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COMPARATIVE FINANCIAL PERFORMANCE ANALYSIS OF THE ETHIOPIAN AND TURKISH BANKING SECTORS: APPLICATION OF TRADITIONAL AND MACHINE LEARNING METHODS

MASTER THESIS

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ÖZ

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ETİYOPYA VE TÜRKİYE BANKACILIK SEKTÖRLERİNİN KARŞILAŞTIRMALI FİNANSAL PERFORMANS ANALİZİ: GELENEKSEL VE MAKİNE ÖĞRENİMİ YÖNTEMLERİNİN UYGULANMASI

Günümüz ekonomisinde finansal hizmetlerin büyümesi bankalardan büyük ölçüde etkilenmekte ve bu da nihayetinde ülke ekonomisinin genel başarısıyla sonuçlanmaktadır. Bu çalışmanın amacı, iki gelişmekte olan ekonomi olan Etiyopya ve Türkiye'nin bankacılık sektörünü CAMEL rasyo yaklaşımını kullanarak 2007-2022 yılları arasında karşılaştırmaktır. Çalışma, çoklu panel regresyon ve makine öğrenimi yöntemlerini kullanarak 2007-2022 dönemi için Etiyopya ve Türk bankacılık sektörlerinin CAMEL oranlarını karşılaştırmaktadır. Rastgele Orman algoritması kullanılarak yapılan analiz, geleneksel yöntemlere kıyasla daha etkili sonuçlar vermiştir. Etiyopya'da faaliyet gösteren özel bankalarda Yönetim Kalitesi için Gelir/Gider oranı %37.04 ile model tahminlerinde önemli bir rol oynarken, Likidite için Nakit/Mevduat değişkeni %25,71, Aktif Kalitesi için Kredi/Mevduat %7,94 ve Özkaynak Çarpanı %29.31 ile diğer önemli faktörler olmuştur. Türkiye'de faaliyet gösteren özel bankalarda, Likidite için Nakit Mevduat ve Aktif Kalitesi için Kredi Mevduat rasyoları daha düşük etkiye sahipken (%5,36 ve %5,45), Yönetim Kalitesi için Gelir Gider oranı %69,93 ile en etkili değişkendir. Özkaynak Çarpanı %19,26 ile daha az etkili ancak önemli bir faktördür. Bu çalışma, farklı ekonomik koşullara sahip ülkelerde bankacılık sektörünün performansının değerlendirilmesinde makine öğreniminin etkinliğini göstermektedir.

Anahtar Sözcükler: Bankacılık Sektörü, CAMEL, Makine Öğrenmesi, Rastgele Orman

ABSTRACT

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COMPARATIVE FINANCIAL PERFORMANCE ANALYSIS OF THE ETHIOPIAN AND TURKISH BANKING SECTORS: APPLICATION OF TRADITIONAL AND MACHINE LEARNING METHODS

The growth of financial services in today's economy is heavily influenced by banks, which ultimately results in the overall success of a country's economy. The objective of this study is to compare the banking sector of two emerging economies, Ethiopia and Türkiye, over the period 2007-2022 using the CAMEL ratio approach. The study compares the CAMEL ratios of the Ethiopian and Turkish banking sectors for the period 2007-2022 using multiple panel regression and machine learning methods. The analysis using the Random Forest algorithm provided more effective results compared to traditional methods. For private banks operating in Ethiopia, the Income/Expense ratio for Management Quality played an important role in the model predictions with 37.04%, while Cash/Deposit variable for Liquidity was 25.71%, Loan/Deposit for Asset Quality was 7.94% and Equity Multiplier was 29.31%. For private banks operating in Türkiye, Cash/Deposit for Liquidity and Loan/Deposit ratios for Asset Quality had a lower impact (5.36% and 5.45%), while the Income and Expense ratio for Management Quality was the most influential variable with 69.93%. Equity Multiplier is a less influential but important factor with 19.26%. This study demonstrates the effectiveness of machine learning in evaluating the performance of the banking sector in countries with different economic conditions.

Keywords: Banking Sector, CAMEL, Machine Learning, Random Forest

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ABBREVIATIONS

AWB	Attijar Wafa Bank
BCBS	Basel Committee on Banking Supervision
BCP	Banque Central Populair
Birr	Ethiopian Dollars
BMCE	Banque Marocaine du Commerce Exterieur
BMCI	Banque Marocaine pour le Commerce et l'Industrie
BRSA	Banking Regulation and Supervision Agency
CAM	Credit Agrigole du Maroc
CBE	Commercial Bank of Ethiopia
CD	Cross-sectional Dependence
CDM	Credit du Maroc
CDR	Cash to Deposit Ratio
EDA	Explanatory Data Analysis
FE-OLS	Fixed Effect Ordinary Least Square
FFIEC	Federal Financial Institutions Examination Council
k-NN	k-Nearest Neighbor
ML	Machine Learning
MPF	Mandatory Provident Fund
NBE	National Bank of Ethiopia
PCA	Principal Component Analysis
SVM	Support Vector Machines
TCMB	Türkiye Cumhuriyeti Merkez Bankası
UFIRS	Uniform Financial Institutions Rating System

1. INTRODUCTION

In today's world, finance has a vital role in the economy, providing capital, liquidity, and contributing to the country's construction and development. All other sectors are affected by bank performance, which is the primary financial performer in economies. The banking industry is a crucial component of the economy as it is necessary channel for boosting the accumulation investments. Due to the fact that the banks are connected to each other for payment and other functions all banks are affected by failure of a single one, leading to a disorder in the economic (Kumbirai & Webb, 2010).

This means there are many types of risk that bank face due to various situations, in which can result in different levels. As follows, credit risk, which happens when a borrower fails to make timely interest and principal payment; liquidity risk, which arise from being unable to meet current demand; interest rates risk, and so on. As a way of preventing this, the United States created the CAMEL's rating system, which is a supervisory rating for assessing a bank's overall condition. By identifying financial institutions that will overcome and those that will break down, the CAMEL's strength lies. The concept was first put into practice in 1979 by the Federal Financial Institutions Examination Council (FFIEC) under the name Uniform Financial Institutions Rating System (UFIRS).

The objective of this study is to compare the profitability of Ethiopia and Türkiye, and to identify which country have a higher bank profit by employing the CAMEL ratio. Firstly, we will start by learning about the bank's origins in Ethiopia and Türkiye, afterward moving on to studying the banking system. Secondly, we will focus more on previous research or articles that were taken in the same courses as ours. Thirdly, Machine Learning (ML) will be used to obtain an accurate result.

Machine Learning algorithm is designed to provide the most accurate results by identifying data patterns and analyzing them to make recommendations or predictions. We will finish our research by concluding all the results that were studied.

2. THE BANKING SYSTEMS IN ETHIOPIA AND TÜRKİYE

The banking and finance history of both countries is examined in this section in order to compare the banking systems of Ethiopia and Türkiye. First, banking activities in Ethiopia will be discussed and then information about the Turkish financial system will be given.

