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EXPLORING THE NEXUS OF MACROECONOMIC FACTORS AND FINANCIAL RATIOS: A HOLISTIC ANALYSIS OF COMPANY PROFITABILITY IN DEVELOPING MARKETS

Araştırma

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Dilek Yomralıoğlu, İstanbul Medipol Üniversitesi Yönetim ve Strateji Doktora programında tez sunum aşamasındadır. Özel sektörde yirmi yılı aşkın bir süredir finansal alanda yöneticilik deneyimine sahiptir. Finansal stratejiler ve finansal yönetim alanlarında araştırmalar yapmaktadır. Bu makale doktora tezinin bir bölümünden üretilmiştir.

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Abstract

Purpose of the Study: The primary objective of this document is to find out the patterns among macroeconomic factors, related indexes (as external variables), financial ratio indicators (as internal drivers) that had impact on company's profit with a holistic approach. This research also aims to clarify the threshold values and the margin of these variables to achieve profit for the listed manufacturing companies which are registered to BIST (Istanbul Stock Exchange) and operating in food, chemistry, and metalware sectors. The companies which have net profit margin greater than zero are taken into the pool of investigation for the period from June 2007 to December 2022.

Methodology: The study utilized supervised machine learning algorithms on KNIME Analytics Platform (The Konstanz Information Miner). A successful model has been achieved by using Random Forest Learner and Gradient Boosted Trees Learner Algorithms.

Findings: Ten prominent rules have been extracted by Random Forest algorithm to predict profit/loss probability of companies.

Practical implications: The findings derived from this study have direct relevance for decision makers by formulating the values of variables in different combinations to earn profit. Besides, the threshold values of the financial indicators which deepens our knowledge of the internal and external factors is expected to provide a better insight on the markets of developing countries.

Originality/Value: Previous studies are mostly concentrated on the relationship of two or three macro variables with the chosen financial ratios of the companies. Besides a few studies were conducted on the markets of developing countries and if not none of them, very few of them have employed machine learning algorithms. This study aims to show what direction the variables play a role on company's profit with a holistic approach. The diverse combination of the values of independent variables to generate profit will be evaluated with their threshold values under the country specific conditions of the markets.

Keywords: Profit, Macroeconomic, Financial Ratios, Manufacturing Companies, Machine Learning.

JEL Classification: C81, G01, G10

MAKROEKONOMİK FAKTÖRLERLE FİNANSAL ORANLAR ARASINDAKİ BAĞLANTI: GELİŞMEKTE OLAN ÜLKELERDE ŞİRKET KARLILIĞININ BÜTÜNSEL ANALİZİ

Özet

Çalışmanın Amacı; Bu çalışmanın temel amacı, şirket karlılığına etki eden makroekonomik faktörler, ilgili endeksler (dışsal değişkenler olarak), finansal oran göstergeleri (şirket içi değişkenler olarak) arasındaki örüntüleri bütüncül bir yaklaşımla ortaya çıkarmaktır. Bu araştırma aynı zamanda BİST'e (Istanbul Menkul Kıymetler Borsası) kayıtlı gıda, kimya ve metal eşya sektörlerinde faaliyet gösteren borsaya kote üretim şirketlerinin kar elde edebilmesi için bu değişkenlerin alacağı eşik değerleri ve marjlarını netleştirmeyi amaçlamaktadır. Araştırma kapsamına Haziran 2007-Aralık 2022 döneminde net kar marjı sıfırdan büyük olan şirketler alınmıştır.

Metodoloji: Çalışmada KNIME (The Konstanz Information Miner) Veri Analiz Platformu üzerinde denetimli makine öğrenmesi algoritmaları kullanılmıştır. Rastgele Orman ve Gradyan Artırma algoritmalarıyla başarılı bir model sunulmuştur.

Bulgular: Rastgele Orman Algoritmasıyla şirketlerin kar/zarar etme olasılığını tahmin etmeye yönelik on belirgin kural elde edilmiştir.

Uygulamaya yönelik sonuçlar: Bu çalışmadan elde edilen bulgular, karar vericilerle doğrudan bağlantılı olacak şekilde, kar elde etmek için değişkenlerin değerlerinin farklı kombinasyonlarını sunmaktadır. Ayrıca, finansal göstergelerin eşik değerlerinin elde edilmesiyle iç ve dış faktörlere ilişkin bilgilerimizin derinleştirilmesi ve gelişmekte olan ülke piyasalarının daha iyi anlaşılması beklenmektedir.

Özgünlük: Önceki çalışmalar çoğunlukla iki veya üç makro değişkenin seçilen şirket finansal oranlarıyla ilişkisi üzerine yoğunlaşmıştır. Ayrıca, gelişmekte olan ülke piyasaları üzerine yapılan çalışmalar oldukça azdır ve bunların yok denecek kadar azında makine öğrenimi algoritmaları kullanılmıştır. Bu çalışma, bütüncül bir yaklaşımla değişkenlerin şirket karı üzerinde ne yönde rol oynadığını göstermeyi amaçlamaktadır. Kâr elde etmek için bağımsız değişkenlerin değerlerinin farklı kombinasyonları, ülkeye özgü piyasa koşulları altında eşik değerleri ile birlikte değerlendirilecektir.

Anahtar Kelimeler: Kar, Makroekonomi, Finansal Oranlar, Üretim Şirketleri, Makine Öğrenmesi**.**

JEL Sınıflandırması: C81, G01, G10

INTRODUCTION

Manufacturing companies are recognized as key drivers of wealth and growth of an economy. During manufacturing process companies are faced with technological advances, innovation, dynamic conditions, changing customer requirements, globalization, high competition, and market uncertainty that induce a large amount of complexity. Managing the complexities is a strategic issue for companies to survive in the long run (Issah & Antwi, 2017). Risk managers and company authorities are expected to investigate the effect of internal and external factors on performance in a multidimensional way to predict the direction of future earnings. When businesses are aware of these factors, they may reduce the negative effect of these issues on future profitability and cash flow. Profitability and maximizing the owner's wealth is one of the most important purposes of management. It is also the main goal of the companies in terms of sustainability of business (Bjørnbet et.al., 2021).

