considered necessary by all countries in recent years that entrepreneurship occurs in a new or existing business by combining risk-taking, creativity, and innovation processes significantly affecting countries' economic and social welfare (Işık et al., 2016, 2019a-b).

Personality characteristics such as the need for success, risk-taking, high control ability, innovativeness, vision, devotion, commitment, flexible behavior, and motivation for new achievements are determined regarding the entrepreneurial characters. Social status, political support, reputation, esteem, honor and also well designed promotion campaigns of mass perception can also influence entrepreneurship.

4. Confusing Rational Expectations

Rational expectations theory is an economic theory that won the Nobel Prize in Economics for two economists who developed this theory (Taylor, 1981) based on the hypothesis of rationality in expectations and the openness of markets hypothesis (Karaçor, 2014). According to the theory, since all data are open, decision-makers in the market areas are informed about events and developments. In this case, the market decision-makers anticipate the effects of the measures taken by the government and act accordingly or take an advantage of insider trading. The Rational Expectations Theory argues that individuals will have "*rational*" expectations and immediately take an active stance against economic policies and try to change the expected results of these policies. Individuals who have these characteristics and information will predict the effects of policy measures and will be able to shape their behavior accordingly, thereby nullifying policy implementations (Cukierman et al., 2020).

Therefore, while the Rational Expectations Theory claims that monetary policy will only affect the general level of prices in the economy in the short and long run, it argues that fiscal policy will have adverse effects on employment and production in the long run (Masca, 2007:52). It is stated that the markets are cleared in the incomplete information model, but the short- and long-term aggregate supply curves may differ due to misperceptions about prices. The Lucas model has three assumptions (Bull & Frydman, 1983):

- Markets are clearing.
- Expectations are rational, and
- Economic agents' knowledge of the economy is incomplete.

Figure 1. Critical attributes of Rational Expectation Theory

Robert Lucas revealed the assumption that "*structural parameters do not change according to the policy applied*" in the macro-econometric models used to make policy evaluations is invalid. These models accept that individuals form their expectations under adaptive expectations. However, the rational behavior of rational individuals in the face of policy changes can eliminate the effectiveness of policies (Yıldırım & Karaman, 2001). Decisions that determine many macroeconomic variables, especially consumption and investment, are vitally dependent on expectations about the future state of the economy. Lucas has argued that an essential aspect of most policy interventions is to change the way individuals form their expectations about the future (Ökte, 2001). Therefore, if the policy changes, internal expectations will also change, which will affect savings, investment, supply, and demand for labor and goods. These decisions will also change the structural parameters that reflect the relationship between the variables. As a result of the criticisms against active economic policies, it was agreed that monetary policy should be followed according to a previous rule. Discussions about the procedures to be implemented have emerged from the framework of adjustable policies and focused on the types of regulations (Muslümov, Hasanov, & Özyıldırım, 2002:5).

The word “rational” means mind-based, measured, reasonable and affordable. The term “irrational” is opposed to be not based on a reason and unmeasured. Here are the questions that stir our minds from a spiritual or moral context (Yıldırım, 2001):

- If the goods, money, fame, and career are all temporary and will undoubtedly leave us in a day, why are we not rational and searching for eternal goods and long-lasting life alongside with the worldly?
- If we have rational behavior, do not we have to spend one hour of life in the most important capital of our lives at least once a day for the Hereafter?

The theory does not seek explanations that envision beyond mortality to answer such quintessential questions, but rather until the end of worldly life. The rational expectations theory is solely considered economical, because all the data are explained. Market decision-makers are informed about events and developments as much as those who manage the economy. In this case, market decision-makers anticipate and act according to the effects of measures taken by the economic actors. Suppose the government has decided increasing consumption to stir economic development. In line with this decision, the central bank has increased the money supply more than the economic growth rate. Market decision-makers then expect that this approach will create inflation and increase the sales prices of their products. The Central Bank began to use the monetary policy instruments to reach the inflation target. Those who can decide on investment, production, entrepreneurships, purchases, wage bargains, or pricing in the economy will act according to the expectation that inflation will fall. These behaviors will lead to a fall in inflation. One day an increase in risks starts due to various reasons and the effect of the reflection on the exchange rate, the inflation will be rising again. At the same time, this situation continues while the political power, despite the legal regulations brought by the Central Bank, reduces the interest rate by half. Markets consider this demand to be irrational, as in the current situation of the monetary government. If the Central Bank reduces the interest rate by subduing political pressure, the market perceives irrational behavior will replace rational behavior. In this case, the expectation of hiking inflation will increase, and if the decisions taken by the decision-makers change in this direction, the inflation will also increase. However, as the central government considers high interest rates as immoral or against religious obligations, the decisions taken are considered very rational in terms of their assumptions. They ususlly argue that there is a perception engineering over economic expectations, so it is legitimate to gauge some settings of policies and practices with close oversight in line with moral and religious context.

While the supporters of the opposition constantly and systematically believed that a large reserve of 128 billion US dollars was stolen by the government via irrational monetary decisions, the government bodies and the supporters of the government have always argued that there is no question of a lost reserve money and irrationality. At this point, there is no doubt that there is information pollution as a result of multilateral and comprehensive perception engineering and the negative impact of rational expectations. In this case, rational expectations are being replaced by unjustified expectations that increase investment risks in all real sectors. In other words, really or artificialy irrational approaches are becoming so widespread that markets can predict that the decision coming from political power is foolish. In this case, the opposite can be realized in the direction of the decision. For example, even if the Central Bank lowered the interest rate, banks do not lower their interest rates because they predicted that this decision would increase the credit and real interest risks and hence inflation. Under normal circumstances, such an approach creates a shock effect and market distortions. However, this approach has become a routine in many areas, not only in this area, so the shock effect is not too significant if the irrational methods are to be expected. Although there is a market fluctuation, this effect does not last long. In a sense, people and markets are rationalizing irrationalism because they expect that there will always be irrational approaches. This can be called the theory of unreasonable expectations.

5. The New Illusion in Cyber Capitalism: Perception Engineering of Masses

Expectations are mainly driven by perceptions of economic actors on the policy development, systematic flactuations and possible behaivors within the free markets. Getting a better understanding of the current globalization system requires a new conceptual framework that captures different formations of globalization, ranging from the embodied to the disembodied. The multiple disjunctive relationships that have developed among and within these formations shape the morphology of the current globalization system and cast a long shadow on its future dynamics (Steger & James, 2020).

Every day new concepts and inventions are beginning to enter our lives. One of these is social engineering to change perceptions. Although it is not a new concept, its awareness has increased recently. Social engineering is a concept in the field of study and research of sociology, anthropology, political philosophy, and also economics (due to its relationship with shaping economic decisions). Social or community engineering takes its roots from the theory of hegemony that requires convincing people to take them under submission without brute force. Thus, since they do not consent to hegemony and take the front, the dynamism and variability of hegemony cannot reveal "*hegemony*." As a result of their ideological struggles, they can demonstrate the new hegemony they are in and believe that they have their wishes or result from "*misleading consciousness*." They are connected to the newly formed hegemony with more enthusiastic consent and become their defenders by acquiring habits. This result emerges, which can be called a hegemonic environment. This madness, which has "*fuel power*" in its tank, is perhaps an indispensable phenomenon caused by power for humanity (Wheatley et al., 2012).

Even bubbles, in many markets, are consistent with rationality, that phenomena such as runaway asset prices and market crashes are consistent with rational bubbles (Blanchard & Watson, 1982). Perception management in markets combines facts, projection, deception, and psychological operations to some extent supporting financial bubbles. According to this definition, the attitudes, behaviors, logic, and emotions of groups are affected and shaped by perception management done by powerful rulers and capitalists. In other words, perception management includes all the activities carried out to influence the target audience's views. Therefore, the Machiavellian approach is valid in perception management and similar concepts that the philosophy of "*everything is permissible on the way to the goal*" is based.

Successful perception management practices consist of essential elements such as reflecting the facts using various methods, providing operational security, concealing and distorting the truth, and managing psychological operations. In this context, perception management strategies have an important role in manipulating information for specific interests and directing the target audience. When considered in this context, states, capitalist cartels or groups that can control the flow of information in their favor or the political parties they are affiliated also hold the economical, political, psychological and social advantage. In this respect, the perception management process stands before us as a power struggle over manipulation or fabrication of data, information and knowledge. The "*number of weapons and soldier,*" which was a tool of

of intimidation in the pre-modern era and accepted as a strategic power in challenging the world, is considered insufficient for states to form a public opinion in their favor today. If we accept that there is a successful perception management available in the markets and societies via troll accounts and artificial intelligence bots, then the question that "*is it possible so talk about rationality and rational expectations*" remains unanswered.

Since the classical methods are also worn out in the new period, hegemonical or monolitic structure of economic or political power centers take refuge in several mechanisms for perception management:

- Trolls from professional groups and bots with legitimacy and prestige are used both in the new media and in the mainstream media, disinformation is made through these trolls, the production of consent or rebellion is triggered by shaping the perceptions of the masses.
- As is practiced in Russia, blogs or some social media influencers are bought and controlled,
- Censorship and legal prosecution,
- Penal and monetary sanctions or blackmailing and intimidations when they come to the power,
- Bureaucratic sanctions are frequently preferred,
- Media organizations and artificially intelligent bots are purchased or sponsorship is provided for certain referrals,
- Education curricula, scientific publications and reputable persons or institutions can be used as tools.

Perception engineering, global powers, governmentality, opposition, hegemony and propaganda are intertwined concepts where one cannot exist without the other. Although these relations have been used extensively throughout the ages, their usage varies from age to age. However, perception management plays a central role in seizing power or producing the policies desired by the interests. In order to seize the power, to demolish or capture the power, to establish hegemony, creating perception on the masses and the management of the created perception appear as reality (Bayrakcı, 2021).

Community or mass engineering is a concept in political science for the efforts of state power or private groups to directly or indirectly affect the attitudes and social behaviors of a large part of society. Here are the questions that stir our minds:

- Can social engineering successfully format and change human behavior for economic and political purposes?
- What kind of social engineering is done on advertisements and media to keep people in the pursuit of temporary pleasures by giving their requirements for the comfort of their worldly life?
- How should we protect ourselves from the drawbacks of social engineering and perception alteration?

Economic and political relations, which became increasingly dirty, have begun to look for new ways to increase their impact on society. Community engineering is a term used in political science for studies that affect the cultural and social habits of a large part of society by governments or particular communities. This concept is confused with the concepts of brainwashing, misinformation, disinformation and indoctrination. Humans use behavioral synchrony to promote neural synchrony and, thus, social bonding. This reverse-engineering of social connection is an important innovation likely underlying this distinctively human capacity to create large-scale social coordination and cohesion (Wheatly et al., 2012).

Social engineering may work to a certain degree on perception management without living examples that guide people to the truth and realities. Suppose people do not believe that their rulers and government officers act with justice and devotion, in that case, their perception are corrupted or self-interest seekers, then that becomes impossible to guide them to the right path. In addition, global tools such as social media, simultaneous news broadcasts around the world, internet and ease of news preparation. In terms of business, it is possible to manage or direct the societies or target audiences covering the field of businesses with tools that can help perception management such as communication, feedback and motivation (Bakan & Kefe, 2012). It would not be wrong to say that "information" and "knowledge" are used or abused wisely for politial or economic gains. Although it is important to analyze the issue of who is doing it and for what purpose, it is a very complex and difficult task. In this context, it is a good approach to focus especially on the public relations policies of international companies and political parties. When these structures are examined, it is seen that while they think globally in their perception management studies, they have different views locally. It is seen that religious and ethnic communities have very impressive and attractive emphasis on their cultures. Perception management with words like; "Think globally, act locally", "End the one-man regime", "Those who keep silent against injustice are the dumb devil", "Those who do not drive out the thief are criminals", "One must fight fascism" and "palace gangs" are very effective. However, it is clearly seen how important a function of moral values, common sense and prudence are (Erbay & Arslan, 2019). Because the essence of perception management is "*persuasion activities*." global powers of cyber capitalism try to ensure the legitimacy of their power and policies to increase their reputation and maximize their benefits. Institutions and individuals sought ways and methods to persuade their target audiences and enable them to see the world from their own eyes, and developed various strategies in this regard. Still, in recent years, these concepts sound better with the thought that these concepts have negative connotations in public, such as public diplomacy, soft power, reputation management, image management, public relations. In other words, information wars based on manipulation between actors have started to be constructed over the digital world. Generally accepted that these practices' general purpose is to voluntarily persuade a particular audience and create a perception in the desired direction. In this respect, perception management is defined as a communication discipline to deceive the target audiences in line with their interests and turn them into elements that they will use in line with their own goals (Wheatley *et al.*, 2012).

Although perception management is used in daily life, even at more limited points, from the advertising sector to the health sector, its use in shaping social events and political preferences inevitably necessitates it to be considered within the scope of psychological operations in perception management. All societies witness the practices that can be considered as a part of social engineering that will make this issue of secondary importance. This supports Industry 4.0 and Society 5.0 perception engineering requirements. Psychological warfare is the use of information in order to change the feelings, thoughts and behaviors of the masses in both war and peace environments. Among the goals of psychological warfare are;

- to weaken the enemy's combat power and resiliency,
- to break the will of the defeated enemy to fight,
- to create a sense of obedience/disobedience,
- to mislead the public,
- to discredid key figures,

- to open the gap between the administration and the people, and
- to provide cultural change.