2.1. Development of the Ethiopian Banking System

In Ethiopia, the banking system was started with the establishment of Abyssinia Bank by the Emperor Menelik II in 1906. Addis-Ababa, Paris, Vienna, New York and London were the locations where shares of the bank were sold. The Franco-Ethiopian railway, which reached Addis Ababa in 1917, was one of the first project that Abyssinia Bank financed. In 1931, the banking system underwent reforms introduced by Emperor Haile Selassi. Haile Selassi was the Emperor of Ethiopia from 1930 to 1974 after the death of the emperor Menelik 2. The bank of Abyssinia´s management, staff and premises were taken over by the newly established Bank of Ethiopia which was a fully government-owned bank, after it was liquidated. As a result, commercial and central banking services were provided by Bank of Ethiopia (Mauri, 2010). The Italian invasion in 1935 resulted in the demise of one of the earliest initiatives in Africa banking. Italy´s banks were active in Ethiopia during the Italian occupation.

The State Bank of Ethiopia which was established in 1942 was split by the Ethiopian government in 1963 into the National Bank of Ethiopia, the Central Bank, and the Commercial Bank of Ethiopia (CBE) (Brimmer, 1960). National and Grindlays Bank established Addis Ababa Bank in 1963. Addis Bank and CBE were merged by the government in 1980 to create CBE as the sole commercial bank in the country. Addis Bank and the commercial bank of Ethiopia were merged by the government in 1980 to create CBE as the sole commercial bank in the country. (Yonas, 2021).

Ethiopia’s economy has been controlled by the state through various industrial development plans since the imperial government of Haile Selassi, making it one of the oldest civilizations in Africa. The Soviet-style centrally planned economy was managed by a socialist government from 1976-1991, later government have introduced further reforms. In 1992, the Ethiopia government implemented a reform measure called "liberalizing" the financial sector. Prior to 1992 in Ethiopia, the financial sector was highly restrained;

characterized by restricted entry, constrained bank's role in interest rates, credit limits, and other factors (Yesuf, 2010).

Furthermore, as Yesuf (2010) stated, the government-owned banks that were present at the time were being regulated by the central government due to the country's command economy. The institutional framework resulted in almost no competition in the banking market, with all banking activities being concentrated in government-owned banks. The government´s objective was to minimize competition between commercial banks and existing specialized banks. Following the government change, various reforms, including in the financial sector, were implemented, enabling banks to set lending interest rates independently, allowing the country men to join the banking industry.

To accomplish this task, the Ethiopian government chose a strategy of (a) gradualism: the foreign exchange market will be gradually liberalized along with the gradual opening up of the private banks and insurance companies alongside public ones, and (b) improving domestic competitive capacity before full liberalization (this includes restricting the sector to domestic investors, strengthening the NBE´s regulatory and supervision capacity, granting banks autonomy, and opening up the interbank money market) this strategy has resulted in the passage of numerous proclamations and regulations since 1992 (Yesuf, 2010).

At present, the Ethiopian banking sector consists of a central bank (The National Bank of Ethiopia or NBE). A state-owned development bank, a government-owned commercial bank, 16 private banks. The banking business proclamation (Federal Negarit Gazeta proclamation 592/2008) is the law that governs banking in Ethiopia since August 2008, it has been in effect and provides the NBE of the banking regulator with the full range of powers (Yonas, 2021). The banking business proclamation addresses mandatory requirements readings:

(1) the new banks licensing;

(2) sharing shareholders and registry;

(3) the certificate management of director;

(4) limitations and obligations of bank´s financial;

(5) keeping record and audits of finance;

(6) inspection and disclosure;

(7) and other alternative areas.

The proclamation stipulates that NBE will periodically issues and revise detailed directives in all the areas mentioned above.

In Ethiopia the public sector has one commercial bank and one specialized (development) bank. Commercial, cooperative, and specialized banks are among the private sector banks that are further categorized. The private banking sector had 21 commercial banks, 1 specialized bank, and 1 cooperative bank in operation by 2022. Commercial banks in the private sector can be classified into Islamic commercial bank and conventional bank. A total 3 Islamic commercial bank and 18 conventional commercial banks were active in June 2022. The banking sector is exclusively regulated and monitored by NBE. Currently, Ethiopia does not have foreign banks with registration and head offices in foreign country, licensed foreign exchange offices, investment banks, or licensed money remittance providers that are operating in Ethiopia (Abate & Kaur, 2023).

2.2. Development of the Turkish Banking System

2.2.1. Ottoman Empire

The Crimean war in 1856 resulted in domestic debt reaching 20,000,000 British pounds, and the annual installment of foreign debt was around 800,000 British pounds. Galata bankers were hesitant to give the government any more loans. Their suggestion was to open a bank that wanted handle the financial affairs of the empire. Foreign financiers were suggesting a similar solution and willing to provide assistance in starting a bank. In 1856, Ottoman Bank was established with the assistance of British finance group. The central office of it was located in London and had branches in Istanbul, Izmir, Beirut and Thessaloniki. Despite the Ottoman governments agreement not issue any banknotes, the bank had the privilege of issuing banknotes convertible to gold. The bank would be responsible for handling all the types of banking activities and could participate in certain trading activities without having to pay a large number of customs and duties. Financing activities in the Ottoman Empire were handled by “Galata Bankers” on behalf of French and British bankers until Ottoman Bank was founded. The bank was mostly owned by French and British bankers. However, the bank´s activities were diversified by Galata bankers due to their strong connections with both British and French financial groups. (Bayraktar, 2002;

Kazan, 2006; Kazan, 1995). With the signing of a new agreement between Sultan Abdulaziz and the Ottoman Bank´s shareholders, the bank rights, capital and privileges were reassigned to a newly founded bank "Bank-i Osmani-i Şahane" in 1863. It was a continuation of Ottoman Bank, but only a minor name change, so it was called Ottoman Bank in short. The primary interest groups remained unchanged in the first Ottoman Bank established in 1856. In 1875, this bank was granted the title of treasurer of the empire, in the meantime Galata Bankers established a second bank, Ottoman Empire general company, through a partnership with Ottoman Bank founded a year earlier (Arikan, 2009).

The Ottoman Bank faced several government notes bonds issued that caused problem because of air games which was popular at the time. They decide to handle it by consolidating than to a single bond with 5% annual interest rate. The Galata Bankers were prepared for this kind issued because they were aware of the government policies and actions. Resulting to an organized of formal security exchange market in Komisyon Han that is another large commercial building beside Havyar Han that were informal securities exchange operation. Therefore, after consolidation the games on the bonds continued in 1871 (Kazgan,2006).

Total amount of loans was 127.000.000 Ottoman Liras, total debts 239.000.000 Ottoman Liras were to be paid with the government lack of knowledge and experience about the finance and the Galata bankers highly interest demands, the situation aggravated. 1874-1875, the annual income was 25.104.928 Ottoman Liras for the Ottoman Empire. Nevertheless, the same year debt in total was 30.000.000 Ottoman Liras (Yılmaz, 1996; Ortaylı, 1987; Kiray,2008).

For that reason, the government plan an arrangement of payment without suffering the capital holders and domestic producers. On 7th October, 1875. The Empire announce a law that testimony that only half of the annual foreign debt of payment would be paid for the next five years. 5% of the annual interest rate of the government bonds and for the creditors, ten years of maturity will be granted. Another declaration was made by the Empire in the 10th October, 1875. Reported that only the half of the foreign debt will be paid for the next five years and the rest of the payment will not be made, due to the fact that the financial condition was feeble (Unaltay, 2001; Hazgan, 2006). Ramadan law was announced without the consultation of foreign creditors, resulting a demonstrate in foreign creditors. The

Ottoman Empire stopped paying foreign loans after being pressured by foreign governments and declaring a moratorium (Arikan, 2009).