Ratio analysis is a tool used in the evaluation of company performance to predict corporate failure or future profitability and growth potential (Issah & Antwi, 2017). External factors also gain importance with globalization since prediction becomes more difficult for decision makers. Unsustainable consumption and production patterns put the manufacturing companies at the heart of these challenges. Hence, holistic approaches are needed for installing adaptable strategies and designing right components for the company to generate profit (Bjørnbet et.al., 2021). For quantifying the effects of internal and external factors, it is necessary to identify the driver-based data set to achieve profit.

Many studies have been conducted on the drivers of profit by considering the internal firm specific issues and uncontrolled macroeconomic environmental changes. (Lee et.al., 2023; Dewi et.al., 2019; Issah & Antwi, 2017; Rehman et.al., 2021) emphasize the necessity of clarifying prominent drivers of profitability due to diverse country specific factors and dynamics. Most of them are focused on the negative or positive relationships between these variables. In this study, the combination of external variables and financial ratio indicators by finding out the threshold values for generating profit has been investigated. The internal variables are receivable turnover, average receivable collection period, stock turnover, average inventory period, current asset turnover, acid-test ratio, current ratio, cash ratio, leverage ratio, cost of goods sold/sales. The external variables are USD/TL and Euro/TL average selling exchange rate, economic growth rate, monthly production price index on 12 months basis, monthly % difference in production price index, monthly consumer price index on 12 months basis, monthly % difference in consumer price index, unemployment rate, USA unemployment rate, real sector confidence index, consumer confidence index, monthly return of stock exchange market, consumer energy price index, political stability index, Ons price of gold as USD, TL commercial loan interest, USD commercial loan interest. The study is conducted on the manufacturing companies in the food, chemistry, and metalware sectors registered to the Istanbul Stock Exchange in Turkey for

the years Jun. 2007 to Dec. 2022; Random Forest Learner and Gradient Boosted Trees Learner that are the supervised learning algorithms of machine learning, have been used on KNIME Analytics Platform. Prominent rules for predicting profit/loss probability of the companies have been obtained. The manuscript covers internal and external drivers of company performance and a summary of ratio analysis indicators. Then a literature review, method and findings will follow. The last part will be the conclusion. The findings are promising to provide new ways for decision-makers by adjusting the financial strategies parallel to the changes in external factors of emerging markets.

THEORETICAL FRAMEWORK AND DRIVERS OF PERFORMANCE

Both micro and macro-economic factors affect the performance of a company. Microeconomic factors such as production line and its components, company specific structure, implemented strategies can be mostly controlled by the company's management. However, it is difficult to forecast the changes in external environment and other conditions. Macroeconomic factors such as unemployment rate, interest rate, economic growth rate, regulation changes, etc. are beyond the control of companies and it is difficult to predict heterogeneous effects of these variables on future company performance (Pervan et al., 2019).

Theoretical Framework

There are two approaches on the determinants of company performance: One of them is the 'resource-based theory' which claims that internal resources and factors drive the competitiveness and profitability of the company. This approach suggests that companies should match their existing valuable, rare, inimitable, and non-substitutable resources to requirements of the business activities in the market (Giustiziero et.al., 2023). Barney (1991) concludes that small differences between the companies can explain the performance differences among them. Small differences may create big value and has a positive impact on performance. Otherwise, all companies reach the identical resources and extent their performance with the similar strategies (Egbunike and Okerekeoti, 2018). Kogan, L. and Tian, M.H. (2012), include firm size, leverage, liquidity, asset growth and turnover into internal characteristics of the company besides ownership structure, age, and managerial abilities. Porter (1997) within the field of strategy, suggests that external factors are more important than firm-specific factors which is called as 'system theory'. According to 'system theory,' internal resources are based on the analysis of external factors. Globalization has also amplified the relevance of external elements. The Asian Financial Crises and the Global Financial Crises have even taken more attention to the external factors that affect company's performance since The Global Financial Crisis began in the USA had comprehensive influence on economies around the world (Cheong and Hoang, 2021). Our study investigates the effect of external factors on company's profit based on the 'system theory' and how internal factors differentiate the profitability condition of the company based on 'resource-based theory'.

External Drivers of Profit

The transformation in economic activity within a nation can influence the company's performance in both ways. During periods of economic growth, it is expected that the company will increase its sales due to increasing demand of good and services. The increased demand can positively affect companies, leading to higher sales volumes and potentially increasing revenues. On the contrary, unfavorable economic conditions like recession, global crises, demand fluctuations may deteriorate the company's performance. As demand decreases, companies may experience lower sales volumes and subsequently reduced revenue. This can lead to decreased profitability and financial instability. Companies may delay or cancel capital expenditure projects, such as expanding facilities or upgrading technology, during periods of economic uncertainty. This can impact future growth potential (Pervan et al., 2019)**.** It can be said that Gross Domestic Product Growth is the sign of economic state of a country and expected to have positive effect on profitability. Gross Fixed Capital Formation is one of the mechanisms that creates wealth. Gross Fixed Capital Formation comprises public and private sector activities (Ekren et.al., 2020). Another important macroeconomic factor is inflation rate which dominates the increase in the price level of an economy. It is negatively correlated with company profit because it reduces the total demand amount and raises the corporate borrowing costs or interest expenses (Cheong & Hoang, 2021). The measure of inflation relies on price index as Consumer Price Index (CPI) and Producer Price Index (PPI). CPI shows the price changes of daily life commodities and services. PPI shows the manufacturing inputs and consumer goods distributed by industrial enterprises (Özpolat, 2020). Unemployment rate is also the sign of economic development. Increasing unemployment rate will have a negative impact on social, political, and economic stability. When unemployment is low, it suggests that a significant portion of the workforce is employed, which can lead to increased consumer spending, higher tax revenues, and overall economic growth. Unemployment can lead to reduced consumer spending, as unemployed individuals have less disposable income. This reduction in spending can negatively affect businesses and further exacerbate economic challenges, creating a cycle of decreased demand and business contraction. The unemployment rate is a crucial economic indicator with wide-ranging implications. It is not only a measure of economic development but also a reflection of social well-being and political stability. Efforts to address unemployment can have positive effects not only on economic growth but also on the overall quality of life and stability within a society (Gustriansyah et.al., 2023). When economic or political stability is threatened, gold may offer a reliable harbor from other financial assets such as bonds, exchange rates, etc. In some cases, volatility of financial instruments may increase demand for gold as an investment instrument. Therefore, gold price is a topic that has been extensively examined in the realm of international finance (Beckmann et.al., 2019). Energy Prices have taken the consideration of researchers recently since it is transmitted from one market to another. When the price of a commodity has a relationship with the price of another, it is possible to have more accurate planning in a global context. Changes in energy prices can trigger a chain reaction that affects costs,