Today, although normal wars have become very common as low-intensity conflicts, psychological warfare has become a constant practice as one of the most transformative aspects of societies today. The following psychological techiques are being used for perception engineering (Gürsoy, 2020):

- Gaslighting Manipulation: It is a method of ignoring reality with sentences such as “this has never happened”, “you are dreaming of it” in order not to make you feel the reality and to confuse it.
- Projection Technique: Mental depression is a method of convincing the desired community by reflecting the bad features in perception and creating the impression that it is a real part of them.
- Purposeless Monologues: It is the creation of monologues that do not provide any benefit in order to destroy the perception and tire the mind, especially to facilitate the manipulation phase. The audience listens to monologues under dictation.
- Generalized Disqualifications: It is a method in which intellectual appearance and uncertainty are preserved and the target message is generalized by using general and ambiguous expressions. Examples of sentences using this method are “everything bothers you”, “you always want to be right”.
- Deep Insult Shallow Compliment: It is a method in which real hatred and sarcasm are cast into shadow by creating the impression that they are complimenting the target individual or audience. To give an example, in this perception that the target audience is told "You are more virtuous than what we know so far", the mental breakdown will be perceived positively and favorably by the person or persons to whom it is intended. In reality, however, the target audience was either “you weren't brave before” or “I didn't think you were brave before.” contains the message.
- Manipulation of Facts: It is a method of replacing facts with needed facts in order to turn the truth in its favor and push the target audience to question.
- Alleged Insufficient Dialogue: It is a method of creating a syndrome on the target audience by saying that it is impossible to speak to the target audience and that it is not spoken effectively and correctly. Thus, the syndrome is created and the target audience is prevented from talking about the problem.
- Intellectual Harassment: It is the technique of non-stop argument generation by making distorted reasoning through different information and facts in order to emotionally exhaust the target audience or accelerate the mental breakdown in perception.
- Use of Irony and Bad Humor: It is a method of making ironic analogies and bad humor in order to belittle the target audience, to make them accept psychological superiority and to disperse the subject in addition to psychological pressure.
- Mask of Not Being Understood: This method, which is widely used regardless of the type of discussion, is also used when it is desired to create a mental breakdown in perception. It is claimed that the expressions and perceptions of the target audience cannot be understood in order to devalue and make meaningless the expressions and perceptions of the target audience.
- Hiding the Purpose: The strategy of hiding the purpose is to hide the perception in mental depression. In other words, it is aimed to change the current perception by producing false purpose. They usually hide misinformation or falsification in a pile of fact-based information. While the purpose is hidden, it is aimed to make the newly changed truths accepted at the organizational stage of the mental collapse in perception and to take action in the direction of these truths.

6. Social Capture as A New Way of Communication

The 21st century is almost at the peak of innovative digital technology. Although we currently use the technology as consumers, we can probably use it for different purposes in the future, such as human hacking. Society engineering aims to take some actions and instill baised information to people. Community engineers have succeeded in changing/altering society's perception, or the individual's perception, with various advertisements, techniques, directions, and repetitions using social media and artificial intelligence (AI). AI algorithms can be used to process vast amounts of data and identify patterns that are not immediately apparent to humans. This ability can help economic agents to make better decisions based on accurate and timely information. For example, AI-powered financial analytics tools can provide investors with real-time insights into market trends and help them identify potential opportunities for investment (Gencoglu & Hancer, 2020).

AI can also be used for perception engineering, which refers to the deliberate manipulation of people's perceptions through the use of various techniques, including social media. Social media platforms are often used to influence public opinion and shape perceptions of products, services, and political ideologies. AI-powered social media analytics tools can analyze vast amounts of user-generated data to identify patterns in public opinion and sentiment, allowing marketers and political campaigns to create targeted messaging and campaigns (Gao et al., 2021).

The impact of AI on perception management is significant. The use of AI in perception management can help organizations to better understand their audiences and tailor their messaging accordingly. However, it also raises concerns about the ethics of using AI to manipulate public opinion. The use of AI-powered deepfakes, for example, can create realistic but entirely fabricated video and audio content that can be used to manipulate public opinion (Wang et al., 2021). The authorities and giant companies have been hacking societies for a long time and now in a different dimension. Hackers are more intelligent than they are in the past with the application of AI tools and techniques. They no longer write a lot of code or malware instead of using available ones directly through outomated tools and techniques. The living information (social DNAs) of a social system, which we call culture, is recorded in the human brain and the relations of production (historically formed) between the people who source them. Thus, the change of connections between the elements of society and the elements of the system is related to the realization of new relations of production in that society based on new knowledge and technology, which is a task that no social engineer can accomplish with a voluntary effort from top to bottom. In the information age we live in, the power of mass media and especially social media is unquestionably accepted. Thanks to technological developments, the masses are faced with an intense information bombardment, and often they cannot distinguish what is real and what is fiction. This tremendous speed allows for the dissemination of a large amount of information that cannot be verified and creates information pollution. What we will watch on which radio and television channel, what we will read in which

newspaper or magazine, are determined within today's capitalist relations and our perceptions can be shaped (Utma, 2018).

The more one uses social media, and the more one thinks they are an excellent way to connect with others (perceived intimacy). The more one is likely to be happy, the more feels associated with others (Pittman, 2018). Social anxiety and happiness vary significantly by social media addiction. (Baltaci, 2019). New power structures are being reproduced within the new communication practices on these networks. The processes and experiences of commodification on networks have led to understanding the capitalist economy since the 90s. Here are the questions that stir our minds:

- Do social media make people alienated and asocials?
- Is social media addiction a prominent feature of cyber capitalism?
- Why do people hesitate to communicate directly with each other, even though there are excessive communication possibilities?
- What are the relations of production on which social media platforms are based?

Communication, however, has to be perceived as more than interpersonal communication, even more than a capitalist economy. Communication networks carry the information of the collapse of capitalism and the knowledge of the development of the capitalist economy. Communication networks that expand the capitalist economy and produce new power structures carry the information they need in the processes of understanding and making sense of the world, which establish the social relations of production or, in other words, live within the given social links. User satisfaction or social media communication mainly emphasizes the subjectivity and psychological well-being of the users, privacy and resolution of the private sphere, and social media. However, social media platforms are a part of the market and are commercial structures. Priority of their missions are capital accumulation, which requires us to remember that they are a commercial company, analyze them as a technology, and see social relations as activators. Such a view establishes the media as a dynamic area of struggle between the audience (labor) and the media owners (capital). It emphasizes that it has become a process of surplus value through the media in its free time.

More time in the day can be spent on Facebook by communicating and socializing. Self-surveillance technologies, such as Foursquare or Facebook Locations, keep users close to friends by expanding the duration of their active presence in the social network. Furthermore, the information gathered about the viewer is much more precise and distinct. For this reason, social media users have the unique ability to run in the process of capital accumulation to be based on information production through communication and sociality. This explanation of the social relations of the Internet and social networks is striking. It critiques all approaches that address social media only as part of participation, freedom of expression, and democratization. Because, within the social relations of production, it requires re-thinking labor and enables us to understand the Internet and social media as the basis for developing the cyber-capitalist economy and the platforms containing the knowledge of capitalism's destruction.

Social media with innovative tools, inputs, and outputs has become an intersection of social culture, psychology, pedagogical education, criminal law, religion, and behavioral economics. It can be virtual or online, but if it contains immoral elements that disrupt public order or deliberately upset their work/social friends, they can sometimes turn into heavy baggage that is very difficult to carry spiritually. What is missed for young people now and for future generations is that all searches in social media channels should be based on seeking the best morality and living humanly. On the other hand, social media, which represents the pinnacle of innovative technology, can suddenly become the center of cruelty and insobriety while being aware of and persecuting (i.e., a moral stance). Just like a scalpel that saves lives in the surgeon's hands or is a murder tool in the hands of the killer.

7. A Discussion on Social Media as A New Way of Perception Engineering

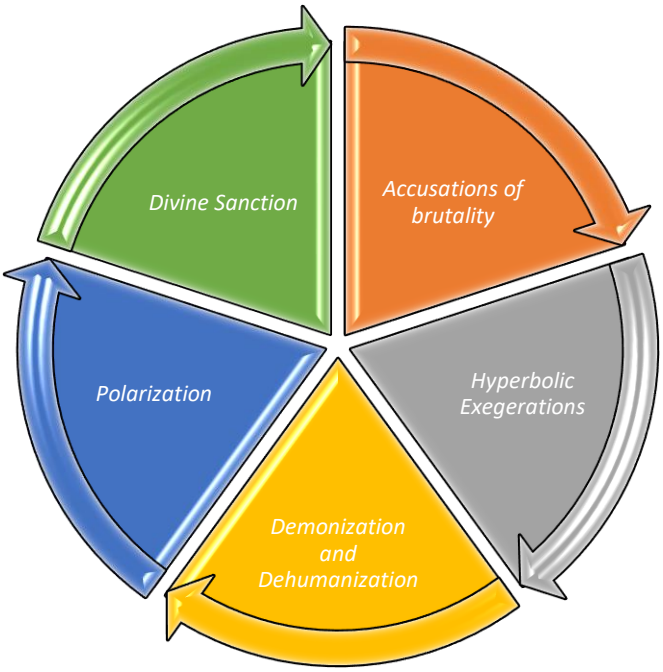
Perception carries the meaning of being aware, understanding and recognizing. Perception begins with the sensing process. At the same time, the data perceived through the senses are shaped according to the experiences and knowledge of the person. In this sense, the perception process may show individual differences. Perceptions of people are tried to be directed through the perception formation process. Today, new communication technologies are frequently used for perception creation and perception management. In this way, it is possible to reach large masses in a short time. Thanks to new communication technologies, access to the masses has become easier and certain strategies have been developed to direct the target audiences (Saydam, 2005). Regardless of the name of the effort to direct the kits in the historical process, there has always been and will always be an effort to direct the masses towards predetermined targets by manipulating the information applied to the target audience. In this way, the masses left under the influence of information will begin to change their attitudes and behaviors as desired (Arğın, 2021).

Thanks to the current advanced technology, the messages desired to be conveyed can be delivered to the target audiences more efficiently by using perception management techniques through social media tools. The impact of these messages on people may vary in proportion to their wishes and needs and the level of social media use. Twitter, Intagram and Facebook are the leading social media platforms where perception management is done the most. Without checking the accuracy of their content, the news that comes before people spreads rapidly, and fake comments or support can be made. Since disinformation means false, biased or inaccurate information and intentionally spread, this misinformation spreads faster than factual information because it is tailored to be interesting. Especially during the first year of coronavirus epidemic, there were a lot of online rumors and fake news. Fake news contains information that is quite surprising or triggers people's anxiety compared to accurate information because fake news aims to attract people's attention. As a different dimension of perception management on social media, we can give an example of the presidential elections held in the USA in 2016. It was revealed that Cambridge Analytica had accessed confidential information on 50 million Facebook accounts to influence the presidential election at the time of the election. In doing so, Cambridge Analytica used an algorithm that extracts the psychological profiles of users interacting with Facebook. They classified people according to their personality traits. Profiles of Facebook users were created according to the content they liked, their shares, the videos and photos they commented on (Wallin, 2013). Cambridge Analytica worked with Donald Trump's campaign before the 2014 elections and used user data. Therefore, each share and like/unlilke on social media gives a clue about who we are. However, for any content shared on social media, the message that each person receives and perceives is not the same. People's past life experiences, social lives, cultural differences, and moral structures can also affect the message they receive. In other words, people from different cultures may tend to interpret the same message

quite differently. We may all have been exposed to perception management in a way that we did not realize while browsing social media. We overlooked a situation in a video we watched, or any visual or written text we saw may have caught our attention. We may have shown a positive tendency towards it.

In the same way, with the advertisement of a product that we do not even think to buy, we may consider buying that product and even find ourselves clicking on the product and paying. Another event of perception management is subliminal messages that try to change your choices and decisions. A subliminal message is a sign or message embedded in another object. They are designed to not be noticed easily. Some subliminal messages can be used in advertisements, especially for products whose sales are desired to be increased, and people may attempt to buy those products without realizing it. As a result, social media tools and perception management techniques can ensure that the messages desired to be given can be delivered to the targeted people and turn to the targets determined in line with their wishes. Human psychology, which is open to external factors by nature, can effectively manage perceptions and the psychological power of social media on communities. For this reason, it is necessary to be skeptical of the information read and obtained in social media and diversify the information channels. It will only be possible for people to reach the true meaning of the messages they access when evaluated with reliable, straightforward, evidence-based information (Aksakallı, 2020).

Figure 2. Main Techniques used in social media for perception engineering



Some of the Perception Management techniques they have stated as *"Accusations of brutality, Hyperbolic Inflations, Demonization and Dehumanization, Polarization and Divine Sanction"* in their book "War and Counter-War" by Toffler (1995) can be applied on social media:

Accusations of brutality

The other party is accused of committing immoral and brutal acts with this method. Thus, the opponent is shown as someone who shockingly commits inhuman acts. E.g.;

- Make propaganda that exploitations of children or young activists, women, and the elderly.
- A pervert's crime is generalized to a whole community due to physical intimacy, and his crime is shown as the community's crime.
- Give different news about immorality of corruption of political leaders to instigate social dissent.

The most important and striking example in this regard is the accusations made against the late Prime Minister Adnan Menderes of Tukey in the Yassıada courts after the 1960 coup that he slaughtered young people in a meat grinder. During the trial until that time, a committee was formed on this subject, but no evidence was found. This perception created before the coup was a perception operation to legitimize the coup. No evidence was found on these issues during the proceedings. The same situation applies to Libya, Iraq and other middle east countries.

Hyperbolic Inflations:

This method is used to exaggerate the beliefs or actions of the other party and make them terrible. A small mistake anyone can always make is magnified, and exaggerated generalizations are made about the person. E.g.;

- Some innocent words and behaviors of the other party are deliberately exaggerated and shown as treason.
- Based on some personality traits, it is claimed that the other party is a dictator.

The counter-power uses intense methods to create public opinion in this way. In recent years, Turkey's perception operations have revealed that an institution with a security and media component of law enforcement origin can be created that can counter-operate in this regard.

Demonization and Dehumanization

With this method, all the other party's actions are portrayed as bad, as if there is no hope of salvation or transformation. The person on the other end is stubbornly and persistently compared to demonized figures of the past. E.g.;

- The other side's name is cruel. Hitler is constantly mentioned side by side with rulers.

- Every word or action of the other community or party is constantly described as disgusting, dishonorable, and abominable.
- Propaganda is made that the Antichrist is the person on the other side.

Polarization:

It is claimed that the other side is constantly wandering in opposite poles. His beliefs, words, and deeds are reflected as opposite to his followers. It is constantly shown that he is not like us and has different beliefs, morals, and experiences. Those who use this method present themselves as good heroes and the other side as terrible guys. E.g.;

- It is constantly emphasized that he cooperated with terrorism, abused religion, or sold the country.
- Clothing that contrasts with the person's dressing style representing the other party or family is propagated.

The republican period is full of this perception of danger discourse. The May 27, 1960 coup and the following ones had the aim of crushing reactionism, and the society was kept in a state of being against each other.

Divine Sanction

In general, this method is used by so-called clergy who claim to represent religion. Whatever he does, he tries to convince people that he is doing everything according to Allah's will and that it is not possible for him to do anything wrong. However, the other party has the same belief, his own religious leader's political, etc. He tries to show that he is superior and holy to his leader. E.g.;

- They constantly repeat the comments in magazines and newspapers, which reveal that all the actions and words of the other party are unjust, but that every word and action of their religious leader is wise.