After the collapse of the Ottoman Empire did not only drag the end of multi-cultural state, but also tagged a huge burden on the new Turkish Republic. With small amount of inherit of human capital and the debt that was brought from the Empire and the lack of potential for capital formation. Those years were full of challenges. It wasn't until 1950s that the debt payment was paid from the Ottoman Empire (Yüksel, 2008).

2.2.2. Turkish Republic

The economic structure inherited by the Republic of Türkiye from the Ottoman Empire was shaken by the impact of the wars and was largely agriculture-oriented. Banking in this period consisted of banks with foreign capital and local banks with single branches. The inheritance of the debts of the Ottoman Empire and the lack of private capital for the formation of the new financial system can be counted among the factors that prevented the development of the banking and finance sector (Yüksel, 2008).

In 1930, the national central bank was created; there were 22 small domestic and 13 large foreign banks with 419 branches. For the young republic the motivation to continue a policy of nationalization was high. Despite the negative reaction to foreign investment. Nonetheless, the foreign banks were not closed, and continue to provide a much cheaper and long-term fiancé from strong capital base. In 1924, Türkiye İş Bankası which was a private bank capitalized with certain incentives to promote the accumulation of national capital. In addition to that, the rebuilding of Ziraat Bank was completed for agricultural support. These two banks are still operative and are leading banks in their areas. The Industrial Bank of Türkiye (Sinai ve Maadin) was established in 1925 to support manufacturing and in 1927 Emlak ve Eytam Bankası for construction. And in 1932 there were around 45 national banks in Türkiye.

Public banks were introduced into the financial system to enhance support for capital formation. Empowering the young republic through public and private cooperation was deemed to be the path to welfare growth. For that Sümerbank was created to encourage the development of the textiles sector. In order to give fillip for prioritized areas of development.

Banking in the 21st century started with crisis but progress was given an opportunity to concentrate on microeconomic issues. The necessitate for development and the

competition brought a risk and problems for banks following macroeconomic for the last decades. For that reason, everything was managed carefully like for example; Managing EU convergence, managing foreign exchange and …etc. after noticing early signs of the stabilization programs success, foreign investor began searching for potential bank acquisition in Türkiye. Offering good opportunities and an improved capital base (particularly good demographics). The Turkish financial market has received more attention from Greek, British, German, French and American banks compared to other transition economies. And that caused a 30% rise in mergers and acquisitions within a couple of years. Because of the lack of financial deepening, Türkiye offers a huge potential for growth in future. And in that, it could be that the first decade of 21st century will be seen as the end of Turkish national banking. Especially if foreign investors are also given access to state-owned banks. The monetary policy committee of Türkiye Cumhuriyeti Merkez Bankası (TCMB) was established in the first half of the first decade of the 21st century to institutionalize the monetary policy framework. Indeed, implicit inflation targeting was successful in bringing inflation down to the single digits. In light of their full commitment to price stability under floating rates and the independence of the TCMB instrument, the Monetary Policy Committee began to explicitly target inflation with strong transparency, credibility, and accountability. In 2005, inflation was brought down to less than 8% as a result: It is widely acknowledged that even a historically low level of inflation is not the same as price stability as defined by EU institutions. In order to achieve EU convergence, the medium and long-term inflation goal bring inflation to 4% and keep it there until then (MPF, Ankara) (Yüksel, 2008).

2.3. Historical and Economic Relationships in Africa

Türkiye's relationship with north Africa, as well as Ethiopia goes back to the Ottoman Empire, which has led to them sharing common history, including religion and traditions. The current relations in Northern and Eastern Africa are positive because of the Ottoman Empire's non-colonialist policies. Furthermore, in January 2007, Recep Tayyip Erdogan, who currently heads Türkiye, stated in his speech at the 8th African Union Summit in Ethiopia that "Africa is the foundation of our collective future. Africa's success is beneficial to all mankind" as cited by Tepecikliogu (2017), he noticed that Turkish officials frequently emphasize building alliances that revolve around mutual interests and win-win relationships in their public speeches.

Until recently, Türkiye's trade relations have been primarily focused on northern African countries because of natural and geographical factors. Ethiopia turn out to be increasingly relevant as Türkiye aims to expand its economic relations. Between 2004 and 2012, bilateral trade between these two countries tripled, and accounted for 441 million USD in 2014. Türkiye is becoming a more significant player in Ethiopia's economic and political relationship. Türkiye is now second-largest bilateral partner, following China, in terms of investments in Ethiopia (Cheru, 2018).

In 2014, BRICS nation launched a New Development bank as an alternative to the World Bank and the International Monetary Fund. They also set up a mechanism to support members struggling with payments. Those banking and funding mechanisms are not only attractive to BRICS nation, but they're open to other developing and emerging economies that have had trouble dealing with IMF and world bank in past, because those banks have actual policy conditions attached to their loan.

Now, this is why you're hearing about countries that want to join the BRICS banking system. In 2021, Egypt, the UAE, Ethiopia, and others took up small shares in the BRICS banking system. And recently, Saudi Arabia, Mexico, Argentina, and Türkiye have also expressed interest in possibly joining the BRICS banking system. Both Ethiopia and Türkiye want to participate in the BRICS banking system, which is another common ground in their banking systems.

3. BANKING SECTOR

3.1. Bank Regulations

Banks are subject to a variety of policy, condition and guidance. Although legal rules are different from one country to another, it still seeks same objective, like preventing certain risk that may follow from bank fraud or avoiding the risk of trading condition for banks.

The regulation of bank is the action of establishing and implementing a rule for both financial institution and banks. The main objective is to prevent safeguard consumers, a financial crime, and secure the financial system's stability. It also indented to enhance the safety and soundness of banks by making sure that it has sufficient capital to cover their risk, and that will protect and insure consumers from violation and scam.

Banking regulation is highly regulated in worldwide, with variation from country to another. For example, in Türkiye it's the Banking Regulation and Supervision Agency (BRSA) which is a banking Agency for rule and regulation and for Ethiopia it's from NBE which is located in the capital city Addis Ababa.

The soundness and effectiveness of banking sector is ensured by its regulation, which is a critical tool in the global economy. Without it, nothing will avoid engaging the risky behavior that could result to financial crisis and bank failures. To discourage it, rules must be watch over banks action to make sure that it's safe and sound.

3.2. Banking Systems

As one of the economic building blocks of a country, the banking system is vital to its financial stability and economic growth. In modern economies, banks provide essential services such as financial intermediation, credit provision and asset management for both individuals and businesses. These services contribute to increased economic welfare by supporting consumer spending, investment and overall economic activity. Regulation of the banking sector takes place at the national and international level to manage financial risks, prevent economic imbalances and protect consumers. These regulations support the healthy functioning of the financial system by ensuring banks' capital adequacy, risk management and operational transparency. Each country's unique economic conditions and political framework play a decisive role in the structuring and regulation of banking systems. In this

context, it is important to compare the banking systems of different countries to understand how these systems function and how they evolve under different economic conditions.