production, and prices in other commodity markets. Changes in energy prices due to factors like geopolitical events or supply disruptions can lead to increased volatility in other markets. Decision makers need to understand how the price of one commodity can affect the other via different channels. Energy Prices are correlated with most of the commodity prices and prediction of an increase in energy prices may affect the future pricing of another commodity (Kırıkkaleli & Güngör, 2021). Surveys are also widely used in prediction assessments. Real Sector Confidence Index for Turkey has questions providing qualitative information on the current situation and future expectations for a period (Oral & Tuncel, 2014).

Salient Ratios for Assessing Financial Performance

Financial performance is a key indicator of a company's ability to generate profits and create value. Analyzing financial statements through ratios provides valuable insights into different aspects of a company's operations and financial stability. Financial performance reflects how effectively and efficiently a company is operating to generate profits. Profitability is a core aspect of financial performance, indicating the extent to which a company's revenue exceeds its expenses. Financial statements, including the balance sheet, income statement, and cash flow statement, provide essential data for assessing a company's financial performance. These statements offer a snapshot of the company's financial health and performance over a specific period. Ratios are tools used to analyze various financial aspects of a company. They involve comparing different financial data points to gain insights into a company's performance and trends. Ratio analysis is not just about assessing current performance; it can also help predict a company's future financial health. By identifying trends and anomalies in financial ratios over time, analysts can anticipate potential financial issues or opportunities well in advance. It can also provide early indications of financial distress or potential bankruptcy. By monitoring specific ratios and identifying significant deviations from industry norms or historical trends, stakeholders can take corrective actions to prevent financial deterioration. It is essential for stakeholders, including investors, creditors, and management, to understand these ratios and use them as part of their decision-making process. Different categories of ratios provide information about liquidity, leverage, activity, profitability, and market value. Liquidity ratios assess a company's ability to meet its short-term obligations. These ratios are acid-test ratio (quick ratio), current ratio and cash ratio. The current ratio considers all current assets in relation to current liabilities. The acid-test (quick) ratio excludes inventories due to their potential difficulty in converting to cash quickly. The cash ratio focuses solely on cash in relation to short-term obligations, which is especially relevant in uncertain economic conditions (Lee et.al., 2023).

Profitability can be evaluated through various ratios like gross profit margin, operating profit margin, and net profit margin. Leverage ratios, also known as solvency ratios, evaluate a company's financial leverage or the extent to which it relies on debt financing. Leverage shows company’s long-term stability and its capacity to repay long-term debt. These ratios are typically calculated as debt-to-

equity ratio or debt-to-asset ratio. A higher ratio could imply higher financial risk. Activity ratios which are also known as efficiency ratios, measure how effectively a company utilizes its assets to generate sales and revenue. Inventory turnover, fixed assets turnover, receivable turnover, and total assets turnover. These ratios provide insights into how effectively a company's assets are being used to drive revenue (Lee et.al., 2023).

Profitability ratios may evaluate a company's ability to generate profits from its operations. Key ratios include profit margin, which indicates the proportion of sales converted into profit, and return on assets (ROA) and return on equity (ROE), which assess how effectively assets generate profit. Market value ratios relate to a company's stock prices on the stock exchange. These ratios reflect factors such as the company's risk, management quality, and other company-specific attributes that are reflected in its stock prices. Market value ratios are not considered in this study as our focus is on the drivers of profit.

Cost of goods sold (COGS) is a critical factor for manufacturing companies as it directly impacts their ability to predict profits. Manufacturing companies are systems that transform inputs into outputs, with the goal of generating higher output value compared to input value for profitability. COGS affects both sales and profitability by influencing selling prices based on input values (Dewi et.al., 2019).

Literature Review

Financial hardship is a widespread concern in the corporate realm, prompting scholars in the domains of finance and economics to delve deeply into this subject in their academic inquiries and writings. Some studies found that macroeconomic variables have significant effect on company’s performance.

Issah and Antwi (2017), studied on 116 listed UK companies for the period 2002 to 2014 excluding financial companies and it is found out that company performance is related to prior year’s ROA and macroeconomic variables. Doruk (2023) focuses on the Turkish manufacturing sector's performance. The main objective is to understand how certain macroeconomic factors impact the sector's performance for the period from 2006 to 2017. The findings suggest that four macroeconomic factors investigated in the research are interconnected and changes in one can have ripple effects on the others, shaping a country’s economic performance and position in the global economy. The result shows that these factors have a prominent effect on the manufacturing sector in Turkey during the specified period. Rehman et al. (2021) present a similar analysis of Pakistan. The study investigates the impacts of key macroeconomic factors on the financial performance of sugar mills in Pakistan. The researchers utilized ten years of panel data from 2010 to 2019 and examined a range of macroeconomic variables, including the rate of interest, GDP growth, inflation rate, and foreign direct investment, in relation to the financial performance of twenty-nine sugar mills listed on the Pakistan Exchange (PSX). The analysis was conducted using a multivariate analysis model. The findings of the study indicate a negative association between certain macroeconomic indicators and the return on

assets (ROA) of the sugar mills. Specifically, it was found that GDP growth, interest rate, inflation rate, and foreign direct investment had a negative impact on the Return on Assets (ROA) of the sugar mills. The implications of these results suggest that macroeconomic factors, such as the rate of interest, inflation rate, and GDP growth play a significant role in influencing the financial performance of sugar mills in Pakistan.