In this context, people do not always act with cost-profit calculations. While there is sometimes a rational choice in religious devotion, other factors irrationalities may come into play. The fundamental question here is: "*Can the demand for religious life be measured, or how can it be measured?*" Such a measurement can be made indirectly only by identifying the fundamental human problems that religion can answer. Although religious commodification is not new, the economic model of religion has been criticized for treating the concept of religion as a commercial commodity. This tendency is argued by Turkish opponent political parties against the ruling powers to have mobilized critical religious figures, communities, and institutions to support government policies. Those who approach religion economically use the language of the economy as a helpful tool when describing people's religious behavior. On the other hand, the economization of the language of religion is a game, a deception of late modernity.

The ruling powers of global economy criticize that everything should not be handled solely within the framework of radical rational and materialistic approaches in the form of homo-economicus; since solidarity, devotedness, frugality, and sincerity are expected to be the critical essence of sustainable societies. Although the rational choice theory seems to be suitable to be applied to the religious backed economic choices, it does not consider the existing structures, historical and socio-cultural contexts. In other words, it is the opposite of real life when viewed in a realistic sense. Suppose rational choice theory applies the reality of human life, temporary and transient structures, and the possibility of winning everlasting capital. In that case, it can be reasonable to consider religion and faith in assessing decisions based on rational choices.

8. Conclusions and Recommendations

Perception engineering activities can have negative effects on the rational expectations of economic actors, leading to misinformation, cognitive biases, distortions of market signals, reduced confidence, and inconsistent policies. These effects can impact the overall functioning of the economy, potentially creating market inefficiencies and undermining trust in economic institutions. To counter these negative consequences, it is crucial for economic actors to stay informed and critically evaluate information, while governments, businesses, and media should prioritize transparency and honesty in their communications about economic events, policies, and trends.

In the context of entrepreneurship and rational expectations theory, it is essential to consider the influence of social, cultural, religious and psychological factors on economic decision-making, as well as the potential impact of perception engineering on the formation of rational expectations. Social media has become an effective and efficient virtual public space, and just as acts against public order are sanctioned in the actual general area, the same should be valid for social media which is constantly growing and renewing itself via innovative AI based algorithms. AI has the potential to change perceptions of economic agents and impact perception management in significant ways. While AI-powered tools can help organizations make better decisions based on accurate and timely information, the use of AI in perception management via social media raises ethical concerns and requires careful consideration of the potential risks and benefits..

Therefore, Turkey can deal with perception engineering and biased rational expectations with the reasonable measures. Here are some prudent suggestions developed for policy makers and governments to address the challenges posed by perception engineering and its impact on rational expectations:

- *Encourage transparency and honest communication:* Governments, businesses, and media should be transparent and honest in their communication about economic events, policies, and trends. This can help reduce misinformation and cognitive biases that may distort rational expectations.
- *Promote critical thinking and media literacy*: Encourage people and economic actors to stay informed and critically evaluate the information they receive from various sources. This can help them make better decisions based on accurate information and reduce the impact of perception engineering.
- *Regulate social media platforms:* Implement greater regulation of social media platforms to prevent the spread of false information and biases, which could lead to distorted perceptions of reality and undermine rational expectations.
- *Strengthen diplomatic relations and strategic communication:* Maintaining strong diplomatic relations and engaging in strategic communication can help mitigate the negative effects of perception engineering and biased rational expectations.
- *Foster fact-based narratives*: Promote fact-based narratives in public discourse to counteract the influence of perception engineering and help maintain rational expectations among economic actors.
- *Monitor and address the impact of perception engineering on entrepreneurship*: Recognize the potential influence of perception engineering on entrepreneurs and work to create an environment that supports genuine innovation and economic growth, rather than one that is manipulated by perception engineering activities.

- *Encourage consistency in economic policies*: Ensure that economic policies are based on sound economic principles to reduce confusion and uncertainty among economic actors, which can result from inconsistent policy changes driven by perception engineering.

By addressing these issues, policy makers and governments can help mitigate the negative effects of perception engineering on rational expectations and foster a more stable and transparent economic environment.

Data availability: The datasets generated and analyzed during the current study are available in the World Bank Indicator, Materialflows.net, World Intellectual Property Organization repository.
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Analyzing the volatility spillover and cointegration relationship between daily spot West Texas intermediate crude oil price and US dollar

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ABSTRACT

In the study, it is aimed to analyze the diffusion and cointegration relationship between WTI and US Dollar in the period of 2016-2021. In the study, after a comprehensive literature review of the theoretical review, the econometric analysis section was started. In the first part of the analysis, the short and long-term relationships between the variables were examined with the autoregressive distributed lag methodology and the existence of a cointegration relationship was reached. According to the findings, the effect of WTI on foreign exchange volatility in the long run is statistically significant and negative. In the short-term evaluation, ECT is negative and significant within expectations. In this context, the changes between the variables approach the long-term equilibrium level. According to the results obtained in the causality and variance causality analyzes applied in the last part of the analysis, it is understood that there is a volatility spillover effect from WTI to foreign currency.

I. Introduction

The connection between the oil price and the foreign currency has been widely discussed in the literature, but different results have been obtained according to the period in which it was examined and the country and region under investigation. Petroleum and petroleum products have gained increasing importance in terms of the real economy since their use as industrial inputs. Especially after the 1973 oil crisis, this situation emerged more clearly in terms of countries. The price changes frequently encountered in oil prices in current days have revealed the necessity of focusing on its potential determinants and its macroeconomic effects. Foreign currency, on the other hand, provide an idea about the competitiveness of economies at the global level. Due to these characteristics, increase and decrease in considered variables can have very significant macroeconomic and monetary consequences.

Following the 2008 Crisis, the volatility of the oil cost increased, and its predictability decreased due to both OPEC's decline in determining the oil price and global geopolitical risks. The high oil price means an increase in input costs for countries that are net importers. This situation causes both foreign currencies to increase by causing more foreign currency to come out of the country and weakening the competitiveness in exports by increasing production costs. For this reason, the correlation among the oil prices and foreign currency is of vital importance for energy-dependent countries. So much so that the rise in the foreign currency during the periods while the oil cost is in a downward trend eliminates the advantage that the country hopes to gain from the price decrease.

The US dollar, which is the most important currency of the world reserve currency position, plays a key role in the trade of many products, especially petroleum manufactured goods. Rise and fall in foreign currency have various impacts on oil importing and exporting countries. The overvaluation of the foreign currency may cause foreign trade deficit by affecting the trade in cost for oil trade in countries.

In addition, the depreciation of the foreign currency reduces the export revenues of oil-exporting countries and may adversely affect their growth performance (Kızılkaya, 2021:552).

Therefore, unexpected, and damaging rate shocks in international markets might affect important macroeconomic indicators. In this sense, this crucial link among the variables is closely observed by both policy makers and financiers (Reboredo, 2012, 419-420).

In this study, volatility spillover and cointegration relationship between WTI price and USD Dollar. In this context, firstly, relations of the data sets will be examined with the bounds test methodology. Thus, it will be determined if cointegration relationship exist among the series and it will be understood that the effect of oil prices on foreign currency volatility is negative or positive. In the end, the causality relationship will be analyzed considering the causality analysis in variance. The rest of the paper is arranged as follows: main framework of theoretical background of the volatility spillover and cointegration includes the theoretical approach, literature review; and empirical analysis.

2. Theoretical Background

There are many theoretic and experimental studies investigating the link among the considered variables, but it is difficult to take a clear approach due to the lack of consensus on the results. From a theoretic perspective, the relationship among the mentioned variables can operate

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through more than one channel (Huang et al; 2021: 720). While some of these approaches state that the change in oil prices is effective on foreign currency, others state that changes in foreign currency influence WTI. The theoretical results of Caprio & Clark (1981) the effect of the increase in oil prices on foreign currency depends on the portfolio preferences of the oil importing country as well as the oil exporting country. Apart from this, the current account balance also affects the foreign currency results of oil price changes. However, understanding this effect is only possible provided that the asset preferences expressed in the first effect are known. Finally, the foreign currency expectations reflecting the adaptation of the countries to the increasing oil price are also effective in determining the current spot rate (Caprio & Clark 1981: 17-18). It is seen that the terms of trade approach developed by Amano & van Norden (1998b) and the wealth effect approach established by Golub (1983) & Krugman (1983) stand out among the approaches expressing the impact of variations in oil prices on foreign currency. Amano and Van Norden (1998a) showed that oil prices are the main cause of permanent shocks in foreign currency in their study using tradable and non-tradable goods in a simple two-sector model. According to the terms of trade channel approach, if a country's economy is more dependent on imported oil than the other country and if the non-tradable sectors of the economy of that country are more sensitive to changes in oil prices than the tradable sectors, the increase in oil prices will cause a shift in foreign currency instead of the domestic currency. This could lead to a real appreciation of the currency.

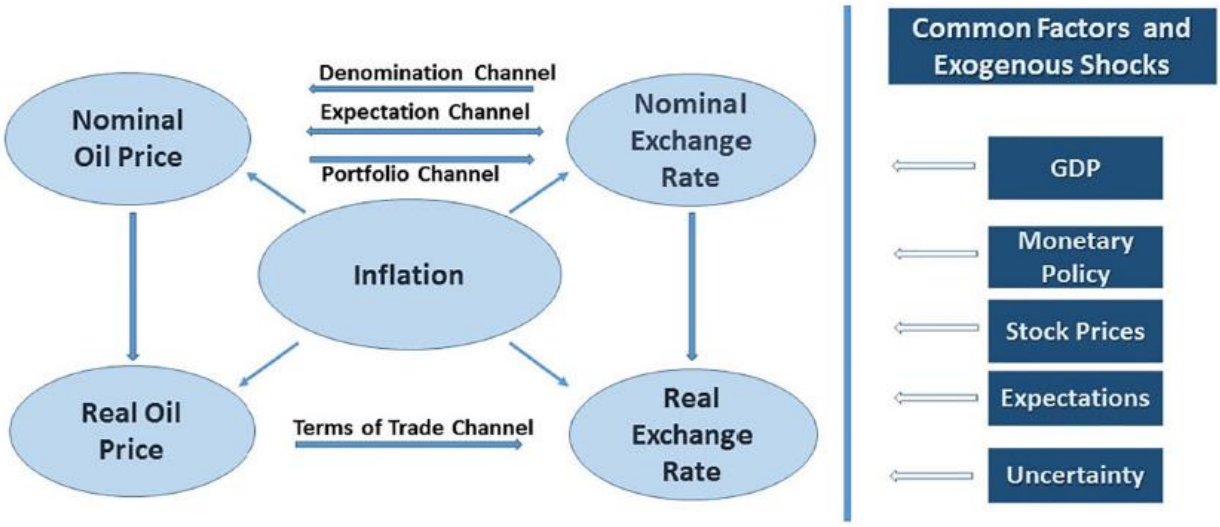
Nevertheless, if tradable sectors in the economy of the relevant country are additional sensitive to changes in oil prices than non-tradable sectors, then a rise in oil prices may cause the currency of this country to depreciate in real terms compared to the currency of the other country (Beckmann, Czudaj, & Arora, 2020:3). For the wealth effect channel, Golub (1983) & Krugman (1983) offer a hypothetical basis for stating that movement in oil price effects in prosperity transmission from oil importers to oil exporting nations and will completely affect balance of payments of the oil exporting nation (Yaman,2021: 160). That may cause the money of the oil exporting nation to appreciate. The current account balance of the oil importing nation will be negatively affected and the country's currency may lose value.

When we look at the theoretical approaches state that changes in foreign currency can be effective on oil costs, it is seen that three approaches stand out here. These; denomination channel, adjustment channel and financial markets channel (Büberkökü, 2021:292). Reboredo (2012), Zhang et al. (2016) and Beckmann et al. (2017) argue that in the short run, nominal foreign currency affects nominal oil prices through the denomination channel, while nominal foreign currency affects oil prices through the portfolio channel.

The mainstay of the adjustment channel is the reorganization of the pricing policies of oil exporting companies and/or the decisions of institutions such as OPEC on the amount of oil to be produced, according to the current conjuncture, to protect the market share and/or the purchasing power of oil revenues after the variations in the value of the US dollar on a global basis (Huang & Sissoko, 2014: 408; Büberkökü, 2021:293). The infrastructure of the financial markets channel, on the other hand, is the tendency of investors to rearrange their portfolios and/or to benefit from hedging transactions against the risks that may arise depending on the future values of the US dollar. In case of a powerful relationship between the US dollar and oil prices, the risks posed by price movements in the US dollar can be hedged with oil futures contracts. This situation may cause a causal relationship from foreign currency to oil prices.

If the resulting rise in WTI starts to an appreciation of the currency, a decrease in the WTI should trigger the currency to depreciate at the same rate. This is an indication that crude oil affects a country's foreign currency symmetrically. The hypothesis of symmetry for oil price changes may not always be true in the real world, as the impact of oil price rises and declines on the foreign currency is likely to vary in sign and/or magnitude (Kızılkaya,2021:553). If the effects of oil prices on foreign currency are asymmetrical, the results of empirical studies conducted under the assumption of symmetry may be misleading. Therefore, it is of great significance to be concerned about the asymmetric assumption to make more precise assessments when examining the effects of oil prices on foreign currency (Baek & Kim, 2020: 120).

Figure 1: Independence Between WTI, Foreign Currency and Other Factors



Source: Beckmann et al. (2020).

The different transmission channels are summarized in Figure 1. Chanel of trade mainly emphasis on foreign currency and real oil prices while the channel of portfolio and wealth suggest an impact from the nominal foreign currency to the nominal oil price. The channel of expectations permits for nominal causality in both directions. In general, it is significant to point out that both foreign currency and oil price changes in volume are defined by various causes and are extremely hard to calculate. While the volatile link between macroeconomic fundamentals and foreign currency are mirrored in the foreign currency separate problem understanding the cycles in oil price variations is often difficult by classifying the basic source of supply shocks and demand (Baumeister and Kilian, 2015).

3. **Literature**

The connection between foreign currency and WTI has also been widely discussed in applied studies. In the current literature, the subject has been examined using different methods for both oil importing and exporting countries.

Eichenbaum & Singleton (1986) , Chaudhuri & Daniel (1998), Amano & Norden (1998), Zhang, Fan, Tsai & Wei (2008), Wang & Wu (2012) & Zhang (2013), Beckmann & Czudaj (2013), Lv at al.(2018), Ağazade (2020), Shi at al. (2020) and Torun & Demirelli (2022) mostly using cointegration and causality techniques that make for developed countries that import oil and generally reached results showing that there is a long-term relationship. Besides, Huang & Guo (2007), Chen, Lee & Goh (2013), Turhan, Hacihasanoglu & Soytas (2013), Ogundipe at al. (2014), Bal & Rath (2015) and De Vita & Trachanas (2016), Yılmaz & Altay (2016), Ojebiyi & Wilson (2011) and Büberkökü (2021) reach different results in studies on developing countries.