Table 3.1. Comparison of Banking Sector between Ethiopia and Türkiye

	Similarities	**Differences**
Ethiopia	• The bank must be licensed and approved by the Central Bank of Ethiopia in terms of opening a new branch. • Any bank's own capital must amount to at least 10 percent of its total debts, and in any case may not be less than 2 million Ethiopian dollars (Birr). • Banks are, furthermore, not allowed to invest in real estate, with the exception of buildings for their own offices or housing for their stull. Some other operations are not prohibited.	• To get the banking license, it requires being either a Joint Stock Company or a partnership, with at least 51% of its capital in the hands of juridical persons of Ethiopian nationality. • Investment in foreign securities is prohibited, and so are loans to foreigners and direct loans to the public administration. • Credits to any one borrower may not exceed 10 percent of the bank's own resources.
Türkiye	• Banking law doesn't regulate the procedures for obtaining a banking license much, so it must be obtained from BRSA. • To be considered founding shareholders, they need to own 10% or more of the bank's shares and have a minimum share capital of 30 million TRL. • Investment banks and development banks are both governed by the banking law. Participation funds and deposits are not accepted by these banks, but they can still grant loans and engage in other activities that are permitted by their operating license. The interest rate must not be lower than 8%.	• Foreigners are allowed to open their bank after receiving approval from 5 out of 7 BRSA. • Borrowers, including foreigners, can obtain mortgages from Turkish banks provided they meet the following requirements: obtaining a loan from the bank and having a residence and work permit for at least 12/24 months. • It's not permitted for a bank to lend more than 25% of its equity to a person or entity.

Table 3.1. presents a comparative analysis of the similarities and differences between the banking systems in Ethiopia and Türkiye. In both countries, banks must be licensed by central banks and comply with certain capital requirements. For example, in Ethiopia, banks' own capital must be at least 10% of their total debt and must be worth at least 2 million Ethiopian Dollars (Birr). Similarly, in Türkiye, bank founding shareholders are required to own 10% or more of the bank's shares and contribute a minimum capital of 30 million TRL.

In terms of differences, to obtain a banking license in Ethiopia, at least 51% of the bank's capital must be owned by Ethiopian legal entities, whereas in Türkiye, foreigners need the approval of at least 5 out of 7 members of the Banking Regulation and Supervision Agency (BRSA) to open a bank. In addition, foreign securities investments and direct loans

to the government are prohibited in Ethiopia, while in Türkiye foreigners can obtain mortgages from banks and the amount of credit that banks can extend to a person or institution cannot exceed 25% of their own equity.

These similarities and differences in the banking systems of both countries reflect the different needs and priorities of each country's financial regulations and economic structures. This comparative analysis is important for understanding the regulatory framework for banking activities in both countries.

4. PERFORMANCE MEASUREMENT IN THE BANKING SECTOR: CAMELS

In modern world, banks are considered an important service industry and contribute to the development of any economy. Most businesses rely heavily on it as their main source of funding. The majority of the research and discussion surrounding financial performance assume that improving the function and actives of organizations are improved by financial performance (Nimalathasan, 2008). Financial performance and measurement are well-developed within finance and management fields. The performance of financial institutions, particularly banks, has been widely evaluated using a well-judged technique called CAMELS rating.

4.1. CAMELS Analysis

The concept of measuring financial performance and the research that goes with are well advance within the financial and management fields. Recently banks and other financial institutions have been evaluated using a well-judged technique called camel's rating (Bagladesh, 2008).

The camel ratio was chosen because its purpose is to assess the banks overall condition and discover the operational, managerial, and financial aspect are the areas where it has both strengths and weaknesses (Wirnker and Tanko, 2007). This model is responsible for the supervision and regulatory rating system. When evaluating the performance of a bank, six important components are taken into consideration. Capital, Assets, Management, Earning and Liquidity to market risk are the components that make up these components. The system assigns ratings to these components on a scale of 1 to 5, which serves as a basic for composite ratings that also range from 1 to 5 (Bulti, 2019). Having a rating of 1 is considered the best, while having a rating of 5 is considered the worst.

4.1.1. Capital Adequacy

Almost all aspect of banking is affected either directly or indirectly by the availability and cost of capital. Capital is a crucial factor in assessing a banks safety and soundness. Capital adequacy is determined on how well the banks are doing financially overall and the managements capacity to meet the need for additional capital. To strike a balance between other factors and risk exposed by the financial institution, including credit risk, market risk, operational risk, and capital adequacy must be maintained to safeguard the debtor from

potential losses and ensure their safety. To determine capital adequacy, it is crucial to meet the statutory minimum capital requirement, and maintaining an adequate level of capital is a critical element". (The United States. Uniform Financial Institution Rating System, 1997).

4.1.2. Asset Quality

The profitability of a bank is influenced by the asset side of its balance sheet, which is another specific variable. Loans, deposit, investments, cash and fixed asset are among the various asset components of the bank assets. There appears to be agreement to priority the quality of the loan portfolio. The primary source of produces the majority of a bank's income is usually bank loans. Therefore, banks profitability is determined by the quality of their loan portfolio (Dang, 2011). States that the loan portfolios quality has a direct import on a bank's profitability.

4.1.3. Management Efficiency

To guarantee that the operation is sound, safe, and efficient while complying with applicable laws and regulation, and management efficiency it must be achieved by taking the risks of institution's activities into controlling, identifying, and measuring by board of directors and management of an institution's activities. (Uniform Financial Institution Rating system,1997; p.6)

Management efficiency involves adhering to established norms, planning and responding to changing environments, and possessing leadership and administrative capabilities at the bank, as explained by (Tesfaye, 2014). Management sets clear strategies and goals for the direction of the banks to keep a watchful eye on both international business and domestic then gathers financial ratio in accordance with management strategies. It is preferable for top management to have excellent reputation in local communication while maintaining good quality and experience.

4.1.4. Earning Quality

This rating takes into account not only earning quantity and trend, but also the factors that may lead to loan losses, which may necessitate increased loan allowance or pose a high degree of market risks. It is important to assign equal or greater value to future earnings performance compare to past and present performance. (The United States. Uniform financial institution Rating system, 1997, p.7)

Grin (2007) believes that a steady profit not only builds trust in the bank, but also covers loan losses and provides sufficient funds. A balanced financial structure is crucial for providing shareholder rewards. Banks' sustainability depends on consistently healthy earnings. The effectiveness of a company in generating profits from revenue and assets is measured by profitability ratio. The evaluation of earning involves using certain requirement, such as: most of earnings come from annuities that have low volatility and the growth trend is recent years is in line with or better than the industry norms, with several sources of income both interest and non-interest income.

4.1.5. Liquidity

In order to meet its current obligations, the bank's liquidity ratio is measured. Mobilizing deposits and providing funds to creditors is how banks make money. So it's important for them to meet payment requirements when depositors demand them. Liquidity risk occurs when the bank cannot meet the demand of depositors. To fulfill the financial obligations timely and liquidate assets quickly with minimal less, it is necessary for an institution's fund management practices to ensure a sufficient level of liquidity (Mulalem, 2015).

Scholars have different opinions about measurement ratios. According to Samad (2004), customer deposits to total assets and total loans to customer deposits are the primary financial ratio that indicates a bank's liquidity assets. Other researchers utilize various financial ratios to assess liquidity. As an illustration, Ilhomovich (2009) states that in Malaysia, banks' liquidity level was determined by using the cash-to-deposit ratio.

4.1.6. Sensitivity

Sensitivity is defined as the risk that arises from changes in market conditions, which could have an adverse impact on earning and/or capital. The measurement of market price change is used to evaluate Sensitivity to market risks, precisely on the interest rates, exchange rates, and equity prices that have a negative impact on the bank's earnings and capital (Sarker, 2005). While the variation of financial asset prices is a major factor in banking activity, a number of studies do not consider this to be the sixth component of the CAMELS due to the measurement difficulties associated with accounting and financial data.