Almansour et al. (2021) investigates the effect of inflation on the performance of the banking sector in Jordan. The study focused on five Jordanian banks that are recorded on the Amman Stock Exchange, and the data spanned from 2009 to 2019. The researchers employed a quantitative approach, specifically regression analysis, to analyze how inflation affects various aspects of the banks' performance, including return on assets, return on investment, and net interest rate. The findings of the study reveal a significant and negative correlation between the rate of inflation and the performance of the banking sector. In other words, higher inflation has an adverse impact on the financial well-being of the banking institutions operating in Jordan, under investigation but Zulfiqar and Din (2015) have adverse result for their study which explores the impact of macroeconomic factors on the performance of Pakistan's textile industry. The study found that inflation and interest rates have a significant and positive impact on the Return on Asset (ROA) of the textile industry in Pakistan. This suggests that as inflation and interest rates increase, the industry's performance in terms of ROA also improves. On the other hand, the study revealed that the interest rate has a substantial and favorable influence on Return on Equity (ROE) for the textile industry. This implies that higher interest rates are associated with better performance in terms of ROE unless the inflation rate is kept in single digit for overall economy.

Some researchers conducted investigations by concerning the internal factors of the companies and diverse results are obtained since companies operate in diverse industries and regions, and they may be exposed to different competitive pressures, regulations, consumer behaviors, and economic conditions. These contextual differences can lead to variations in the impact of internal factors on performance as mentioned below.

Sahoo and Bishnoi (2023), found that higher leverage rate had slowed the investment rate in the construction, mining, and service sectors, owing to elevated interest expenses and a rise in retained earnings. Yuliastari et.al. (2022) had a study on thirty-six firms in consumer goods sector registered to Indonesia Stock Exchange during the period 2014-2018. The research finding shows that current asset turnover, asset turnover, and cash flow to total debt have an impact on financial distress. Madushanka and Jathurika (2018) searched for the variables that affect profitability of manufacturing companies. The research was generated on fifteen manufacturing firms registered to the Colombo Stock Exchange for the period from 2012 to 2016. It is concluded that quick ratio is positively related to profitability. Ningsih and Sari (2019) unlikely searched for the effect of financial ratios on company value for the listed companies in automotive and component sub sectors. The result shows that

liquidity and debt to asset ratio do not affect the value of the company but ROA has s significant positive effect on company's value. A joint test shows that liquidity, solvency, and profitability affect the value of the company by 42.1% and the left portion is influenced by other variables which are not used in the study.

Some researchers adopt a comprehensive approach to firm performance by considering a combination of macroeconomic factors, financial ratios, and firm-specific characteristics. This approach recognizes that a multitude of internal and external factors can collectively influence a company's performance.

Egbunike and Okerekeoti (2018) searched for the interrelationship between macroeconomic factors and firm characteristics on Nigerian manufacturing companies. They observed that integrating macroeconomic factors, financial ratio analysis, and firm characteristics provides a well-rounded perspective on firm performance in developing countries. Alomari and Azzam (2017) also investigated the influence of micro and macroeconomic variables on ROA of 24 listed Jordanian insurance companies. According to findings, liquidity and leverage have a negative, size of the company, market share and GDP have a positive effect and inflation has no significant influence on the financial well-being of the Jordanian insurance firms. Widagdo et al. (2020) focused on analyzing the relationships between financial ratios, macroeconomics, investment risk, and Sharia stock returns. The study utilized a sample of twenty-nine companies listed on the JII (Jakarta Islamic Index) and covered a 5-year period ending on December 31, 2018. The study found that financial ratios have a significant impact on Sharia stock returns and investment risk. This implies that a company's financial performance, as reflected in its ratios, can influence the returns that investors receive, and the level of risk associated with their investments. Arilyn's research focused on financial distress in 2020 which aims to analyze the factors that affect the financial distress of agriculture companies registered to Indonesia Stock Exchange. The study considers various financial ratios that provide insights into the financial health and performance of the agriculture companies. Analyzing these ratios can help identify patterns that might signal financial distress. The research also focuses on macroeconomic variables that could impact the performance of agriculture companies. The research period is between 2013 and 2018. The study found that among the financial ratios examined, only the current ratio had a significant impact on the financial performance of the agriculture companies. The identification of the current ratio as a predictor of financial distress suggests that liquidity plays a crucial role in the financial health of these agriculture companies. The study also found that there was no significant influence of the debt-to-equity ratio and net income to total asset ratio on the financial distress of the agriculture companies in the studied context offers important insights into the financial dynamics of these companies. The research examined the impact of macroeconomic variables, specifically the gross domestic product (GDP) and the Indonesia Composite Index, on the financial distress of the agriculture firms. The investigation did not uncover a noteworthy correlation between these macroeconomic factors and financial distress. Overall, the findings suggest that in the specific context

of agriculture companies registered to the Indonesia Stock Exchange, the current ratio is a relevant indicator for predicting and assessing financial distress. Brunnermeier et.al. (2023), observed micro and macro data from the German inflation of 1919-1923 which highlights the effects of inflation on German economy. It is found that inflation led a reduction in debt burdens, decline in interest expenses, increase in equity values and higher employment during the inflation.

Although authors have used some statistical techniques and models to extract correlations or patterns, very few of them have employed machine learning algorithms. Our study differs from the previous research since the research method will show the threshold values of the financial indicators. Additionally, it can predict the combined values of the independent variables for generating profit, considering both internal and external profit drivers through a holistic approach.