Some studies in the literature are also related to OPEC members or other oil exporting countries. Koranchelian (2005), Zalduendo (2006), Korhonen & Juurikkala (2007), Nikbakht (2010), Jahan-Parvar & Mohammadi (2011) and Ağazade (2018) can be given as examples of these studies. In these studies, it has been concluded that oil prices have a positive effect on the real exchange rate.

The previous studies reveal a bi-directional causal connection between WTI and foreign currency. First, the impact of WTI on foreign currency in the medium/long period is obtained from periods of trade and the wealth effect channels. Amano & van Norden (1998) establish the long-term framework with terms of trade channels to obtain oil prices permanently on real exchange rates. Buetzer et al. (2016) show both the oil prices and the countries that produce the oil and the foreign currency with the trade channels in the industrialized countries. Beckmann & Czudaj (2013) aim on the causality connection between currencies and oil price ending that the most meaningful causality goes from foreign currency to oil price. Tantatape et al. (2014) examine the link between foreign currency and U.S. imported WTI. They demonstrated that, in the short term, foreign currency Granger-cause the price of oil. Moreover, the study showed that the oil price response to the foreign currency shock is negative. Nevertheless, oil price shocks obviously have not any effect on the foreign currency. Jammazi et al. (2015) analyze the US dollar foreign currency against WTI and 18 different currencies. Emphasizing that there is an asymmetric shift from foreign currency to oil prices in both the long and short run, the authors argue that negative foreign currency shocks have a greater effect on oil prices than positive ones. Kisswani et al. (2019) examine the asymmetrical connection between foreign currency and oil prices in selected Asian countries for the period 1970-2016 with the non-linear ARDL (NARDL) approach. The article also explores the direction of the causality link between foreign currency and oil price by using the Toda-Yamamoto causality test. Results point to a long-term asymmetry relationship only for Malaysia and Indonesia when structural breaks are considered. In addition, since there is a bidirectional causality among the variables in some countries, the causality test findings are complex, since in some countries there is a unidirectional causality. Şenol (2020) uses Hong's (2001) causality test in variance after estimating the volatility spreads between Borsa Istanbul exchange rate ($/₺) and oil (WTI) for the Turkish economy with the GARCH model of daily data for the period 2010-2019. The volatility spillovers and the relations between the variables were investigated using the DCC GARCH method. The findings of the research showed that there are reciprocal volatility spreads between BIST and the exchange rate, and one-way volatility spreads from oil to BIST and the foreign currency. These findings show that oil is an important factor in the volatility of Borsa Istanbul and foreign currency. Baek & Kim (2020) study11 sub-Saharan African countries with a monthly data set covering the years 2000-2017 and estimated the relationship with the help of the NARDL model. The findings reveal that there is an asymmetrical relationship among the variables, and that foreign currency are mostly affected by WTI increases. Baek (2021) examines the link between WTI and foreign currency with a monthly data set covering the years 1997-2017 in Indonesia. In the study, the relationship was estimated by the QARDL method. The findings show that the relationship between the two is heterogeneous among the quantiles. Therefore, it is suggested that there is an asymmetrical link between WTI and foreign currency in the short and long run. On the other hand, in the study, it was determined that increases in WTI only have an increasing effect on the local currency in the long run.

Kızılkaya (2021), in his study examines the oil price-currency shock relationship for the period 1960-2019 with the asymmetric Fourier Toda-Yamamoto causality test, found a one-way causality from positive oil price shocks to positive real exchange rate shocks. In this context, it emphasizes that asymmetric effects should also be considered while analyzing these two variables. Yaman (2021) evaluates the link between mentioned variables with the help of the daily data set covering the period 2002-2021 with the help of symmetric and asymmetric causality tests. While symmetric causality tests show that there is a feedback relationship between the two, asymmetric analyzes show that there is only one-way causality from oil prices to foreign currency in both positive and negative components. Huang et al. (2021), taking real oil prices and real exchange rate data, they classify 81 countries according to their net oil imports for the period 1997-2015. According to this classification, oil importers show a significant negative bidirectional correlation for countries in the free-floating exchange rate system, while oil exporters do not show a correlation among the variables. In the managed floating system, foreign currency is used to predict oil prices for oil importers or exporters. It is emphasized that knowing these relationships can shed light on the development of government policy to prevent sudden and significant shocks caused by volatility in exchange rate and WTI. Aracan (2022) uses the QARDL model in his study in which he examined the potential long and short run impacts of WTI on the real effective exchange rate of the Turkish lira with data covering the period 2003-2021. The results reveal that oil prices do not affect the real effective exchange rate in the long run but are effective in the short run and this impact is asymmetrical.

4. Empirical Analysis

The empirical analysis consists of two parts, and in the first part, the relationship between imported WTI and foreign currency volatility will be analyzed by causality and cointegration methods.

In terms of market trading, it is assumed that WTI is one of the main councils of the worldwide crude oil comparison cost. In addition, it is accepted that spot trade is developing in world trade and economic literature and is the main direction indicator in worldwide oil markets (Yousefi & Wirjanto, 2004). As a result, daily spot WTI in US dollars/barrel is used in this study. The trade-weighted dollar index was created to measure the value of the Federal Reserve's US dollar based on its competitiveness against its trading partners. The US dollar index – also known as the Broad index – is a measure of the trade-weighted US dollar's value relative to other currencies. It is a trade-weighted index that enhances the older US Dollar Index by updating its weights annually and using more currencies.

In this context, real trade-weighted US dollar index has been considered as the dollar currency in the study. For this purpose, the variables to be used in the analysis, their symbols and the sources obtained can be viewed in Table 1.

Table 1: Series, Symbols and Sources

Variable	Symbol	Source
Trade-weighted US dollar index (Real)	indx	FED
West Texas Intermediate crude oil price	WTI	Bloomberg

∗: *Board of Governors of the Federal Reserve System (US), Real Broad Dollar Index (Goods Only)*

Since speculative and geopolitical non-capitalist factors have had a significant consequence on the worldwide oil market in the recent period, the period of the analysis was determined as 1 March 2016 to 31 December 2021. Thus, it is aimed to reduce the effect of excessive interference of non-market factors as much as possible and to make the contact between the change in oil prices and the foreign currency more realistic and quantitative. As a result of the research conducted with the Tramo/Seat method, which is widely used for both series, it was concluded that the mentioned effect did not exist in the series.

In this study, the link between WTI and US Dollar are examined by causality and cointegration methods, within the framework of the following model:

$$indx = \beta_0 + \beta_1 wti + e_1$$

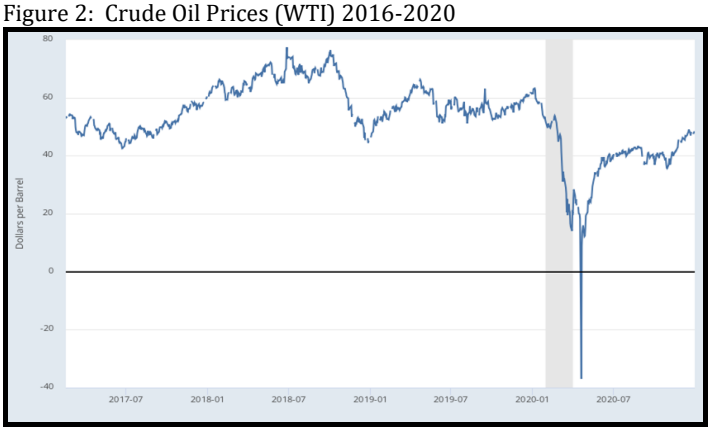
The tendency of the variables subject to the analysis for the period 1 March 2016 to 31 December 2021 can be seen in Figure 1 and Figure 2.

Looking at Figure 2, the remarkable point is that the price of a barrel of US crude oil fell negative for the first time in history. Concerns that the US's oil storage capacity would soon be full caused a sharp decrease in oil prices. In the country, the futures contracts for WTI type crude oil expired on Tuesday, while the barrel price of the oil in question fell by more than 300 percent to minus 37.63, as the contract holders avoided taking the delivery of physical crude oil. WTI experienced its biggest daily drop since it started trading in March 1983.

The dominance of the US dollar in the international trade and financial system has increased the importance of dollar movements, especially for emerging and developing market economies. Considering that the main factor behind the movements in the US dollar is the change in US growth expectations, unemployment figures, changes in fiscal policy or monetary policy, it is considered that the US dollar and dollar index may have different effects on developing countries. The US dollar index is important as it is an indicator of the relative strength of the US dollar worldwide. This is especially true for commodities (gold, silver, oil, etc.) priced in US dollars, when the US dollar is the main currency in currency pairs, and for stocks and indices. Commodity prices generally tend to fall as the value of the US dollar increases. The base currency in currency pairs is the US dollar.

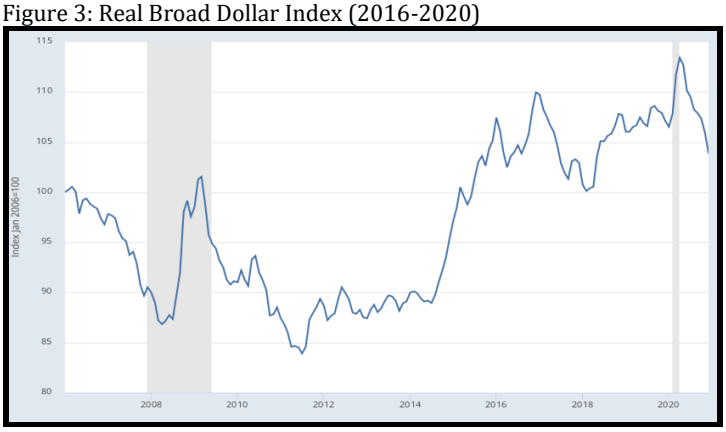
When there is a foreign currency, it usually moves in the same direction as the dollar index and the opposite currency moves in the opposite direction. The trend of the dollar index for the years subject to the analysis can be followed in Figure 3.

Figure 2: Crude Oil Prices (WTI) 2016-2020



Source: U.S. Energy Information Administration

Figure 3: Real Broad Dollar Index (2016-2020)



Source: Federal Reserve

When analyzed on an investor basis, it is expected that the dollar index will increase in case investors prefer the dollar over other country currencies, the interest rates of the American 10-year bonds increase and the US government bonds are preferred, and the risk-taking tendency of the investors decreases. Negative indicators in the American economy, on the other hand, may cause the dollar index to decline. In this sense, the dollar index will be an important indicator and reference for investors and market regulators in national and international investment decisions.

Before beginning the analysis, it is required to analyze the descriptive statistics. Primarily (skewness) and kurtosis (kurtosis) in descriptive statistics values can be viewed. These provide preliminary information in examining whether the distribution of data is normal. Skewness, i.e., slant value, expresses the symmetry of the distribution with respect to the mean (Doane, Seward: 2011). Kurtosis value, on the other hand, expresses flatness or bulge according to the normal distribution. To make a more precise judgment about normality, the normal distribution test results of Jarque-Bera values should be checked. This test is an asymptotic or large sample test. Descriptive statistics are presented in Table 1.

In Table 1, positive skewness values for variables indicate that the distribution is slanted slightly to the right. A value less than 3 for crude oil data indicates that the distribution has a flattened shape, and a value greater than 3 for the foreign currency volatility series indicates that the distribution has a pointed structure. A kurtosis value less than 3 for the WTI data indicates a flattened distribution, and a kurtosis value greater than 3 for the index series indicates that the distribution has a pointed structure. It has a Chi-square distribution with 2 degrees of independent. According to the resulting probability values, the hypothesis of "H_0: error terms are normally distributed" was rejected for both series. Covariance and correlation are used to reveal the relationship between two variables. Unlike covariance, correlation also shows the degree of this relationship. Accordingly, the negative correlation value between foreign currency volatility and WTI is 39%.

Table 1: Descriptive Statistics

	WTI	indx
mean	3.460	0.011
median	3.221	0.008
maximum	3.991	0.181
minimum	2.562	-0,022
std.dev.	0,321	0.016
skewness	0,401	3.011
kurtosis	1.671	24.899
j.Berra	28.567	6412.990
probability	0.000	0.000
sum	1211.221	3.900
sum sq.dev.	133.709	0.176
	Correlation	
	WTI	indx
WTI	1	-0,3921
indx	-0,3921	1
	Covariance	
	WTI	indx
WTI	0.41320	-0,00412
indx	-0,00412	0.000229

Because non-stationary series will cause spurious regression problem, unit root tests were used to decide if the variables were stationary before the econometric analysis was determined. To increase the reliability of the analysis, Clemente, Montañés & Reyes (1998) and Lee & Strazicich (2003) tests, which allow breaks, were preferred besides the traditional Augmented Dickey Fuller (ADF) unit root test. ADF test is a method used for cases involving time trend and constant number. In this context, the ADF test is expressed as in Equation (2) and (3) (Dickey and Fuller, 1981:1960).

$$\Delta X_t = \mu + BX_{t-1} + \sum_{i=1}^{k} \varphi \Delta X_{t-i} + u_t \quad (2)$$

$$\Delta X_t = \mu + \alpha + BX_{t-1} + \sum_{i=1}^{k} \varphi \Delta X_{t-i} + trend + u_t \quad (3)$$

In the calculation in question, the null hypothesis "the series is not stationary" and the alternative hypothesis "the series is stationary" are analyzed. ADF unit root test results can be viewed in Table 2.

Tablo 2: ADF Results

Variables	At level	First Difference	Critical Value (1%)
indx	-2,10(8)	-5,29(5)*	-4.18
WTI	-7,20(1)	-	-4,90

Note:* They are significant at the 1 level, and the values in parentheses indicate the optimal lag lengths determined by the Akaike Information Criteria (AIC).

As can be seen from Table 2, WTI is stationary at the level, while Trade-weighted US dollar index (indx) becomes stationary when their first difference is taken. Clemente, Montañés, Reyes (CMR;1998) unit root test the variables separately under one and two breaks, and breaks are included in the analysis internally, as in the Lee-Strazicich test. In addition, CMR (1998) considers the possibility of shock, which is the cause of structural break in the unit root test variables, to occur gradually or momentarily. In the CMR (1998) test, the null assumption in Equation (4) is tested against the alternative hypothesis in Equation (5).

$$H_0: y_t = y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + u_t \quad (4)$$

$$H_A: y_t = \mu + d_1 DU_{1t} + d_2 DTB_{2t} + e_t \quad (5)$$

Table 3: CMR Unit Root Test Results

Variables	***AO Model***		***IO Model***	
	t statistic	Break date	t statistic	Break date
indx	-3.09 (k=3)	2009, 2020	-2.66 (k=6)	2009, 2020
WTI	-5.11(k=0)	2009, 2020	-4,70 (k=14)	2009, 2020

Note: Critical value for both AO and IO models for Clemente, Montañés, Reyes unit root testing: -6.141 (5%). The lag lengths are shown in parentheses.