Banks evaluate the sensitivity of market risk by examining changes in foreign exchange rates, equity prices, and interest rates. These variables have an impact on the

bank's earning capacity. The bank's Sensitivity to market risk is determined by its response to changes. Market risk is the outcome of trading activities, foreign exchange, and non-trading activities operations.

4.2. Theoretical Framework

Derviz and Podpiera (2008)'s study on the banking sector in the Czech Republic is one of the most complete investigations into the soundness of banks in the new European Union member states employing CAMELS. The study highlights how the financial soundness of the five largest Czech banks changed throughout the pre- and post-privatization period, which is from 1999 to 2005. Atikoğullan (2009) applied a method that was similar to what was done in the CAMEL framework to evaluate the performance of the banking industry in Northern Cyprus. The study on the top five banks in the post-2001 era. Based on the findings, it appears that the profitability and management quality of the analyzed banks have improved during the examined period, but the Capital adequacy and Liquidity levels have decreased.

Ferrouhi (2014) used the CAMEL approach to evaluate the efficiency of major financial institutions in Morocco and identify the financial institution with the highest performance in order to assess Capital they used the debt equity ratio, for Asset was loan loss provisions to total loans, ROE to examine Management, ROA for Earnings, and for Liquidity they utilize deposit on total asset. According to the results CDM (Credit du Maroc) emerged as the highest ranking with CAMEL of 4.4 average by CAM (Credit Agrigole du Maroc) with 4, BMCE (Banque Marocaine du Commerce Exterieur) and BCP (Banque Central Populair) with 3,4, AWB (Attijar Wafa Bank) with 3,4 and BMCI (Banque Marocaine pour le Commerce et l'Industrie) with 2,2.

Barr et al. (2002) demonstrated that there has been a reduction in the length of the CAMEL rating criteria and essential tool for examiners and regulators. They observed a substantial connection between CAMELS rating and efficiency scores. As a result, numerous studies have addressed the assessment of Japanese banks on Earning, Asset, Capital adequacy, liquidity, and Management position was carried out by Said and Saucier (2003) using the methodology called CAMEL rating. Prasuna (2004) conducted an analysis of 65 banks in India that were found to have advantageous performance in the face of though challenger, with innovative products, good service quality, and well bargains that were improved. Sarker (2005) investigated Bengali Islamic banks with the aid of the CAMEL

model, which enabled regulators to obtain a Shariah (Law in Arabic) benchmark for supervising and inspecting financial institution and Islamic banks from their viewpoint.

The study conducted by Mikail Altan et al. (2014) aimed to evaluate state owned companies' financial performance and private-owned Turkish banks in the years 2005 to 2012. The ratio of variables is 23 related to the CAMEL ratio were used to base it. All bans examined in the study met a higher level of BCBS (Basel Committee on Banking Supervision). By adopting the CAMEL model, Kabir and Dey (2012) evaluated Bangladesh's private and commercial bank. Their study revealed that central banks across the globe have enhanced their quality of supervision and technique. Misra and Aspal (2013) examined the accomplishment of state bank group in India using CAMEL ratio. It was discovered that the ratio ranking for different were differs. However, distinction to the CAMEL ratios. Prasad and Ravinder (2012) examined the performance of bank nationalization in India.

Million Gizaw et al. (2015) investigate the association of credit risk measurement and profitability performance of Ethiopian's commercial banks through the use of the CAMEL ratio. National and commercial bank data was obtained by the auditor of financial report of Ethiopia. According to NBE (2012), the country had 18 commercial banks that were operational. The objective was to examine how credit risk affects the profitability of commercial banks in Ethiopia. During the studied period, it was expose that the Ethiopian's financial risk has improved. A panel dataset model was introduced in the study, which had previously been utilize by Kolapo et al. (2012) in their "credit risks and commercial bank performance of Nigeria"; to estimate the determination of the profit function was aided by CAMEL ratio.

Poudel (2012) conducted a study on the factors that impacted commercial bank performance in Nepal from 2001 to 2012 and employed a method for performing linear regression analysis. The research demonstrated that the correlation of capital adequacy and the default are used to measure credit risk and ROA measure the performance of commercial banks were significant. In his study of 4 banks from 2000 until 2008 in Swedish. Hosna et al. (2009) also reaches much as the results with Poudel. The result showed that ROA was inversely linked to the rate of non-performing loans and Capital adequacy ratios, although the rates differ between banks. Several studies have also found the liaison among the credit

risk and performance of profitability metrics that is opposite (Achou & Tenguh, 2008; Funso et al., 2012; Musyoki & Kadubo, 2012).

Does CAMEL analysis have any impact on the profitability performance of banks? In an effort to answer that question, M. B. B. Munir and U. S. A. Bustamam (2017) investigated how CAMEL analysis affects the profitability of Islamic and conventional banks in Indonesia and Malaysia, both partially and simultaneously. The findings of this study on CAMEL analysis can be of great assistance when it comes to evaluating the profitability performance. The two countries have significant variations in comparative performance of each variable. The Management, Earning and Liquidity of both banks in each country are markedly different. Still based on a detailed analysis, the comparison of performance of conventional banks from Indonesia and Malaysia expose significant change, which includes return on investment, management, and liquidity. In comparison to Islamic operation in Indonesia and Malaysia, Liquidity and Management have undergone important changes. In 2011, Tarmila et al reported on the simple measurement of investment and profitability using ROI measurements. Jarmila et al (2011) stated that ROI is highly significant, particularly in maintaining firm growth through considering a medium and short terms budgets plan. Kabaic et al. (2012) used ROA, ROE, and ROI to measure profitability and efficiency for the capital company, and found that they had a significant and positive impact on the share price. Jarmila et al. (2011) discussed some benefits of ROO measurement, such as the ability to plan, make decisions, evaluate investment opportunities, manage performance by operation, and address changing markets based on cost and profitability.

Alemu and Aweke (2017) analyze the overall performance of private commercial banks in Ethiopia using the CAMEL rating approach. A panel data regression model was utilized in the study to analyze the collected data of 6 private commercial banks in Ethiopia from 2007 to 2016. The conclusion was that private sector were most profitable due to Asset quality, Management, Earnings, and Liquidity. The performance of 8 commercial banks during 2000-2013 in Ethiopia was studied by Dakito (2015) through a CAMEL approach, which involved conducting descriptive and econometric analyses. The study demonstrated that NIB's (Nib International Bank) overall performance was satisfactory.

Additionally, he has used the GLS regression model to measure the connection between Capital adequacy and financial performance. A positive correlation was found between Capital adequacy and bank performance in the regression results. Minyahil (2013)

assessed the efficiency of seven commercial banks in Ethiopia from 2004-2005 to 2010-2011. It indicated that NBE (Nation Bank of Ethiopia) directives had major impact on the performance of commercial banks in Ethiopia during the study period.

Liaqat and Alem's 2019 study also covers eight of the largest and mature commercial banks in Ethiopia. The primary goal was to assess the financial performance of commercial banks in the nation by utilizing the CAMEL ratio analysis from 2006 to 2017. The ANOVA analysis result showed that commercial banks have statistically significant differences in their financial performance due to various reasons.

The health of bank can also be assessed using CAMEL. Mulyante Nugroho et al. (2020) used the CAMEL ratio to analyze the connection between bank health and stock price in Indonesia from 2012 to 2019. According to the findings, Capital adequacy ratio has a positive and significant impact on the share price of the stat-owned banks listed on the Indonesia Stock Exchange.