METHODOLOGY

In the modern business landscape organizations are dealing with massive amounts of data. The process of extracting relevant and valuable information from this data plays a crucial role in decision-making across different levels of management. Decision-makers rely on data-driven insights to make informed choices that impact various aspects of the organization's operations, strategies, and goals. Various information systems are used to support decision-making process such Expert Information Systems (EIS) which provide strategic information to top management, facilitating complex decision-making and Management Information Systems (MIS) that generate regular reports, summaries, and ad hoc queries to support tactical decisions, Decision Support Systems (DSS) which assist managers at all levels with interactive tools for analyzing data and making decisions (Silahtaroğlu & Alayoğlu, 2016). Predicting future trends related to a company is especially important for decision-making process in the world of investment and business. This process involves analyzing various factors, such as financial performance, market trends, competitive landscape, technological advancements, and more, to make efficient decisions about where to allocate resources. Artificial intelligence (AI) has gained substantial attention in this context due to its potential to enhance prediction accuracy and reduce uncertainty. AI can help in constructing and optimizing investment portfolios based on desired risk levels and return objectives. It can consider a wide range of variables and constraints to suggest optimal allocations. AI models can reduce uncertainty to simulate various scenarios to help investors understand how different factors could impact a company's performance or the market in areas such as economics, policies related to the economy, innovation, and the practice of efficient management. To increase the likelihood of earning a profit and to analyze multitude of variables for investment decisions, machine learning can offer crucial assistance (Ferrati and Muffatto, 2021). Data mining algorithms are mostly used for bankruptcy predictions, credit risk analysis and financial distress predictions due to its clustering and prediction success. Çöllü et.al. (2020), conducted research on twenty textile companies to find out the prominent factors of financial distress by using the decision

tree algorithm. By clustering the unsuccessful companies, the clustering algorithm predicted the unsuccessful companies by %97.6 accuracy.

This study conducts a quantitative research based on the half year financial reports of the manufacturing companies in food, chemistry, and metalware sectors for the period from June 2007 to December 2022 by using KNIME Analytics Platform. Ninety companies are investigated in total. The dependent variable or class is net profit margin (Net Profit/Sales) which is greater than 0. The companies that have net profit margin greater than zero marked as 1 for the related period. Independent variables are financial ratios, macro-economic variables and indexes which are suggested that may have a relation with macro-economic variables or factors. Financial ratios are chosen as acid-test ratio, cash ratio, current ratio, leverage ratio, financing ratio, receivable turnover, stock turnover, average days of receivable collection, stock period (as days), asset turnover, cost of goods/sales ratio. Macro-economic variables are, USD/TL exchange rate, Euro/TL exchange rate, monthly % increase in USD/TL, growth rate, monthly production price index, monthly consumer price index, monthly unemployment rate, USA unemployment rate, consumer confidence index, real sector confidence index, monthly stock market return per cent, consumer energy price index, gold price as ounce USD, commercial loans as USD, commercial loans as TL.

Data Warehouse

Half year financial statements as balance sheet and income statement are provided from K.A.P. (Public Disclosure) Platform (https://www.kap.org.tr/tr/). This platform has been established to provide periodic and transparent information to public. Listed companies must share their financial statements in this platform according to the Capital Market Board's notification. Half year balance sheet figures of ninety companies have been put into an excel file. Then the financial ratio calculation has been made. The values are calculated in formulation page of the file and then transferred to calculation summary page. Receivable turnover and stock turnover are calculated on yearly basis for more accurate result. Cost of goods and sales figures are taken from income statement for calculating Cost of goods sold/ Sales ratio. Finally, a total of 2,470 rows of financial data have been imported into an Excel file. You may find below in table 1/1 and table 1/2, a screen shot of the financial ratio calculation file for the period from June 2007 to December 2011. The names of the companies are hided. The rows in which net profit margin is greater than zero have been marked as 1. The rows in which net profit margin is smaller than zero have been marked as two.

Table 1/1. Financial Ratio Calculation File

Comp.	Date	Rec. Turn-Over	Average Collection days	Stock Turnover	Average stock period (as days)	Current asset turnover
X	Jun. 2007					1.11
X	Dec. 2007	8.73	40.97			2.58
X	Jun. 2008					0.97
X	Dec. 2008	9.58	41.33	4.22	85.30	2.07
X	Jun. 2009					0.88
X	Dec. 2009	9.04	39.82	4.23	85.19	1.85
X	Jun. 2010					0.92
X	Dec. 2010	8.87	44.75	4.66	77.24	1.95
X	Jun. 2011					0.93
X		10.49	43.74	4.82	74.72	2.03

Table 1/2. Financial Ratio Calculation File

Comp.	Date	Liqui-dity ratio	Cur-Rent ratio	Cash ratio	Leve-Rage ratio	COGS/ Sales	Net Profit Mar-gin	P	L
X	JUN. 2007	0.80	1.12	0.22	0.59	47.96	0.13	1	
X	DEC. 2007	0.79	1.19	0.31	0.53	49.35	0.12	1	
X	JUN. 2008	1.00	1.39	0.38	0.60	48.85	0.13	1	
X	DEC. 2008	0.91	1.26	0.49	0.58	50.72	0.08	1	
X	JUN. 2009	0.75	0.95	0.38	0.60	48.67	0.11	1	
X	DEC. 2009	1.10	1.38	0.71	0.55	50.06	0.11	1	
X	JUN. 2010	1.07	1.33	0.49	0.56	48.65	0.13	1	
X	DEC. 2010	0.95	1.22	0.53	0.50	49.21	0.12	1	
X	JUN. 2011	0.91	1.24	0.33	0.54	50.76	0.11	1	

Table 2/1 and table 2/2 show the descriptive statistics of financial ratio calculations.