The estimations of CMR, the dependent variable ''indx'' contains a variable level unit root. The WTI variable is stationary in the series. The breaking dates are significant dates for the world economy and express the impact of the global crisis in 2009. In 2020, there were two important developments for the world economy. One is the Covid-19 epidemic, and the other is the sharp drop in oil prices. After the meeting of the OPEC and some non-OPEC crude oil producing countries, the decision to cut production did not come out and the statements from the authorities' reduced expectations for any agreement, the price of Brent oil per barrel decreased by 30 percent today to $32. Regarding the production cut, especially Saudi Arabia. While the disagreement between Saudi Arabia and Russia caused the risk of an increase in excess supply in the global market to be priced in, this development combined with the certainty that the Kovid-19 outbreak would slow down economic activity, oil prices saw their lowest level since January 2016.

According to the unit root analysis results, it was understood that the integration degrees of the variables were different. In this context, it is impossible to apply the cointegration approaches recommended by Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990), which permit co-integration analysis for equally integrated variables.

The Autoregressive Distributed Lag (ARDL) established by Peseran (2001) does not impose any restrictions on the degree of integration, and it can also be applied to studies with a small number of observations. One of the basic conditions in the ARDL test is that the dependent variable has a unit root at the level. Due to the fulfillment of all these conditions, it was decided that the most appropriate analysis for the analysis was the ARDL limit test. First, the ARDL model is created according to the appropriate number of delays. Next step, this model is converted as an error correction model (VECM). In the last step, the F statistic is calculated by using the sum of the squares of the error obtained by estimating the constrained and unconstrained models based on the error correction model. If the F statistic is below the lower limit, I (0), the H0 hypothesis of "no cointegration" is accepted, and if it is above the upper limit, I (1), it is rejected. The region between two values is the region of instability. When falling into the indecision region, the long-term coefficients of the model can be estimated and interpreted if they are significant. The constrained and unconstrained model to be used in this context can be followed in Equations (6) and (7).

Constrained Model

$$\Delta y = c + \sum_{j=1}^{p} \propto_i \Delta y_{t-j} + \sum_{j=1}^{q} \beta_j \Delta x_{t-j} + \varepsilon_t \quad (6)$$

Unconstrained Model

$$\Delta_y = c + \delta_1 y_{t-1} + \delta_2 y_{t-1} + \sum_{j=1}^{p} \propto_i \Delta y_{t-j} + \sum_{j=1}^{q} \beta_j \Delta y_{t-j} + \varepsilon_t \, (7)$$

The unconstrained model here is the expression of the ARDL model as VECM. By converting the ARDL model to VECM, both the cointegration relationship is investigated and it can be seen how to correct it when there is a deviation in the short-run balance. In Equation (7), $\delta_1 y_{t-1} + \delta_2 y_{t-1}$ show the long run VECM. According to F statistic, if $\delta_1 = \delta_2 = 0 \delta_1 = \delta_2 = 0$," H_0: no cointegration" hypothesis is accepted (Shresta & Chowdhury, 2005).

In the information criteria considered for the unconstrained error correction models to be established, the delay length with the smallest critical value is selected as the appropriate delay length. Besides, if the selected smallest value has an autocorrelation problem, the next smallest value is accepted as the lag length. This situation is repeated as the autocorrelation problem persists. The lag lengths reached by using the AIC and the Schwarz information criterion can be seen in Table 4.

Table 4: Determining the Appropriate Lag Length

M	AIC	SIC	X^2 BREUSCH-GODFREY
*1**	2.0011	5.312	4.104***(0.210)
2	4.2716	6.322	8.101 (0.200)
3	4.3318	6.110	5.615**(0.208)
4	4.0401	6.810	5.100**(0.318)
5	4.2111	5.391	3.010*(0.444)
6	3.3009	7.180	3.101*(0.198)
7	3.1289	7.220	2.310**(0.332)
8	3.3121	6.241	1.217**(0.227)
9	3.2110	7.108	2.514**(0.156)

Note: *, ** and *** indicate the appropriate delay length selected at the level of 1%, 5% and 10%, respectively. Values in brackets represent the probability value.

According to the results in Table 4, the lag length with the smallest critical value was determined as 1. It is necessary to investigate whether the variables are in a co-integration relationship in the boundary test analyzes for which the lag length is determined. In this context, the F test is used. If the obtained F-statistic is higher than the higher bound value, the null hypothesis is rejected. In other words, a cointegration relationship among the variables is reached. Otherwise, the null hypothesis is accepted. In case the obtained F value is between the lower and upper limit values, no interpretation can be made. ARDL test results are presented in Table 5.

The 8,600 F statistical value reached in Table 5 is higher than the critical value upper limit of 7,920 at the 5% level. According to this result, the null hypothesis stating that there is no long-term level relationship is rejected. In other saying, there is a long-term relationship among the Diagnostic tests are in line with expectations. After deciding whether there is a cointegration relationship according to the critical values, short and long-term relationships can be analyzed. To investigate the short-term relationship, the error correction model calculated from the ARDL (1, 1) model was established according to Equation (6) and (7). The estimation results of Equation (8) are presented in Table 6.

Table 5: ARDL Test Results

F Statistic Critical Values						
	10%		5%		1%	
k		I(I)	I(0)	I(I)	I(0)	I(I)
1	5,993	6,804	6,666	7,920	8,94	9,411
Obtained F Statistic Critical Values						
F_{rate}		8,600				
Diagnostic Tests						
$R^2 = 0{,}59$		*F İstatistiği: 5,827(0,00)*		$Breusch - Godfrey\ LM: 0{,}28(0{,}11)$	*Ramsey Reset:1,81(0,06)*	
$Adjusted\ R^2 = 0{,}48$		*ARCH-LM:2,16(0,10)*		*Jarque-Berra :0,061(0,74)*		

Table 6: ARDL (1, 1) Model Estimation Results (Dependent Variable:indx)

Constant				Constant and trend			
Variables	Coefficient	t statistic	Probability	Variables	Coefficient	t statistic	Probability
indx(-1)	0,411	9,516	0,00	indx	0,419	7,819	0,00
WTI	-0,008	-3,221	0,02	WTI	-0,010	-4,171	0,01
WTI(-1)	0,009	2,991	0,00	WTI (-1)	0,001	2,221	0,00
C	0,011	5,111	0,00	C	0,010	5,817	0,00
				TREND	0,000	-0,888	0,00
Constant				Constant and trend			
Variables	Coefficient	t statistic	Probability	Variables	Coefficient	t statistic	Probability
WTI	-0,016	-2,98	0,000	WTI	-0,018	-1,56	0,000
C	0,011	6,78	0,000	C	0,014	5,90	0,000
Diagnostic Tests				Diagnostic Tests			
R^2 :0,177				R^2 : 0,177			
$\overline{R^2}$:0,2219				$\overline{R^2}$: 0,2201			
X^2_{BG}:1,001 (0,41)				X^2_{BG} :1,012(0,44)			
X^2_{NORM} :1071(0,00)				X^2_{NORM}: 1191(0,00)			
X^2_{WHITE}:44,11(0,00)				X^2_{WHITE}: 49,11(0,00)			
X^2_{RAMSEY} :8,11(0,00)				X^2_{RAMSEY}:9,99(0,00)			

It is seen in Table 6 that the WTI coefficient is negatively linked to the foreign currency series in both models. The coefficient of the oil price variable is significant in both models. According to the long-term coefficients obtained, a 1% increase in oil prices reduces the dollar rate index by 0.016% for constant model and by 0,018 for Constant and trend. X^2_{NORM}, X^2_{BG}, X^2_{WHITE} and X^2_{RAMSEY} tests were used for the diagnostic tests of the model. These are the statistics of normality, autocorrelation, varying variance, and model building error testing, respectively. Accordingly, the jarque-bera test was used in the model for normality. According to the test statistics, the error terms are normally distributed and no autocorrelation in the model. White test results, on the other hand, show that there is no varying variance. In addition, the null hypothesis, which states that the function form of the model is correct (no model building error), is rejected in the fixed model according to the ramsey-reset result, while it is accepted at all significance levels for the fixed and trended model.

Results are in a parallel with the study of Eichenbaum & Singleton (1986), Chaudhuri & Daniel (1998), Amano & Norden (1998), Zhang, Fan, Tsai & Wei (2008), Wang & Wu (2012), Zhang (2013), Beckmann & Czudaj (2013), Lv at al. (2018), Ağazade (2020), Shi at al. (2020), and Torun & Demirelli (2022).

To investigate the short-term relationship, the error correction model (ECM) calculated from the ARDL (1, 1) model was established as follows.

$$\Delta indx_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta indx_{t-i} + \sum_{i=0}^{m} \alpha_{2i} wti_{t-i} + \alpha_3 + \Delta indx_{t-1} + \alpha_4 + \Delta wti_{t-1} + ECT_{t-1} + u_t \quad (8)$$

In the model, the constant term "c" represents the trend value "t". The ECT_{t-1} is one period lagged value of the series of error terms acquired from the long-run. The coefficient of this variable indicates how much of the deviation from the short-run equilibrium will be corrected in the long run. The short-term estimation results of Equation 8 can be viewed in Table 7.

As seen in Table 7, the short-term effect of the change in WTI on foreign currency is negative and statistically significant in both fixed and fixed and trend models. The coefficient of error correction variable was determined as -0.54 in the fixed model and -0.55 in the fixed and trend model. Probability values are statistically significant. Accordingly, about half of the effect of a shock in WTI on foreign currency disappears within a year for both fixed and fixed and trend models. Accordingly, about half (54%-55%) of the impact of a shock in WTI on foreign currency disappears within a year for both fixed and fixed and trend models. According to the results of the diagnostic test, no problems were encountered in the short-term model either.

Table 7: ECM Based on ARDL (1, 1) Approach

Constant				Constant and trend			
Variables	Coefficient	t statistic	Probability	Variables	Coefficient	t statistic	Probability
WTI	-0,011	-2,71	0,000	WTI	-0,012	-1,56	0,000
C	0,010	6,68	0,000	C	0,012	6,01	0,000
ECT_{t-1}	-0,54	0,033	0,000	ECT_{t-1}	-0,55	-10,10	0,000
Diagnostic Tests				Diagnostic Tests			
R^2 :0,180				R^2 : 0,181			
$\overline{R^2}$:0,2291				$\overline{R^2}$: 0,2311			
X^2_{BG}:1,001 (0,45)				X^2_{BG} :1,012(0,50)			
X^2_{NORM} :1066(0,00)				X^2_{NORM}: 1169(0,00)			
X^2_{WHITE}:44,18(0,00)				X^2_{WHITE}: 49,22(0,00)			
X^2_{RAMSEY} :8,11(0,00)				X^2_{RAMSEY}:9,99(0,00)			

4.1. Variant Causality (Volatility Spillover)

After determining the cointegration relationship, it was investigated whether there was a causal relationship between the two series. There are various methods used to determine the causality relationship. However, the causality test in the variance selected for the study is significantly different from other causality tests. In causality tests such as time varying causality, causality is tested in error term averages, while causality is tested in variance in this method. In standard econometric models, the error term variance is expected to be constant. However, many time series fluctuate with major crisis periods and the assumption of fixed variance is not valid. Other causality tests are based on the variance of two variables. They fall short of measuring the volatility spillover effect from changes.

There are two test methods used in this regard. First, the Cheung & Ng (1996) method is based on the cross-correlation function (CCF) of standard residues obtained from the GARCH estimation. However, the portmanteau test used to test the null hypothesis is based on the CCF function and is affected by the sample size problem for small and medium-sized samples when the volatility process is flattened from the sides. The second difficulty in this method is that in the CCF-based volatility spread test, the results take different values according to the degrees of the leads and lags in the VAR model (Hafner & Herwatz, 2008: 222). The second method, the Hafner & Herwartz (2006) test, is based on the LM (Lagrange Multiplier) principle, its application is simpler, and the above-mentioned problems are not experienced. In the Hafner & Herwartz (2006) method, the univariate GARCH model is estimated first.

In previous tests improved by Cheung & Ng (1996) and Hong (2001), methodologies focused on cross-correlation functions. In these tests it is estimated from standardized residuals of univariate GARCHs. Also, a major shortcoming of these methods is that they take on problems, especially when the volatility of the sample series is Leptokurtic. Another critical shortcoming of previous methods is that they are vulnerable to the order selection of leads and lags (Nazlioğlu et al., 2013), which raises questions about the stability and robustness of the method. On the other hand, the Hafner & Herwartz (2006) method eliminates the shortcomings based on the Lagrange Multiplier principle. In addition, since our sample size is quite large, Hafner & Herwartz (2006) works much better under these conditions.

The null hypothesis, which says that there is no causality in the variance between two variables, is defined in Equation (9) as follows.

$$\varepsilon_{it} = \sqrt[\Phi_{it}]{\sigma_{it}^2(1 + z_j'\pi)} \tag{9}$$

Where;

$$z_{jt} = (\varepsilon_{jt-1}^2, \sigma_{jt-1}^2)' \tag{10}$$

In Equation (10), σ_{it} σ_{it}^2 are the standardized residuals and conditional volatility of the i series. ε_{jt-1}^2 and σ_{jt-1}^2 respectively denotes disturbance term and conditional standard deviation, both squared of series j. Normalized balances are regressed on derivatives and the null hypothesis for the process is dependent upon the π in the equation. If $\pi = 0$, this implies there is no volatility spillover between variables *i* and *j*. The other hypothesis for, though, is $\pi \neq 0$ which denies there is no volatility spillover from *j* to *i*. The Hafner Herwartz (2006) test confirms the null test through LM test statistics as follows.

$$\lambda_{LM} = \frac{1}{4T}\left(\sum_{t=1}^{T}(\sigma_{it}^2 - 1)z_{jt}'\right)V(\Phi_i)^{-1}\left(\sum_{t=1}^{T}(\zeta_{it}^2 - 1)z_{jt}\right) \tag{11}$$

The value of V (Φ_i) in this equation is as in Equation (12).

In the Haftner and Herwartz method, first ε_{it} and ε_{jt} for the GARCH (1:1) model is estimated. Then the standardized residuals ζ_{it}^2 and the GARCH model derivative the value X_{it} is obtained.