CAMEL ratings were used by Al-Najjar & Assous HF (2021) in their study to determine Saudi Arabi's deposit volume. The purpose of the study was to examine the impact of the CAMEL ranking on total deposit by analyzing Saudi bank financial ratios from 2014 to 2018. 13 ratios were employed by them to decrease the running of the CAMEL. The data analysis revealed that Alimma Bank had the highest CAR ratios and the highest Asset, while Arab National Bank and Bank Albilad had the lowest CAR. The lowest ranking was achieved by Bank Albila.

Despite its popularity as an analysis tool, the CAMEL framework has been the subject of debate from various authors. While some may argue that it has a positive impact on bank performance, others may disagree. Halil (2012)'s study examines which bank-specific, industry-specific, and macroeconomic factors have a positive or negative impact on the profitability of Turkish commercial banks. The author repeatedly asserted that there are two groups of factors that impact bank profitability. The first one being internal (bank-specific) and the other one external (industry-specific and macroeconomic). The objective was to determine whether these factors have a negative or positive impact on 26 commercial banks in Türkiye over the period of 2005-2010. Using ROA as the main indicator of profitability and measuring ROE enables banks to measure the efficiency of their use of shareholder equity to generate profits. The bank-specific performance shown to have a negative impact on its profitability, while industry-specific performance was mixed. The HHI (Herfindahl-

Hirschman Index) for credit is positive in relation to ROA, but the HHI for deposits was negative in relation to profit. Finally, in terms of macroeconomic determinants, inflation has negative and significant effect on bank profitability, in accords to the result. In relation to the study above, Athanasoglou et al. (2008) investigated how bank-specific, industry, and macroeconomic factors affected the bank profitability in Greece from 1985 to 2001. Nurazi & Usman (2016) analyzed the impact of financial fundamental by utilizing the CAMEL ratio and macroeconomic variables in Indonesia 2002 to 2011.

Angela and Alina (2013), aim to evaluate the financial soundness of banks using the CAMELS framework for period of 2004-2011. According to findings, all chosen banks are well-capitalized and have increased Capital adequacy to absorb any potential losses caused by the conducted activity. One bank recorded the lowest Asset quality, while five banks were found to have the weakest Management quality. Two banks had the financial performance, as highlighted by the indicators regarding Earning and profitability. The Liquidity analysis focuses on the weaknesses in one bank. However, when it comes to market risk sensitivity, there were two banks that stood out the most.

It has been noticed that the CAMEL rating system has different dimension of financial ratios when analyzing potential financial-troubled and sound financial institutions by certain predictions (Sahut et al., 2011). Mali's 2001 article used CAMEL analysis to determine which bank would collapse in the future. Taking into account all possible criteria can allow for both interbank comparisons and monitoring of the bank's historical development. In additions, it serves as an early warning system, enabling the detection of bank problems before they become worse, which allows for more intense and frequent supervision. However, bank conditions have the ability to change during on-site visits. Therefore, to ensure bank safety and soundness during on-site visits, supervisors use off-site monitoring.

The CAMEL approach is a method of financial performance to assess banks' soundness and safety, as Sarker (2005) explains. In today's dynamic environment, swiftly can experience changes due to multiple factors, as shown by its development in recent years. The global crisis is undoubtedly one of the most effective factors. Hasan Dincer et al. (2011) played a role in the CAMEL ratio analysis to develop the Turkish banking industry and analyze the general situation of foreign, state-, and privately-owned deposit banks, and to predict their future success. The objective was to develop a dataset that captures the impact of the global economic crisis of 2001 and 2008. As result of analysis data, it was observed

that positive developments were observed in terms of the performance of state-owned, privatized, and foreign banks after the 2001-2008 crises. In Gazi et al. (2022) study, they investigated how Covid 19 affect the financial performance and profitability of the listed private commercial bank in Bangladesh by utilizing the CAMEL rating approach.

Many studies choose for financial distress analysis over CAMEL and CAMELS because it includes variable S, which measures sensitivity to market risk by measuring interest rate sensitivity. According to Hays et al. (2009), the indicator S signifies sensitivity to the market for the purpose of evaluating interest rate risk or other market factors. Betz et al. (2014) reports that US regulators introduced CAMEL rating in 1979 to assess Capital adequacy, Assets quality, Management quality, Earnings, and Liquidity. Then CAMELS analysis was created in 1996 by adding the measurement rating system to CAMEL analysis. Betz et al. (2014) stated that CAMELS analysis is a tool for internal measurement that can evaluate and identify the health of financial institutions that are underperforming. CAMELS analysis is the most frequent and accessible method for risk analysis in commercial banking, as stated by Hays et al. (2009).

In this study, sensitivity to market risk is not included to concentrate on the CAMEL ratio, which is related to comparing the profitability of the two countries' banks.

Rustam and Saragih (2018) use Random Forest methods to forecast bank financial failures that occurred due to the financial crisis in Türkiye between 1994 to 2004. The purpose of this study is to examine how Random Forest is utilized and how accurate it is. 20 ratios are used as a variable of the CAMELS. The training performance of Random Forest is 100% accurate, with a higher accuracy rate than other methods, according to the results. The same method was employed by Tanak et al. (2016) to indentify patterns that indicate banks in danger of insolvency by analyzing their financial statements at the bank-level.

Almaskati (2022) this study examines the most crucial factors that impact bank risk and profitability by employing the Random Forest measure of relative value importance. The findings indicate that bank-specific factors are main determinants of profitability, while country-level factors have a significant effect on risk.

Table 4.1. Summary of the Previous Studies

Citation	Model	Ratios	Result
Dincer et al. (2011)	Multiple Regression (Panel)	**C**: Loan + Market + Principle Amount Subject to Operational Risk; Shareholders' Equity to Total Assets **A**: Financial Assets (Net) to Total Assets; Total Loans and Receivables to Total Assets Permanent Assets to Total Assets **M**: Interest Expense to Total Expense; Interest Income to Total Income; Total Income to Total Expense **E**: Net Profit (Losses) to Total Assets; Net Profit (Losses) to Total Shareholders' Equity **L**: Liquid Assets to Total Assets; Liquid Assets to Short-term Liabilities; Liquid Assets to Deposits+Non-Deposit Funds	In line of the result, positive developments were observed, as per the observation. The performance of bank system that are, privatized, foreign, and state-owned, during the 2001-2008 crises.
Halil (2012)	Multiple Regression (Panel)	**C**: Equity to Total Assets **A**: Loan Loss Provisions to Total Loans **M**: ROE, Total Costs to Total Income **E**: ROA **L**: Liquid Assets to Short Term Liabilities	The bank-specific performance shown to have a negative impact on its profitability, while industry-specific performance was mixed. The HHI (Herfindahl-Hirschman Index) for credit is positive in relation to ROA, but the HHI for deposits was negative in relation to profit. Finally, the impact of inflation in bank profitability is negative and significant, in terms of macro-economies analysis.
Andela and Alina (2013)	Multiple Regression (Panel)	**C**: CAR **A**: Impaired Loans Ratio; The Coverage of Non-Performing Loans; Total Loans to Total Assets **M**: Operating Expense to Total Assets; Deposit Interest Expense to Total Deposit **E**: ROA; ROE **L**: Liquid assets to Total Deposits	According to findings, each bank chosen has well-capitalized accounts and improved Capital adequacy to handle any possible losses that may arise from the conducted activities. One bank recorded the lowest Asset quality, while 5 banks were found to have the weakest Management quality. 2 banks had the financial performance, as highlighted by the indicators regarding Earning and profitability. The Liquidity analysis focuses on the weaknesses in one bank. However, when it comes to market risk sensitivity, there were 2 banks that stood out the most.