Table 2/1. Descriptive Statistics Provide a Summary of The Main Characteristics of The Dataset

	Rec. Turn-over	Average Collection Days	Stock Turnover	Average Stock Period (days)	Current Asset Turnover	Liquidity ratio
STD. DEV.	13.264,74	71.62	4.65	182.68	0.94	1.66
AVERAGE	397.80	89.75	6.12	104.34	1.41	1.41
MIN	0.65	0.16	0.068	9.29	0.079	0.037
MAX	452.178	1.100	39	5.304	10	33.94

Table 2/2. Descriptive Statistics Provide a Summary of The Main Characteristics of The Dataset

	Current ratio	Cash ratio	Leverage ratio	Financing ratio	COGS/ Sales %
STD. DEV.	1.95	0.95	0.52	2.11	12.76
AVERAGE	1.99	0.41	0.58	1.46	77.68
MIN	0.045	0.00	0.032	- 0.90	3.21
MAX	33.94	16.51	9.83	30.31	225.29

Macro-economic variables and indexes have been inputted into another excel file. Monthly values are provided from TURKSTAT (Turkish Statistical Institute) and Electronic Data Distribution System of Central Bank of the Republic of Turkey. Growth rate is announced quarterly basis, so it is entered quarterly as yearly cumulative sum. There are totally 193 rows for 16 years. In table 3 and in table 4, there are screenshots from the excel file in which macro-economic variables and indexes have been entered. The figures which can be provided on monthly basis, are entered monthly. The macroeconomic variables which can be provided on quarterly basis, are entered quarterly. These values are also entered as monthly basis by dividing quarterly figures in three. Descriptive statistics of these variables are given in table 5/1, 5/2 and 5/3.

Table 3. Data File of Macroeconomic Variables

Date	Average USD/TL rate	Monthly difference	Quarterly growth rate	Monthly growth rate	Monthly Unemployment rate	USA Unemployment Rate
JUNE 2007	**1.43**			**2.4**	**8.8**	**4.6**
DEC 2007	**1.40**	**- 2.13**		**2.4**	**9**	**4.5**
JUNE 2008	**1.41**	**0.90**	**7.2**	**2.4**	**8.9**	**4.4**
DEC 2008	**1.36**	**- 3.51**		**1.13**	**9.2**	**4.5**
JUNE 2009	**1.34**	**- 1.76**		**1.13**	**9.2**	**4.4**
DEC 2009	**1.32**	**- 1.27**	**3.4**	**1.13**	**9.2**	**4.6**

Table 4. Data File of Indexes

Date	Production Price index %	Consumer Price index %	Consumer Confidence index
JUNE 2007	**9.68**	**9.76**	**101.3**
DEC 2007	**10.08**	**9.92**	**101.4**
JUNE 2008	**10.63**	**10.15**	**101.6**
DEC 2008	**11.01**	**10.3**	**101.8**
JUNE 2009	**10.95**	**10.24**	**102.1**
DEC 2009	**10.09**	**10.11**	**102.4**

Table 5/1. The Descriptive Statistics of Macro-economic Variables and Indexes

	USD/TL rate	Monthly difference	Monthly Growth rate	Quarterly growth rate	Production price index
STD. DEV.	**3.96**	**4.00**	**1.80**	**5.41**	**22.76**
AVERAGE	**1.43**	**1.25**	**2.40**	**4.95**	**9.68**
MIN	**1.18**	**- 9.04**	**- 4.70**	**- 14.10**	**1.14**
MAX	**18.70**	**22.21**	**7.47**	**22.4**	**157.69**

Table 5/2. The Descriptive Statistics of Macro-economic Variables and Indexes

	Consumer Price index	**Monthly Unemployment rate**	**USA Unemployment rate**
STD. DEV.	**2.55**	**1.62**	**2.23**
AVERAGE	**101.30**	**8.80**	**4.05**
MIN	**92.70**	**8.00**	**3.5**
MAX	**103.20**	**14.5**	**14.8**

Table 5/3. The Descriptive Statistics of Macro-economic Variables and Indexes

	Consumer Confidence index	**Real Sector Confidence index**	**Stock Exchange Monthly Return %**	**ONS Gold Price USD**	**USD Commercial Loan interest**	**TL Commercial Loan interest**
STD. DEV.	**2.55**	**9.71**	**6.88**	**329.82**	**1.33**	**5.14**
AVERAGE	**101.3**	**101.60**	**8.29**	**1.214.5**	**7.44**	**16.34**
MIN	**92.7**	**59.80**	**- 24**	**631.00**	**2.33**	**8.09**
MAX	**103.2**	**115.90**	**21.89**	**1.969.00**	**9.61**	**36.17**

Conceptual Framework

Data driven decision making is a strength for many industries since it led to identify the trends and patterns that can be adjusted to business models. This, in turn, enhances their competitive edge in the market. Companies give priority to be in line with developments in data science and analytics to categorize and analyze the data coming from different sources. Data mining helps to determine significant facts, relationships, trends, patterns, exceptions, and anomalies that might be otherwise overlooked. This technique associates' rules or if-then rules, finds correlations between big data sets, and can make predictions by learning from the past experience (data). Machine learning algorithms learn from the data and extracts prediction as output. It is a type of artificial intelligence used to perform a special task without being explicitly programmed. Machine Learning Statistical methods have different distributions of parameters and independent attributes. Various studies have shown that machine learning suggests mostly better prediction accuracy. It is free of underlying parametric and assumptions of statistical methods which usually give interpreting results (Mahesh, 2020).