In the third step, the σ_{it}^2term, which is the GARCH model variance, which expresses the volatility process, is calculated using the z_{jt} term. In the next step, the specification indicators in the $\zeta_{it}^2 - 1$ expression is regressed on x_{it} and z_{jt}'. λ_{LM} is obtained by multiplying the R^2 from this model with the number of observations T (Hafner & Herwartz, 2006:137-141). In this context, the ARCH (1;1) and GARCH (1;1) model results can be viewed in Table 8.

Table 8: ARCH (1,1) and GARCH (1,1) Models

Variable	Coefficient	St.Dev.	Z stst.	Probability
C	0.005118	0.000221	7.77141	0.000
Y (-1)	0.552791	0.022141	12.2784	0.000
Equality of Variance				
C	0.0000214101	2.10901	4.21011	0.000
RESID $(-1)^2$	0.58011	0.06119	7.36012	0.000
GARCH (-1)	0.22197	0.03112	7.73211	0.000
Variable	Coefficient	St.Dev.	Z stst.	Probability
C	0.001293	0.002410	0.74511	0.02
X (-1)	0.18111	0.087432	2.22121	0.00
Equality of Variance				
C	0.00394	0.0000	2.41217	0.00
RESID $(-1)^2$	0.22908	0.03111	4.29786	0.00
GARCH (-1)	0.554509	0.07600	5.55455	0.00

In the equation, where Y is the volatility of foreign currency and X is WTI, ARCH (1;1) and GARCH (1;1) models are as follows, first for Y and then for X, respectively.

Y=0.005118+0.552791 y (-1)
X=0.001293+0.18111 x (-1)
Y=0.0000214101 + 0.58011resid $(-1)^2$ + 0.22197 GARCH (-1)
X=0.001293 + 0.22908 resid $(-1)^2$ + 0.554509 GARCH (-1)

Accordingly, the coefficients in all models are statistically significant. The coefficients in the variance equations are positive and the conditional variance of the foreign currency volatility converges towards oil prices.

ARCH parameter indicates resid $(-1)^2$ and GARCH parameter indicates GARCH (-1) and different values are reached in both models. If α+β expression is less than "1", it indicates the degree of persistence of the shock. The magnitude of the coefficient "α" while giving its response to market movements, the size of the "β" coefficient expresses the reaction of volatility-to-volatility resistance (Yılmaz & Altay, 2016: 668). In the study, in the GARCH where x is the dependent variable, when the coefficient of GARCH (-1) is compared with 0.55 and the ARCH coefficient RESID $(-1)^2$ is 0.22, the volatility of oil prices is mostly due to the GARCH effect, that is, in the long run. It can be said that the volatility effect has increased. In the last part of the study, the results of the λ_{LM} statistics are evaluated and can be viewed in Table 9.

Table 9: Volatility Spillover Results

Volatility in Variance	LM Stat.	Probability
WTI ⟹ foreign currency volatility	10.01	0.00
foreign currency volatility ⟹ WTI	9.18	0.00

According to the results, both the volatility spillover effect from oil prices to foreign currency and the existence of a volatility relationship from foreign currency to WTI have been reached.

5. Conclusion

Two of the variables that directly affect the success of macroeconomic policies are foreign currency and oil prices. Oil, which is used as a raw material in many industries, is a variable that is always on the attention of policy makers. Sharp changes in oil prices during periods of events that directly affect economic variables are an indication of how dependent their economies are on crude oil. Apart from the oil crises, this situation has been felt even more by the recent pandemic and the Russia-Ukraine war. On the other hand, low savings, and investment rates especially in developing countries, high budget and foreign trade deficits, and high imports of raw materials and intermediate goods due to foreign savings increase the importance of foreign currency even more.

Causality in variance shows the reaction of the market to new information. Information reaching the markets causes volatility in the returns of assets. This information may originate from the national market as well as from international markets. Likewise, the flow of information may originate from stock markets as well as from commodity markets such as oil. Knowing the volatility spillovers that cause volatility in markets and asset returns is important for portfolio risk management, investment decisions, internationally operating companies, and international capital movements. Instability in foreign currency negatively affects many variables, especially foreign trade. According to the empirical analysis results of the study, a long-term cointegration relationship was determined between WTI and the US dollar, that is, these two variables act together in the long run. In addition, there is a volatility spillover effect from the fluctuation in WTI to the foreign currency. Recently, excessive fluctuations in oil prices have increased the upward pressure on foreign currency, which disrupts macroeconomic stability and makes it difficult to reach macro targets. Therefore, it may be useful to consider the shocks in oil prices in foreign currency policies. Excessive fluctuations in oil prices increase the upward pressure on exchange rates, which destabilizes the macroeconomic and makes it difficult to reach macro targets. Therefore, it may be useful to consider the shocks in oil prices in exchange rate policies.

Data availability: The datasets generated and analyzed during the current study are available in the World Bank Indicator, Materialflows.net, World Intellectual Property Organization repository.
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Understanding employee wellness in industry 5.0: A systematic review

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ABSTRACT

The 21st century has brought about significant technological advancements, leading to Industry 5.0—marked by cutting-edge technologies such as AI, robotics, and the Internet of Things. While these advancements have brought numerous benefits to organizations, including heightened productivity and efficiency, they have posed new challenges in employee wellness. This systematic review investigated the impact of emotional intelligence and new technologies on employee wellness in Industry 5.0. The review yielded seven studies meeting the inclusion criteria. Findings showed that emotional intelligence positively influences work performance and job satisfaction. On the other hand, factors such as organizational justice and job dropout harm employees' wellness. The study also found that physical workplace conditions and employee autonomy play a significant role in employee wellness and job satisfaction. Using new technologies, such as robotization, can potentially dehumanize employees, but it can be prevented by exploring sustainable solutions and addressing ergonomic adverse effects. The study concludes with the importance of considering employees' subjective wellness and promoting a human-centric approach in Industry 5.0. The results of this study have important implications for organizations and provide a foundation for future research in human resource management.

1. Introduction

The dawn of the 21st century has seen a tremendous surge in technological advancements, culminating in the formation of Industry 5.0, a new era of work marked by the integration of advanced technologies such as artificial intelligence (AI), robotics, and the Internet of Things (Østergaard, 2018). The widespread adoption of these technologies has brought various benefits to organizations, including increased productivity and efficiency. However, the rapid pace of technological change and the associated demands of the digital age has also created new challenges, particularly in employee wellness.

Employee wellness refers to employees' physical, mental, and emotional wellness, significantly impacting their overall job satisfaction and productivity (Roslender et al., 2006). In the fast-paced and demanding environment of Industry 5.0, employees face increased workloads, longer working hours, and heightened job stress levels, which can negatively impact their wellness. As such, organizations must understand the challenges and opportunities associated with employee wellness in the digital age in order to develop strategies to support the wellness of their employees.

Employee wellness is critical to an organization's success and significantly impacts employees' overall job satisfaction and productivity (Qaisar et al., 2018). In addition, the widespread adoption of digital technologies has led to a blurring of the boundaries between work and home, making it increasingly difficult for employees to achieve a healthy work-life balance (Søvold et al., 2021). This includes identifying best practices and strategies to promote employee wellness in the digital age and developing innovative approaches to support the wellness of employees in this rapidly advancing era.

The study of employee wellness in Industry 5.0 is an emerging field of research, and while there has been some work done in this area, there is still much to be explored. The present review analyzes the existing literature to understand the challenges and opportunities associated with employee wellness in Industry 5.0. The findings of this study will provide valuable insight into the current state of employee wellness in the digital age. They could help organizations adopt best practices and strategies to promote employee wellness in this rapidly advancing era.

2. Method

The systematic review methodology was chosen for this study as it provides a comprehensive and rigorous approach to reviewing the existing literature on a particular topic. A systematic review will ensure that the study's findings are robust and can be used to inform practice and inform future research in this area. The following steps were taken to achieve the research objectives:

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Identification of Relevant Studies: The screening process was conducted on Google Scholar to identify relevant studies. Google Scholar has an extensive database of peer-reviewed articles for running a systematic review. This database regularly updates the latest publications and provides access to articles from various fields and disciplines. Furthermore, Google Scholar provides a user-friendly interface and advanced search options, allowing more efficient and comprehensive searching. Replacing the databases mentioned in the research proposal with Google Scholar can provide a more comprehensive and up-to-date source of literature while also making the literature screening process more efficient. In addition, a manual search of the reference lists of relevant studies and a review of relevant conference proceedings were conducted to identify additional studies. The search terms will include a combination of keywords related to employee wellness and Industry 5.0, such as "employee wellness," "employee well-being," "Industry 5.0," and "digital age."

Study Selection: All studies identified through the screening process were reviewed, and those that met the inclusion criteria were selected for inclusion in the review. The inclusion criteria for this study were as follows: (a) peer-reviewed articles or conference proceedings published in English, (b) studies that have been published in the last ten years, (c) studies that specifically focus on employee wellness in Industry 5.0, and (d) studies that provide insights into the challenges and opportunities associated with employee wellness in the digital age.

Data Extraction: Information from the selected studies was extracted using a standardized data extraction form. The information that was extracted included (a) the study design, (b) the sample size and population, (c) the research methods used, (d) the main findings, and (e) the implications for organizations.

Data Analysis: The extracted data were analyzed to identify patterns and trends in the existing literature on employee wellness in Industry 5.0. The analysis involved synthesizing the selected studies' findings and identifying common themes and challenges associated with employee wellness in the digital age.

3. Results

A total of seven studies from 26 potential studies met the inclusion criteria (Table 1).

Influence of Emotional Intelligence on the Workforce for Industry 5.0 (Chin, 2021): The article explores the impact of emotional intelligence on the workforce in Industry 5.0. The ability to identify and control one's emotions and those of others is referred to as emotional intelligence. The author argues that emotional intelligence will play a crucial role in work productivity in the current era of Industry 5.0, characterized by advanced technologies and automation. This is because, as machines increasingly perform tasks that humans once did, the value of human skills such as empathy, communication, and collaboration will become increasingly important. Therefore, individuals with high emotional intelligence will likely be more successful in this new work environment.

A Structural Equations Model of Job Disengagement from the Constructs of Organizational Justice, Job Satisfaction, Innovation, and Trust in the Era of Industry 5.0 (Esthela et al., 2021): The article presents a structural equation model that explores the relationship between various factors and job disengagement in the era of Industry 5.0. The model looks at the influence of organizational justice, job satisfaction, innovation, and trust on job disengagement. The authors suggest that these factors significantly impact employees' motivation and engagement in their work. They find that a lack of organizational justice and job satisfaction can increase job disengagement. In contrast, a high level of trust in the organization and opportunities for innovation can lead to increased job engagement. The article highlights the importance of addressing these factors to reduce job disengagement and increase employee motivation in the era of Industry 5.0.

The Human Role in Human-Centric Industry (Kalateh et al., 2022): The article explores the human role in a human-centric industry. It argues that Industry 5.0, with its advanced technologies and automation, presents opportunities and challenges for the workforce. On the one hand, humans can focus on more complex jobs because computers and technologies can carry out tasks faster and more correctly than people. On the other hand, the increasing automation of jobs can lead to concerns about job security and the displacement of workers. The authors argue that the key to success in a human-centric industry is for humans to leverage their unique strengths, such as creativity, empathy, and problem-solving skills. This will allow humans to complement and enhance the capabilities of machines rather than being replaced by them. The authors suggest that companies should focus on developing human skills, such as emotional intelligence, critical thinking, and communication, and preparing employees for the demands of Industry 5.0. The article concludes that the human role in a human-centric industry is to use their unique strengths to create value and solve problems, working in partnership with machines to drive progress and innovation.

Collaboration Between Humans and Robots in Organizations: A Macroergonomic, Emotional, and Spiritual Approach (Firescu et al., 2022): The article focuses on the collaboration between humans and robots in organizations, taking a macroergonomic, emotional, and spiritual approach. The authors argue that integrating robots into the workplace will affect the workforce, influencing their physical and psychological wellness. They suggest that a macroergonomic approach, which considers the broader organizational and societal context, is necessary to ensure that the collaboration between humans and robots is successful and sustainable. The article also emphasizes the importance of emotional and spiritual factors in this collaboration. The authors argue that the relationship between humans and robots is not just technical but also emotional and spiritual. They suggest that companies consider the emotional impact of robots on the workforce and ensure that employees feel supported and valued. Additionally, the authors propose that companies embrace a spiritual approach, recognizing that robots and humans are interconnected and that both have a role to play in creating a better future. In conclusion, the authors argue that a macroergonomic, emotional, and spiritual approach is necessary to ensure that the collaboration between humans and robots in organizations is successful and sustainable. They suggest that companies should consider the broader context, the emotional impact on the workforce, and the spiritual significance of this collaboration to create a positive and harmonious work environment.

Effects of Human–Machine Interaction on Employee Learning: A Contingent Perspective (Sen et al., 2022): The article examines the impact of human-machine interaction on employee learning from a contingent standpoint. The authors suggest that human and machine relationships can significantly impact employee learning and development. They argue that the effectiveness of human-machine interaction for learning depends on various contingencies, such as the task, the technology, and the individual. The article discusses how human-machine exchange can support employee learning through immediate feedback, reduced cognitive load, and promoted engagement. However, the authors also highlight the potential drawbacks of human-machine interaction, such as reduced social interaction and over-reliance on technology. The authors anticipate that the impact of human-machine interaction on employee learning will largely depend on the context and the individual involved. In order to maximize the benefits of human-machine interaction for employee learning, they propose that organizations should adopt a contingent approach, considering the specific task, technology, and individual. In brief, the article highlights the complex relationship between human-machine interaction and employee learning.