EM Ferrouhi (2014)	Multiple Regression (Panel)	**C**: Debt to Equity **A**: Loan Loss Provisions to Total Loans **M**: ROE **E**: ROA **L**: Deposits to Total Assets	According to the results CDM emerged as the highest ranked with an average of 4,4 in CAMEL, next by CAM with 4, BMCE and BCP with 3,4, AWB with 3,4 and BMCI with 2,2.
Mikail et al. (2014)	Multiple Regression (Panel)	**C**: CAR; Equity to Total Assets, Net On-Balance Sheet Position to Equity, Net-On and Off-Balance Sheet Position to Equity **A**: NPLs (net) to Total Loans and Receivables; Fixed Assets to Total Assets **M**: Profit per Employee Business per Employee; Personnel Expenses to Other Operating Expenses **E**: Net Profit (Losses) to Total Assets; Net Profit (Losses) to Total Shareholders' Equity **L**: Liquid Assets to Total Assets; Liquid Assets to Short-term Liabilities; Liquid Assets to Total Deposit	Their study revealed that central banks across the globe have enhanced their supervision quality and technique.
Gizaw et al. (2015)	Multiple Regression (Panel)	**C**: Capital to Asset, Debt to Equity **A**: Fixed Asset to Total Asset **M**: Non-interest expense to Gross Expense, Net Profit to Number Employees, Total deposit to Number of Branches, Total Loan to Number of Branches **E**: ROA, Interest Income to Total Income **L**: Liquid Asset to Deposit	It was revealed that the credit risk profile of Ethiopian banks has improved.
Maryam Munir et al. (2017)	Multiple Regression (Panel)	**C**: Debt to Equity **A**: ROA M: Cost to Income **E**: ROE **L**: Interest Expense to Deposit	Both countries have significant variations in comparative performance of each variable. The Management, Earning and Liquidity of both banks in each country are markedly different. Still based on a detailed analysis, comparing the performance of Indonesia and Malaysia conventional bank, show a significant alternation, including Management, Liquidity, and return on investment. And for both countries' Islamic bank's performance, the result reveals that change have been implemented in Liquidity and in Management.

Alemu & Aweke (2017)	Multiple Regression (Panel)	**C**: Capital to Asset, Debt to Equity **A**: Fixed Asset to Total Asset **M**: Non-Interest Expense to Gross Expense, Net Profit to Number of Employees, Total Deposit to Number of Branches, Total Loan to Number of Branches **E**: ROA, Interest Income to Total Income **L**: Liquid Asset to Deposit	The conclusion was that private sector were most profitable due to Asset quality, Management, Earnings, and Liquidity.
Liaqat & Alem (2019)	ANOVA	**C**: Equity multiplier, Dept to Equity **A**: Loan to Deposit **M**: Income Expense, Operating Efficiency **E**: ROA **L**: Cash to Deposit	It showed that commercial banks have statistically significant differences in their financial performance due to various reasons.
Bulti Haily (2019)	Multiple Regression (Panel)	**C**: Equity to Total Assets **A**: Net Fixed Asset to Total Assets **M**: Non-Interest Expense to Gross Expense **E**: Interest Income to Total Income, ROA, ROE **L**: Liquid Asset to Total Deposit	The outcome revealed that the liquidity ratio had positive associations with the profitability of banks for both ROA and ROE. Additionally, the liquidity ratio was statistically significant at the 1 percent significance level.
M. Nugroho et al. (2020)	Multiple Regression (Panel)	**C**: CAR **A**: Non-Performing Loans to Total Loans **M**: Net Profit to Total Revenue **E**: ROA **L**: Loan to Deposit	According to the findings, state-owned banks' share price is positively and significantly impacted but the Capital adequacy ratio listed on the Indonesia Stock Exchange.
Al-Najjar & Assous (2021)	Multiple Regression (Panel)	**C**: CAR, CAR Tier 1 **A**: Loan Losses to Total Loans, Loan Losses to Total Equity **M**: Net Profit per Employee, Efficiency Ratio, Earnings Growth **E**: ROA, ROE, Net Interest Income to Total Assets, Net Interest Income to Net Revenue **L**: Loans to Deposits, Saving Accounts to Total Deposits	The data analysis revealed that Alimma bank possessed the assets that were higher and the CAR ratio were higher, despite the fact that bank Albilad and Arab National bank were among the few institutions with the lowest CAR. The lowest ranking was achieved by Bank Albila, etc.

5. DATA AND METHODOLOGY

In the methodology section, the performance of private banks in Türkiye and Ethiopia for the period between 2007 and 2022 using the ratios of CAMEL Analysis is compared. First, (C) Capital Adequacy, (A) Asset Quality, (M) Management Adequacy, (E) Earnings, and (L) Liquidity ratios of the banks are analyzed for both countries and then Panel Data Analysis and Random Forest algorithm are used to analyze the ratios that affect profitability. In addition to comparing the bank performances of the two countries, the study also evaluates the performance of traditional and machine learning methods. The variables used in the models are compiled from the studies on bank performance evaluation in the literature.

5.1. Data Selection

The selection of Ethiopian private banks subject to the analysis was based on the criteria of establishment date and asset size. As of the end of 2022, of the twenty-nine banks operating in Ethiopia, one is publicly owned and twenty-eight banks are privately owned. According to these criteria, eight banks are selected, and the panel data set is constructed. These are Awash International Bank (AIB), Bank of Abyssinia (BOA), Cooperative Bank of Oromia (CBO), Dashen Bank (DB), Lib International Bank (LIB), Nib International Bank (NIB), United Bank (UB), and Wegagen Bank (WB) in alphabetical order. Table 5.1. shows the Total Assets and the establishment year of selected banks.

Table 5.1. Selected Banks in the Analysis from Ethiopia

Name	**Total Asset (In Millions of Birrs)**	**Establishment Year**
Awash International Bank	183,391.05	1994
Bank of Abyssinia	149,451.44	1996
Dashen Bank	117,144.03	1995
Cooperative Bank of Oromia	114.605,81	2005
United Bank	67,409.29	2000
Nib International Bank	61,491.32	2000
Wegagen Bank	43,121.66	2000
Lib International Bank	32,972.85	2007

Table 5.2. shows the years of establishment and asset size of Ethiopian private banks. Asset Size of Banks data was obtained from the Central Bank of Ethiopia. The table is ranked according to Asset size.

Table 5.2. The Name, Establishment, and Assets of Ethiopia Private Banks

Abbreviation	Name	Total Asset (In Millions of Birrs)	Establishment Year
AIB	Awash International Bank	183,391.05	1994
BOA	Bank of Abyssinia	149,451.44	1996
DB	Dashen Bank	117,144.03	1994
CBO	Cooperative Bank of Oromia	114,605.81	2008
UB	United Bank	67,409.29	1998
NIB	Nib International Bank	61,491.32	1999
OIB	Oromia International Bank	52,045.17	2008
WB	Wegagen Bank	43,121.66	1997
AB	Abay Bank	40,695.50	2010
ZB	Zemen Bank	35,119.78	2009
BulB	Bunna International Bank	34,103.55	2009
BrB	Berhan International Bank	33,064.67	2010
LIB	Lion International Bank	32,972.85	2006
SB	Siinqee Bank	20,537.07	2022
EB	Enat bank	17,209.03	2014
DGB	Debub Global Bank	14,085.62	2013
AdIB	Addis International Bank	10,788.31	2012
OB	Omo Bank	9,515.06	2022
AmB	Amhara Bank	7,073.24	2022
ZZB	Zamzam Bank	3,156.89	2022
ShB	Shabelle Bank	3,130.92	2021
HjB	Hijira Bank	2,279.13	2022
GBB	Goh Betoch Bank	1,210.18	2022
SdB	Sidama Bank	609.92	2022

The analysis includes all private banks operating in Türkiye, as presented in Table 5.3. Data on banks are obtained from the official website of the Banks Association of Türkiye.