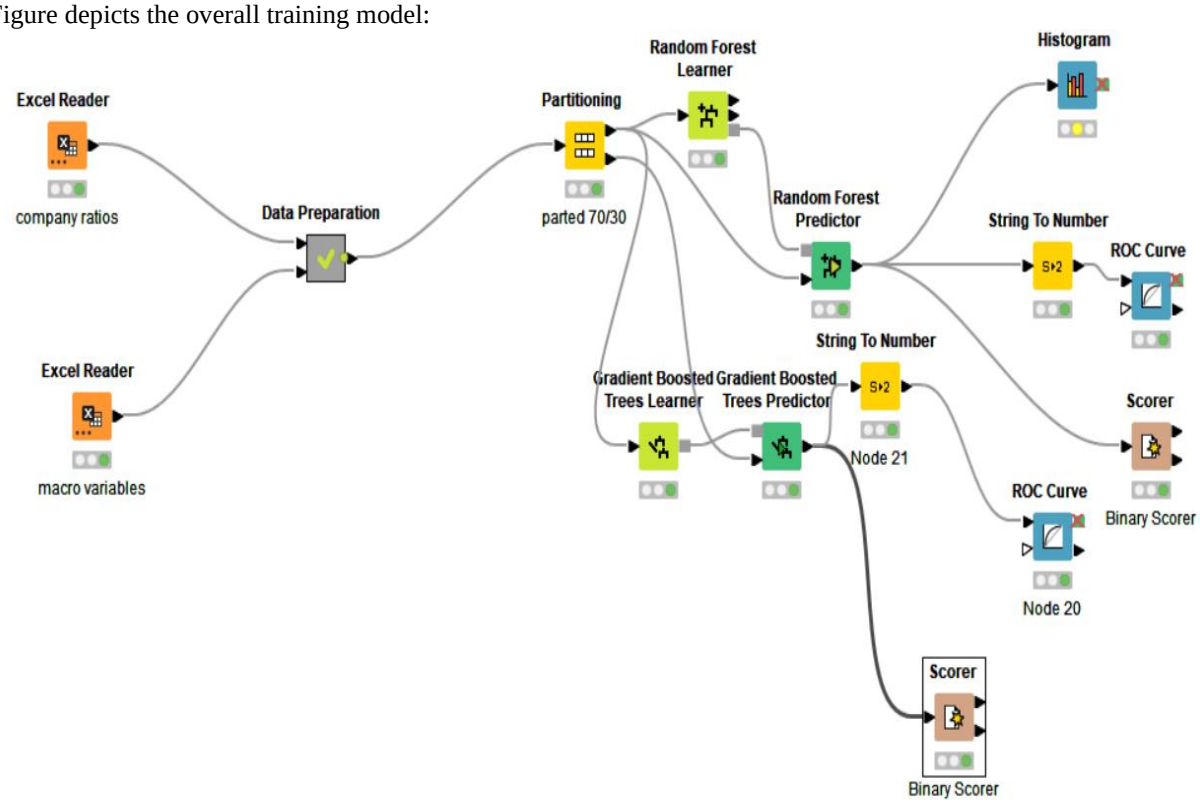
KNIME is a free, open-source data mining and machine learning platform for integration and predictive analytics. It is possible to create a workflow or pipeline in this system that is composed of different nodes which pass data from one end to another. These nodes from different research areas can be composed to create cross-domain workflows. KNIME Analytical Platform can manage complex data types by using advanced algorithms for business intelligence. In financial area, it is

commonly used for credit scoring, fraud detection and risk management (Shrivastava et al., 2023). There are many Machine Learning (ML) algorithms which are well known as good learners. In this study, we have used two supervised machine learning algorithms: Random Forest and Gradient Boosted Trees. Random Forest is a popular machine learning algorithm which uses an ensemble of decision trees for reaching the most accurate result. It combines multiple decision trees; each trained on a subset of the data to improve accuracy of predictions and reduce overfitting. It is mostly used for classification and regression problems in diverse fields such as finance, healthcare, and natural language processing (Aydın & Silahtaroğlu, 2021). Gradient Boosted Trees, or Gradient Boosting, is also an ensemble learning method. It uses multiple decision trees to make predictions. Each tree is built sequentially, with each subsequent tree aiming to correct the errors of the previous one. Gradient Boosting has been shown to be effective in many applications, including ranking and classification tasks (Friedman, 2001).

Research Model

In this research model, Random Forest and Gradient Boosting have been used as machine learning algorithms.

Figure depicts the overall training model:



The data set of macro-economic variables and financial ratios are loaded as two excel files. Seventy per cent of data set is used for learning and thirty per cent of data set is used for testing. These are the independent variables of the algorithm. The dependent variable or the class variable of the model is

profit variable. The Random Forest Algorithm was configured with hyperparameters set at 100 trees, using the Gini criterion for splitting, and incorporating five-fold cross-validation. This model aimed to predict the probabilities of profit occurrences for companies across diverse scenarios. Despite employing the Gradient Boosted Trees Algorithm to enhance accuracy, the results indicated that the Random Forest Algorithm outperformed in terms of accuracy.

Since the optimal values for hyperparameters depend on the dataset and task, here are the values that we have fine-tuned the algorithm based on its performance:

-Learning Rate: 0.01

-Number of Trees: Sample: 100

-Tree-Specific Parameters: max-depth 7

-Regularization Parameters:

gamma: 0.1

alpha: 0.2

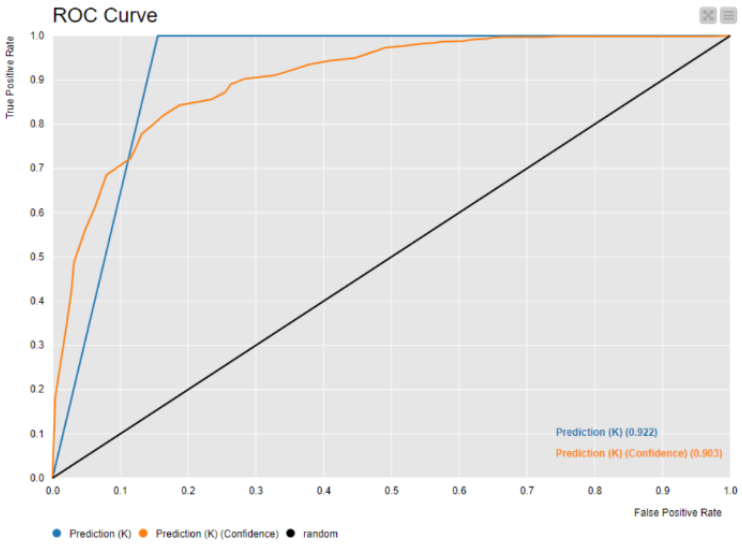
lambda: 0.2

The Accuracy statistics of Random Forest and Gradient Boosting can be seen below in Table 6. Based on the accuracy figures of the algorithms, we can say that the model is successful for composing the financial ratios and macro variables for achieving profit for the companies and sectors included in this study.