Table I: Studies Included

Article	Design	Sample Size & Population	Research Methods Used	Main Findings	Implications
Influence of Emotional Intelligence on the Workforce for Industry 5.0	Quantitative	110 Employees from Smart Investment Centers	Questionnaire	The research suggests that emotional intelligence has a positive impact on workforce performance.	Emotional recognition and expression and direct emotional cognition were found to have a greater effect on performance.
A Structural Equations Model of Job Disengagement from The Constructs of Organizational Justice, Job Satisfaction, Innovation, and Trust In The Era of Industry 5.0	Quantitative	555 Employees of a food industry company	Questionnaire	The findings show that fair workplace culture and job satisfaction have a detrimental impact on employee turnover. However, this effect is not as vital for trust and support for innovation.	Promoting employee well-being must be considered, and recommendations for effective management practices have been provided.
The human role in Human-centric Industry	Review		Review	Industry 5.0 acknowledges the importance of factors beyond employment and economic expansion and strives to create a sustainable source of prosperity by prioritizing environmental preservation and the well-being of its workers. It emphasizes a human-centred approach, placing employees at the core of the industry's innovative processes.	The physical work environment should be tailored to improve worker performance and satisfaction and meet the workforce's specific requirements.
Collaboration Between Humans and Robots in Organizations: A Macroergonomic, Emotional, and Spiritual Approach	Mixed	Three interviews, 363 Romanian IT employees	Multidisciplinary bibliographic study and interview	To maximize the value of the human capital to the organization, a personalized approach must be taken, considering each employee's unique identity and physical, cultural, emotional, psychological, and spiritual characteristics.	Organizations should assess the effects of new technology on humanity and seek sustainable solutions to prevent the dehumanization of employees.
Effects of human-machine interaction on employee's learning: A contingent perspective	Quantitative	319 Employees from 100 artificial intelligence companies	Survey	Giving employees control over their work timing, location, and method likely positively impacts their well-being.	The findings of this research may have important implications for organizations, as they may help inform strategies for optimizing the use of technology in the workplace and ensuring that employees can effectively learn and utilize new technologies.
Basic human needs and robotization: How to make deployment of robots worthwhile for everyone?	Quantitative	4089 Finnish worker	Survey	The study found that worker autonomy is crucial in enhancing well-being in industries undergoing automation, particularly in science, office work, and retail.	The implementation of automation requires careful evaluation and proactive organizational attention to the changes in job responsibilities and potential impact on worker well-being.
Cybergonomics: Proposing and justification of a new name for the ergonomics of Industry 4.0 technologies	Qualitative		Review	Cybergonomics is a field of research that focuses on developing modern wearable and non-wearable technologies for ergonomic purposes (such as cybergonomic devices and assistants) and addressing their potential adverse ergonomic effects.	Cybergonomics has the potential to support Industry 5.0 in realizing its goal of safeguarding workers from the negative impacts of new technologies by establishing guidelines and promoting harmonious interaction between workers and advanced technologies.

Basic Human Needs and Robotization: How to Make Deployment of Robots Worthwhile for Everyone? (Turja et al., 2022): The article focuses on the relationship between basic human needs and the deployment of robots, exploring how to make this deployment beneficial for everyone. The authors argue that the deployment of robots has the potential to improve the satisfaction of basic human needs, such as safety, security, and self-actualization. However, they also acknowledge that this deployment can have negative consequences, such as job loss and reduced social interaction. The authors suggest this to make the deployment of robots worthwhile for everyone. It is necessary to consider the impact of robots on basic human needs. They propose that companies adopt a human-centred approach, considering robots' social and emotional effects on employees and their technical capabilities. The article highlights the importance of considering robots' psychological and social impact on employees, suggesting that companies should work to ensure that robots complement, rather than replace, human workers. The authors propose that companies invest in employee training and development to help workers adapt to the changing work environment and enhance their skills in areas where robots cannot compete. Companies must consider the impact of robots on basic human needs and adopt a human-centred approach that considers both the technical and social implications of this deployment.

Cybergonomics: Proposing and Justification of a New Name for the Ergonomics of Industry 4.0 Technologies (Pouyakian, 2022): This article defines Industry 5.0 as Industry 4.0. The article proposes and justifies "Cybergonomics" as a new name for the ergonomics of Industry 4.0 technologies. The author argues that the traditional field of ergonomics, which focuses on the design and optimization of physical work environments, is not adequately equipped to deal with the challenges posed by Industry 4.0 technologies, such as artificial intelligence, robotics, and the Internet of Things. The author suggests a new approach, Cybergonomics, is needed to address the complex interaction between humans and these new technologies. They define Cybergonomics as the study of the interaction between humans and cyber-physical systems, focusing on the design, implementation, and assessment of the human-centred use of these systems. The author argues that Cybergonomics should concentrate on various issues, including the impact of Industry 4.0 technologies on worker wellness, the development of new technologies that support human needs and capabilities, and the ethical and social implications of these technologies. They suggest that Cybergonomics should be interdisciplinary, drawing on fields such as psychology, sociology, and engineering, to provide a comprehensive understanding of the human-centred use of Industry 4.0 technologies.

The systematic review of the existing literature on employee wellness in Industry 5.0 revealed several key findings. Firstly, emotional intelligence was found to influence workforce performance significantly. Emotional recognition, expression, and direct emotional cognition had the greatest impact. Secondly, organizational justice and job satisfaction negatively affect job dropout. This influence did not, however, have a negative outlook on the factors of trust and support for innovation. Thirdly, the review revealed the importance of considering actions that promote workers' subjective wellness, such as adapting the physical workplace conditions to improve work satisfaction and considering employee identity, with its physical, cultural, emotional, psychological, and spiritual aspects. Fourthly, employee autonomy plays a significant part in employee wellness, especially in fields such as science, office work, and retail trade. Fifthly, robotization calls for careful assessment and organizational attention to the changes in work after robotization and understanding the effects on individual employees' wellness. Finally, the development of modern wearable and non-wearable technologies for ergonomic purposes, defined as cybergonomics, can help Industry 5.0 achieve its goals of protecting the human from the adverse effects of new technologies and providing necessary rules and adaptations for better interaction between the workforce and high technologies.

4. Discussion

This systematic review/analysis of existing literature on employee wellness in Industry 5.0 provides essential insights into the challenges and opportunities facing employees in this new era of work. The results suggest that emotional intelligence, organizational justice, and job satisfaction are key factors that impact employee wellness.

Emotional intelligence has been found to play a significant role in the performance of the workforce, with emotional recognition and expression, as well as emotions that direct cognition, having a greater impact. This highlights the importance of considering the emotional needs of employees and providing them with support and resources to manage their emotions in the workplace.

Organizational justice and job satisfaction were found to have a negative impact on job dropout, suggesting that these factors play a significant role in retaining employees. This highlights the need for organizations to address issues of fairness and justice in the workplace and to create a positive work environment that promotes job satisfaction.

The results also highlight the need for organizations to consider the impact of new technologies on employee wellness. The widespread use of robotics and automation in Industry 5.0 may adversely affect employee wellness. Organizations must understand these effects and explore solutions to mitigate them. This may involve the development of modern wearable and non-wearable technologies for ergonomic purposes, as well as addressing the ergonomic adverse effects of these technologies in terms of Cybergonomics.

In terms of employee autonomy, the ability to decide when, where, and how the job is to be done was found to have a significant impact on employee wellness, particularly in fields such as office work and retail trade. This highlights the need for organizations to provide employees with a level of autonomy in their work and to ensure that work is flexible and adaptable to meet the needs of individual employees.

The review is limited to a systematic analysis of existing literature, which may not include all relevant studies or the latest research in the field. The quality of the studies included in the review may vary, which could impact the accuracy and reliability of the findings. The review does not include the potential impact of other factors on employee wellness, such as work-life balance, job demands, and support from colleagues and superiors. Furthermore, it does not systematically evaluate the effectiveness of interventions aimed at promoting employee wellness in Industry 5.0.

The results of this systematic review provide essential insights into the challenges and opportunities for employee wellness in Industry 5.0. Organizations must take a holistic approach to employee wellness, considering their employees' emotional, physical, cultural, psychological, and spiritual aspects. By considering these factors, organizations can create a positive and supportive work environment that promotes employee wellness and enhances the value of their human capital.

5. Conclusion

The study aimed to systematically review the existing literature on employee wellness in Industry 5.0 to gain a deeper understanding of the challenges and opportunities in this new era of work. The study results provide valuable insights into the factors influencing employee wellness in Industry 5.0, including emotional intelligence, organizational justice and job satisfaction, workplace conditions, employee autonomy, and cybergonomics.

The findings of the review emphasize the importance of considering emotional intelligence in promoting workforce performance and the negative effect of organizational justice and job satisfaction on job dropout. The review also highlights the importance of adapting the workplace physical conditions to improve work satisfaction and considering employee identity, physical, cultural, emotional, psychological, and spiritual aspects.

The review also shows the importance of employee autonomy in promoting wellness in robotization and the potential of cybergonomics in protecting humans from the adverse effects of new technologies and improving the interaction between the workforce and high technologies.

To sum up, the results of this systematic review provide valuable insights into the challenges and opportunities for employee wellness in Industry 5.0, highlighting the importance of considering a range of factors in promoting employee wellness in this new era of work. The study findings have important implications for organizations, policymakers, and researchers in employee wellness and Industry 5.0.

4.1. Implications for Occupational Health Practice

The results of this systematic review have several important implications for organizations, policymakers, and researchers in employee wellness and Industry 5.0. Some of the possible implications include the following:

- Emotional intelligence should be considered an essential factor in promoting workforce performance and should be prioritized by organizations.
- Organizations should prioritize employee wellness and satisfaction. Organizations should consider organizational justice and job satisfaction and adapt the workplace's physical conditions to improve work satisfaction.
- Employee autonomy should be considered in robotization, and organizations should take necessary actions to mitigate any potential adverse effects on employee wellness.
- The potential of cybergonomics should be explored in promoting employee wellness in Industry 5.0. Organizations should consider the development of modern wearable and non-wearable technologies for ergonomic purposes and address their adverse effects.
- Future research should focus on exploring the factors that influence employee wellness in Industry 5.0 in greater detail, including the role of emotional intelligence, organizational justice and job satisfaction, workplace conditions, employee autonomy, and cybergonomics.

4.1.2. In Summary

- The results of this systematic review suggest that emotional intelligence plays a significant role in the performance of the workforce in Industry 5.0.
- Organizational justice and job satisfaction are found to have a negative impact on job dropout, highlighting the need for organizations to address issues of fairness and justice and promote job satisfaction.
- The widespread use of robotics and automation in Industry 5.0 may adversely affect employee wellness. Organizations must consider the impact of new technologies and explore solutions to mitigate these effects.
- Employee autonomy significantly impacts employee wellness, particularly in fields such as science, office work, and retail trade. Organizations must provide employees with autonomy and ensure that work is flexible and adaptable to meet their needs.

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Circular economy in Bosnia and Herzegovina

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ABSTRACT

The degradation of the environment is one of the most urgent challenges today. Since the industrial revolution, we have only known the model of linear economy that deals with the relationship between growth and consumption with the creation of large amounts of waste. As an alternative, a new the concept of the modern economy, the circular economy. The underlying assumptions of such a system are characterized by a tendency towards efficient use, and recycling and re-use of resources as it would limit the negative environmental impacts of the economy, while reducing costs in economic activities with the aim of economic growth. Our goal in this paper is to highlight the role and significance of the circular economy (CE) and natural resources in the process of creation of competitive advantages in a globally connected world as well as in Bosnia and Herzegovina. Our companies have preferred the mass production method of material wealth based on the mass consumption of natural resources as the main economic development method while pursuing high economic growth and maximum economic profit. These days, this economic development method faces various limitations. Many problems, such as mass generation of wastes exceeding the natural purification capacity, enormous damage environment, deepening of natural disasters and global warming, various disputes surrounding natural resources. This analysis highlights that the use of CE tools can help economic policy makers and researchers to take into account the impact on the environment during strategic planning activities and projections of economic growth in BiH.

I. Introduction

The circular economy (CE) is emerging as an alternative to solve various serious problems inherent in traditional economy, because the CE is an economy that guarantees economic development, environmental protection, and social development by satisfying people's demands while maintaining the value and use value of products or parts for as long as possible through various activities including reuse and recycling. In this regard, research on the CE has been deepened in recent years, and in this process, various examples of the CE have been created in various countries, regions, and companies, and various views related to the CE have been raised by various scholars and institutions (Lacy & Rutqvist, 2015). Ideas specific to the CE have appeared since the 18th century. Hans Carl von Carlowitz (1645-1714) was the first who introduced the concept of sustainability, advocating for sustainable use of the forest. John Law (1671-1729) and Richard Cantillon (1680-1734) tried to describe the circular flow of income and expenditure. In 1798, Thomas Malthus, in the work entitled "An Essay on the Principle of Population", pointed out that continued population growth would diminish the world's ability to feed itself. John Stuart Mill (1806-1873) postulated that the economy is governed, in fact, by the laws of nature and not by humans. He believed that it was preferable for the economy to reach a stationary stage that would facilitate the transformation of capitalism into a more humane economic system (Kirchherr, Reike & Hekkert, 2017).

The development of the concept of CE has also involved different approaches to how this type of economy is defined. Thus, the specialized literature contains over 100 definitions regarding the circular economy, focused on key concepts such as sustainable development, the 4Rs (Reduce, Reuse, Recycle, Recover), the systemic approach (micro, meso, macro), the waste hierarchy. It is possible to define the process of CE on different levels: worldwide, specific country, specific industry, and specific company. We would like to show the mechanism through which economic growth leads to environmental degradation and overexploitation of natural resources. (Bringezu, Ramaswami& Schandl, 2017). Starting from the common elements of these concepts, Kirchherr proposed a concise definition of the circular economy: "CE is an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes". This required a shift from the traditional economic development method based on the extraction-manufacturing-use-disposal to a new economic development method that guarantees sustainable development. In other words, the economic growth pattern was recognized as unsustainable in the long run. We shall make a critical review of particular indicators of CE.

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According to the decision of the European Union, the transition to a circular economy is essential in order to ensure a sustainable development, a smart use of natural resources and to prevent dramatic changes of the climate on earth. To evaluate the progress to a circular economy of each country, ten main indicators with different sub-indicators grouped in four areas of economy were established by the European Commission and presented in the European Parliament on 16th January 2018. The area and the corresponding indicators are presented in Figure 1.

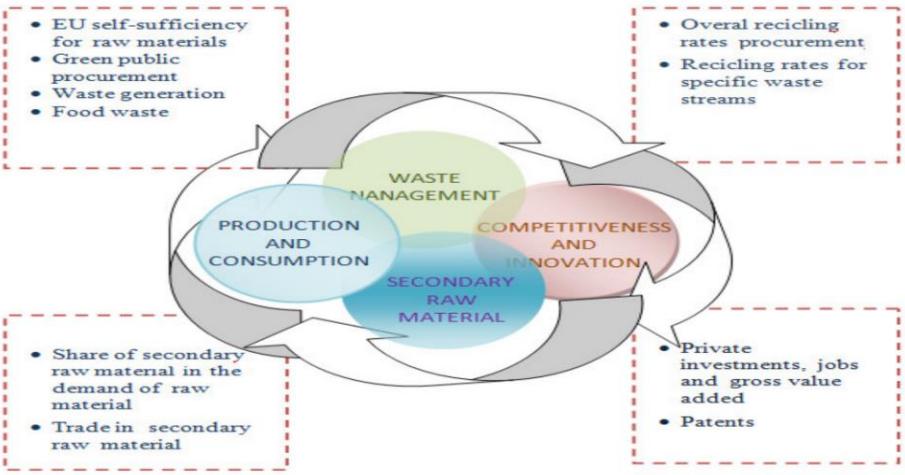

Figure 1. Measuring progress towards circular economy in the European Union.