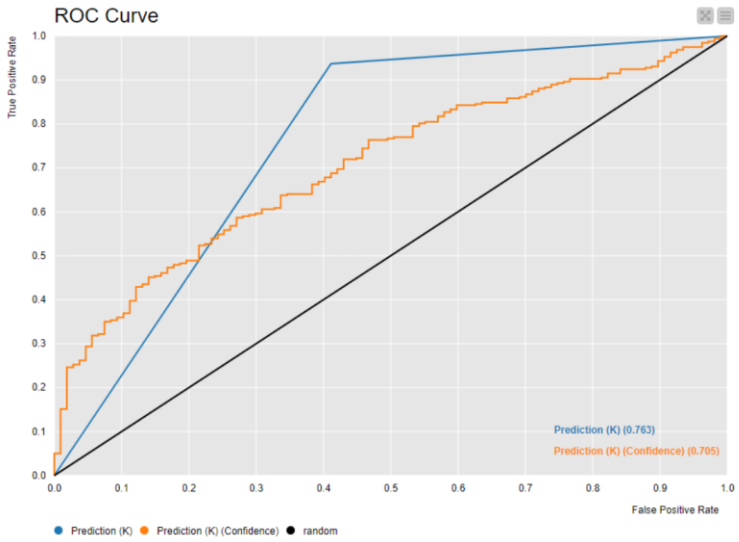
Table 6. Accuracy Statistics of The Algorithms

	Accuracy	**Cohen**
Random Forest	0.961	0.89
Gradient Boosting	0.849	0.57

Random Forest algorithm's ROC Curve is attached below. It can be said that the model has high confidence level for prediction.



Gradient Boosting Algorithm has lower confidence level than Random Forest Algorithm as seen below.



FINDINGS

In this research, Random Forest Learner has the accuracy of 0.961 and Gradient Boosted Learner has the accuracy of 0.849. The results suggest that it is a successful model. Based on this model Random Forest algorithm has generated below mentioned rules. According to the rules in table 7/1 and in table 7/2, the machine learning algorithm considers cost of goods sold, current ratio, acid-test ratio and price indexes are the most important variables. The rules imply that when the companies' acid-test ratio is lower than 0.61 companies may generate loss with the probability over 83% as seen in table 6, rule four and rule six. Besides the breakpoint of cost of goods sold is 0.92. Minimum level of

current ratio is 0.75 that is rule one in table 7/1. The increase of current ratio has positive effect on the ability of generating profit.

CONCLUSION

Turkish economy is fragile and may show volatility in macro-economic values such as foreign exchange rate, growth rate, interest rate, etc. The study was conducted to find out the interrelationship between macro-economic variables and indexes and financial ratio indicators of the companies. Our study shows that the influence of macro-economic factors depends on the internal conditions of the companies. It can be said that internal factors (Financial ratio indicators of this study) have the most significant effect on profit. When cost of goods/sales ratio is above 0.88 and acid-test ratio is below 0.61 it poses a significant threat to generating profit. Current ratio has positive impact on financial performance, which aligns with the findings of previous studies. Also, the outcomes of this research align with the findings of previous research by Yuliastari et.al. (2022) and Arilyn (2020). In this study the minimum current ratio is considered as 0.75 but if it is kept over 0.97 the adverse effects of other factors can be reduced. The impact of macro-economic variables is based on their combination with financial ratio indicators of the companies. It can be said that growth rate impacts the profit positively for this study, but further research is needed for a better understanding.

Limitations of the study

This study is limited with ninety manufacturing companies from three sectors. Sectoral differences and the size of the companies are not considered. Further studies may be exercised to comparatively analyze sector-specific results by expanding the pooled sample. It should be considered that the results may vary according to the size of the companies.

Table 7/1. Prominent Rules Generated by RF to Predict Profit/Loss.

Rule	Leverage ratio	Current ratio	Production price index on 12 months basis	Monthly increase in TL/USD rate	Gold Ons USD	Monthly growth rate	Cash ratio	USA unemployment rate	Profit	Loss
1	0.74-0.86	0.75-0.9668	38	7.13					93	
2	0.88				1.708	0.91			94	
3		0.97			1.434-1.761		0.04-0.057	6.4	90	

Table 7-2. Prominent Rules Generated by RF to Predict Profit/Loss.

Rule	Cost of Goods Sold/ Sales %	Current ratio	Acid-test ratio	Real sector confidence index	Consumer energy price index	Monthly growth rate	Cash ratio	USA unemployment rate	Pro-fit	Loss
4	92-94		0.58-0.61	104-111				8.8		98
5	88	0.93			172				93	
6	92.72	0.9	0.51							83.2
7						2.04			89	
8			0.62		172		0.15		85	
9		1.25		97.75			0.058		88	
10							0.058		88	

RECOMMENDATIONS

Based on the findings of this research and insights derived from the machine learning model, the following recommendations are suggested to enhance financial performance and profitability for companies:

Optimize Cost of Goods Sold (COGS): Given the significant influence of COGS on the model's predictions, companies should focus on cost management strategies to ensure efficient production processes, minimize wastage, and negotiate favorable terms with suppliers. Regularly review and analyze the components of COGS to identify potential areas for cost reduction without compromising product quality.

Enhance Liquidity and Current Ratio Improvement: The importance of current ratio and acid-test ratio in the model highlights the significance of liquidity. The positive effect of an increased current ratio on profit generation stresses the importance of managing current assets and liabilities effectively. To maintain a balanced current ratio by managing inventory turnover, optimizing accounts payable, prompt accounts receivable collection to strengthen the liquidity ratios.

Mitigate Risk of Loss: The model's observation that an acid-test ratio below 0.61 and cost of goods/sales ratio over 0,88 increase the probability of generating losses highlighting the necessity for risk mitigation. Foster collaboration between finance, operations, and data science teams to ensure a holistic understanding of the factors impacting financial performance and enable the implementation of data-driven strategies. Thus, companies can harness the power of data-driven insights to optimize financial performance, enhance profitability, and navigate the complexities of today's business landscape effectively.

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