Driven by the estimated population growth for 9 billion people by 2050, severe anthropological and environmental impacts are taking place, such as the decrease in biodiversity, which worsens the ecological imbalance on a large scale, and the scarcity of raw materials due to the demand extraction by millions of inhabitants, which causes fluctuations in market prices and instability in the world economic system (Arruda, 2021).

CE is based on design of manufactured products with added value and maximum use in longer life cycles; creation of versatile products with different uses, in different periods of their useful life, thus guaranteeing the reuse of a single good; restitution of solid waste to the industrial sector in an orderly manner, where the cost of secondary raw materials from recycling is competitive in the market; as well as a systemic approach to supply chain management, evaluating the interconnections between the energy produced, the extracted material, and the natural environment (Arruda, 2021).

However, there is a lack of consensus on the definitions and terminology of CE in the scientific community and a deformed and dissipated relationship with other concepts in sustainability such as green economy, clean production or industrial ecology (Beveridge & Guy, 2005).

Awareness of the importance of the circular economy exists not only among large but also small and medium-sized enterprises, which is confirmed by numerous scientific papers. Increasingly a set of academic literature have focused upon the role of these individuals as being in the vanguard of a shift to a new form of capitalist development that can help to directly address fears over global warming, climate change and their associated negative environmental impacts (Tilley, 2007). Sustainability entrepreneurs are those who attempt to combine the environmental, economic and social components of sustainability in a holistic manner and are said to have a different organizing logic to more conventional entrepreneurs (Hart, 2006).

Moreover, many of these sustainable entrepreneurs are said to operate their businesses in ways that run counter to popular perceptions of entrepreneurial behavior. In particular, sustainable entrepreneurs seek to use the enterprise as a tool for perpetuating resources involving “whole enterprise design” focused on sustainable development (Parrish, 2006).

2. The green agenda for the Western Balkans

The adoption of the green agenda for the Western Balkans consists of 5 main topics (Kamberović et al., 2020). First, climate change includes regional initiatives to align with the EU’s CLI legislation, preparation and implementation of long-term climate adaptation. Strategies to increase resilience, in particular through investments in climate protection. To implement this strategy, it is necessary to provide technical assistance to Emissions Trading Scheme and fossil fuel alternatives, to explore opportunities for early inclusion of the Western Balkans in EU Emissions Trading and inclusion of the region in the European climate pact and its activities. The clean energy transition will help to align with the EU. Legislation, the development of National Energy and climate plans, the development of water and public schemes for renovation and security of buildings, adequately funded by extending the “wave of EU reconstruction” to the Western Balkans, assistance to partners in the implementation of programs to address energy poverty in the region, joining the Western Balkans initiative “coal regions in transition”, and the assessment of the socioeconomic impact of decarbonization in the region. Smart and sustainable mobility implies the implementation of a regional plan for sustainable development. Transformation of railways, a strategy to increase the capacity of railways and develop new transport models, implementation of EU standards, through the European system management of railway traffic (Ec.europa.eu, 2023). Second, this is an important step towards horizontal changes in waste, recycling, sustainable production, and efficient use of resources and establishing sustainable development policies. It also implies regional improvement of the sustainability of raw material production and joint work on integration into the EU’s industrial wake-up chains. A regional strategy for the circular economy has been developed consumer initiatives, as well as the establishment of a regional agreement on preventing plastic pollution, with a special focus on the issue of marine litter. The European Commission has announced further measures in the EU’s CE action plan.

There will be 101 in 2021 present a number of initiatives, including a review to strengthen basic packaging requirements and reduce packaging and packaging waste, limit intentionally added microplastics and measures for unintentional release of microplastics, as well as a policy framework for bio-based plastics and biodegradable or compostable plastics. In 2021 and 2022 in 2020, the Commission will further present mandatory requirements for the content of recycled plastics and measures to reduce plastic waste for key products such as packaging, building materials and vehicles. Third, to develop and implement an action plan on biodiversity in the Western Balkans. The Balkans by 2030. The restoration of the forest landscape in the Western Balkans, the establishment of biological diversity and their integration into the development of the fight against climate change. Strengthen regional cooperation for the preservation of biodiversity and the implementation of the United Nations Convention on Biological Diversity. The exchange of knowledge between research centers of the Western Balkans and the EU, with the possibility of establishing Information Centre for biodiversity in the Western Balkans (Stefan, 2015).

Fourth, this includes the development of a regional strategy for air quality and the implementation of BAT according to the Industrial Emissions Directive. In the fight against regional it was agreed to carry out accreditation of air quality monitoring networks and to include the region in pan-European networks. It is planned to modernize the water and wastewater monitoring infrastructure as well as regional implementation of water and wastewater regulations through a common cooperation cycle on the prevention of cross-border pollution. There are also planned development infrastructure projects for waste and wastewater management (Topliceanu, 2023).

Fifth, initiatives for regional harmonization of agri-food and primary production sectors with the EU and food safety standards have been established health and well-being of plants and animals. Improving health care throughout the day food chain and labelling of food products in accordance with the food safety regulations. Support to improved consumer information and the movement of organic food through the promotion of organic and organic agriculture reduce the use of synthetic chemicals. In this process, collaboration is key between scientific and educational institutions and producers and processors in the agriculture-food sector and promotional actions to reduce waste in rural and coastal areas (along roads, in rural rivers). The common development initiative for sustainable development of rural areas through improvement of rural infrastructure within IPARD. In the famous concept of "planetary limits" presented by Stefan et al. (2015), The large use of fertilizers based on nitrogen and phosphorus in agriculture leads to exceeding the planetary limit of "biochemical fluxes", contributing to the eutrophication of aquatic ecosystems and the associated loss of biodiversity. In addition, fossil fuels continue to play a dominant role in the production of fertilizers and energy use in agriculture, thus contributing to climate change (European Commission, 2022).

All financial grants so far have focused on the process of alignment with the EU acquis in accordance with the requirements of Chapter 27 and climate change. IPA III pre-accession financial instruments a dedicated financial framework for the implementation of the green agenda and sustainable connected and digital transformation of 14 billion for the period from 2021-2027. In 2018, Europe produced around 61.8 million tons of plastic, which represents 17% of world production. Packaging with a share of 40% and construction with a share of 20% represent by far the largest end-use markets (Tatić et al., 2020).

3. The current state of the economy in BiH

Bosnia and Herzegovina is an upper middle-income country which has accomplished a great deal since the mid-1990s. Bosnia and Herzegovina is a small and open economy, dominated by services, which accounted for 55% of GDP in 2021, with a moderately developed industrial and manufacturing sector (23% and 12%, respectively), and a limited agricultural base (about 6% of GDP). The gross domestic product (GDP) in Bosnia and Herzegovina was 23.37 billion US dollars in 2021, according to official data from the World Bank. The GDP value of BiH represents 0.01 percent of the world economy. The economy of BiH expanded by 2.6 percent in the 2022. BiH, through strategic documents, strives to improve competitiveness national economy, digitalization and a better social environment in line with global and European policies. However, the ways and the period for achieving these goals are not yet sufficiently harmonized and synchronized with each other (Işık et al., 2023; Džafić, et al., 2018).

Bosnia and Herzegovina is on an path from a middle-to high-income country while achieving greater social harmony. On this path, it is also committed to full integration into the European Union, which seeks to become the most dynamic and competitive, knowledge-based economy in the world, and to place itself at the center of the globalized world without remaining sideways to it (Džafić et al., 2018). Based on the current situation and respecting the element of the Lisbon strategy, BiH development policies focus on strengthening the role of knowledge and innovation, completing the internal market and strengthening growth and employment for greater social coherence. By doing so, they contribute to improving competitiveness, i.e., fulfilling the economic conditions for becoming a member of the EU society and better positioning themselves globally. BiH is now a partner in the stabilization and association agreement. At the heart of the consensus is the recognition of three dimensions: environmental, economic and social, which must be viewed with equal consideration in local, regional and national sustainable development strategies as well as international agreements reached under global governance to achieve sustainable development. The fourth strategic goal of the development strategy is sustainable development (Tatić et al., 2006).

4. Establishing functional institutional capacity for agriculture and Rural Development

Insufficient institutional building, lack of accredited laboratories and low level of professional education is a group of weaknesses that are listed in the SWOT analysis and have a common denominator in the non-existent or existing but unenforceable institutional infrastructure that poses serious obstacles to the normal functioning of the sector. The problem is that there is a general lack of institutional capacity for development in BiH. The lack of institutional support at all levels has continuously undermined the competitiveness of the agricultural and food sectors, resulting in a constantly increasing trade deficit in foreign trade in primary and processed agricultural products. The establishment of functional and responsible institutional capacity for agriculture and rural development would certainly lead to the improvement of this situation (Džafić, 2014). The lack of effective management and intuitively supported structures, combined with inadequate staff in key functions, hinders the competitiveness of the agri-food sector in BiH. The measures of the priority area will strengthen the general coordination of capacities at the state level and enable gradual harmonization of the policy and support measures needed to meet the conditions for membership in the EU and the WTO.

4.1. The improvement of competitiveness fully takes into account the economic structure of BiH, in which agriculture and forestry and land.

Due to the poor economic and social situation, farms are not able to provide sufficient resources to modernize production on their own. Production is also less efficient and human resources are less used. With better equipment and modern machinery, it is possible to raise the level of production technology and significantly better manage production costs through a combination of production factors on the farm and manage the quality of the product that is directly dependent on the time needed to perform certain work operations. Small and medium-sized farms are the main obstacles to improving the competitiveness of agricultural production. In addition, knowledge of the characteristics of land profiles and agroclimatic characteristics of the territory would enable a more systematic approach in the planning of agricultural production. To achieve this, it is necessary to develop a project of digitalization of the Land Information System. Many existing processing capacities, in addition to providing the raw material base, require significant investments in the renewal and modernization of production technology and marketing. Several processing capacities must comply with EU standards when it comes to food quality and safety (Džafić, 2015). Processing capacities represent a significant potential for employment of labor force in rural area and development of small and medium-sized entrepreneurship. One of the main weaknesses of the agricultural sector is characterized by an unorganized market of agricultural products, a purchase system, a small volume of production and an unprotected position of agricultural producers in the face of competition.

4.2. Using renewable and non-renewable natural resources to ensure sustainable development

Renewable and non-renewable resources should be used in such a way that the total capital of the company is increased. By using renewable natural resources, natural capital is not reduced, and created capital (public and private) is increased, people are employed, and the quality of life is increased. The use of non-renewable resources consumes natural capital (e.g., available mineral wealth), but the created social capital would have to provide the preconditions for sustainable development –even when non-renewable resources are exhausted. So, before exhaustion, a replacement must be provided. Resources that are not used are worthless –this in fact shows the inability of the community to design its own development and take appropriate measures to make optimal use of all available resources. The measure is necessary in order to eliminate the identified weaknesses and non-harmonized work of all institutions at the level of BiH, entities, FBiH cantons and municipalities. Due to underdeveloped and weak capacities, as well as corruption, both domestic and foreign investors are discouraged for any ventures aimed at using renewable and non-renewable natural resources. Examples are numerous, so BiH is among the last in the world by many parameters, e.g., by using hydropower potential, irrigation of agricultural areas for the production of high-quality food, etc. The laws on concessions in the field of the use of natural resources and renewable energy sources are mostly applied without developed strategic documents, plans and programs, but this is discussed in more detail in the "improvement of skills in the labor market, vocational education and training" most often responds to the own-initiative offers of investors, and most often intermediaries, or tenders are announced completely unprepared.

4.3. Meeting and increasing the mobility of goods and people, and contributing to overall sustainable social and economic development

It is necessary to increase the performance of the work in terms of better planning of project implementation, more efficient work and significantly increase the results of road construction. Reforms, which are often a condition of the use of financial resources, met in time with the preparation of projects, especially in the railway sector. In determining the priorities for reconstruction and modernization, the degree of greater economic and financial cost-effectiveness and the resolution of transport problems, such as the use of river and rail transport, which are currently very neglected. Mobile capacities in some modes of transport, such as rail, air and water transport are in very poor quality and capacity. It is necessary to increase the capacity and modernize the mobile capacity. Some arrangements have already been made, such as leasing and recapitalization in air transport, and contracted tilting trains. The regional agreement on the joint development of the basic transport network of Bosnia and Herzegovina wide range of standards and directives. Establishing a transport community between the EU and the countries of Southeast Europe, which is under way, will increase BiH's obligations in this regard. All current agreements primarily require regional cooperation and joint development of transport, where BiH must not lag, because joint development and cooperation in time mean mutual competition. Existing transport does not meet the social and economic needs as it does in developed European countries, and therefore great efforts are needed to increase the functionality and cost-effectiveness of transport.

5. Conclusion and policy recommendations:

A linear economy, one that has dominated for more than two centuries, based on representatives of classical political economy (Smith, Ricardo, Petty) until recently rested on faith in the unlimited resources and environment, and was unaware of its environmental impact. It took a kind of crisis, resource depletion and climate change to finally understand and acknowledge the inefficiency and baselessness of the existing management model. The solution to these problems is the circular economy. The European Union has taken on the task of a complete exit from the linear, and transition to a new economy. The circular economy not only seeks to recover resources, but it is also fully in line with nature. Nontheless to succeed, it needs the common strengths of all people, as well as the activities of policymakers, industries, and citizens. She is more and more aware of her potential, and her the effectiveness is confirmed by numerous examples from practice. In the near future, BiH, also as a future member of the EU, will have to transition to a circular economy.

Unfortunately, there is still not enough talk about the circular economy at the BiH level. Therefore, education and awareness of citizens will be the main prerequisite for the transition to the new economy, as well as investments. In addition to the lack of understanding circular economy, there is also the problem of waste, i.e., non-recognition of waste as a valuable resource, which is the main and first setting of the circular economy. However, in BiH, certain regulations, laws and strategies are adopted, as well as new policies in accordance with the principles of the circular economy that will enable economic growth and development.

The basic recommendation for the creators of economic policies is that key changes should be accompanied by strong support from the authorities through defined work priorities, taking into account the adoption of strategic documents related to the promotion of the circular economy. In the transition period, it will be necessary to redefine priorities, introduce legal norms in BiH harmonized with EU norms. It is necessary to actively monitor regulations from the EU policy area in the context of CE, and especially focus on the activities of EU policies regarding the coherent framework of production policies and their contribution to CE. Also, it is important to monitor the use of the best available techniques in the context of CE, and to actively raise the capacities of the BiH economy for the transition to the CE model.

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