Table 5.3. Selected Banks in the Analysis from Türkiye

Name	Total Asset (In Millions of TRL)	Establishment Year
Türkiye İş Bankası A.Ş.	1,408,323	1924
Yapı ve Kredi Bankası A.Ş.	1,108,094	1944
Akbank T.A.Ş.	1,075,186	1948
Türk Ekonomi Bankası A.Ş.	275,147	1927
Fibabanka A.Ş.	74,109	1984
Şekerbank T.A.Ş.	63,244	1953
Anadolubank A.Ş.	39,295	1997
Turkish Bank A.Ş.	2,895	1981

After reviewing the theoretical framework and previous studies on banking ratios, the following four hypotheses are developed based on the findings of these studies and the ratios used. These hypotheses are designed to examine in detail the impact of banks' financial ratios on ROA (Return on Assets). In particular, we focus on how ratios such as CASH_DEP, EQUTY_MULT, INCOMEXP and LOAN_DEP may have different effects in the banking sectors in both Ethiopia and Türkiye. The purpose of these hypotheses is to contribute to a better understanding of the factors affecting the performance of banks in different economic and regulatory environments by extending the existing body of knowledge in the literature. Thus, the following hypotheses were considered:

H_1: Equity Multiplier will be positively related to Return on Asset

H_2: Loan to Deposit Ratio will be positively related to Return on Asset

H_3: Operational Income to Operational Expense will be positively related to Return on Asset

H_4: Liquid Assets to Deposit will be positively related to Return on Asset

The abbreviations and formulas of the ratios used in the analysis are explained in Table 5.4. All ratios are obtained from the Central bank of Ethiopia and the official website of the Banks Association of Türkiye.

Table 5.4. The Ratio Used for This Study

Abbreviation	**CAMEL**	**Ratios**	**Formula**
EQUTY_MULT	Capital Adequacy	Equity Multiplier	Total Asset/ Total Equity
LOAN_DEP	Asset Quality	Loan to Deposit	Total Loans/ Total Deposit
INCOMEXP	Management Quality	Income to Expense	Net Income/ Operating Expense
ROA	Earning Ability	Return on Asset	Net Income/ Total Asset
CASH_DEP	Liquidity	Liquid Assets to Deposit	Total Cash/ Total Deposit

5.2. Ethiopia Private Bank’s Ratio Analysis

In this section, performance comparison analyses of selected private banks from the Ethiopian Banking System are conducted using CAMEL ratios.

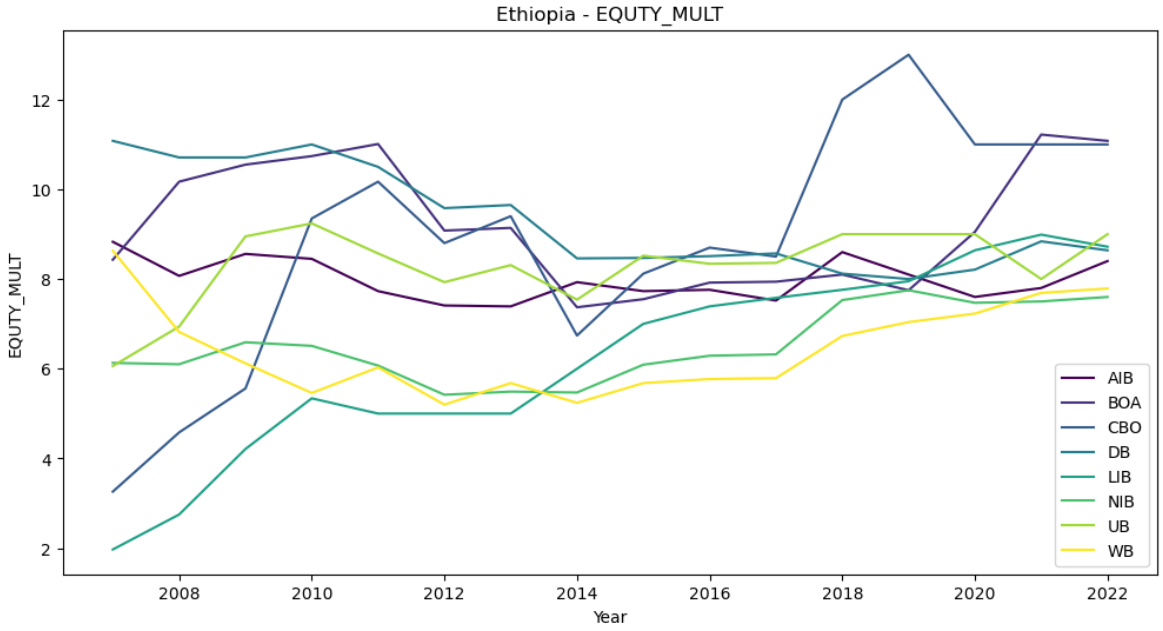
5.2.1. Capital Adequacy: Equity Multiplier

This ratio shows the level of assets held by shareholders' equity. It evaluates what percentage of the bank's assets are backed by equity.

Table 5.5. Equity Multiplier

Years/Banks	AIB	BOA	CBO	DB	NIB	UB	WB	LIB
2007	8.83	8.43	3.26	11.08	6.13	6.06	8.63	1.97
2008	8.07	10.17	4.58	10.71	6.10	6.94	6.82	2.75
2009	8.56	10.55	5.56	10.71	6.59	8.95	6.12	4.21
2010	8.45	10.74	9.35	11.00	6.51	9.24	5.46	5.34
2011	7.73	11.01	10.17	10.50	6.07	8.57	6.03	5.00
2012	7.41	9.08	8.80	9.58	5.42	7.93	5.20	5.00
2013	7.39	9.14	9.40	9.65	5.49	8.31	5.68	5.00
2014	7.93	7.37	6.74	8.46	5.47	7.54	5.24	6.00
2015	7.73	7.55	8.12	8.47	6.09	8.52	5.68	7.00
2016	7.76	7.92	8.70	8.51	6.29	8.34	5.77	7.39
2017	7.52	7.94	8.50	8.57	6.32	8.36	5.79	7.58
2018	8.60	8.10	12.00	8.12	7.53	9.00	6.73	7.76
2019	8.10	7.75	13.00	8.00	7.75	9.00	7.04	7.95
2020	7.60	9.05	11.00	8.21	7.47	9.00	7.23	8.64
2021	7.80	11.22	11.00	8.84	7.50	8.00	7.69	8.99
2022	8.40	11.08	11.00	8.64	7.60	9.00	7.79	8.72

Figure 5.1. Equity Multiplier Ratio



As shown in Table 5.5. and Figure 5.1. it's the private bank of Ethiopia's equity multiplier. Starting in 2007, the LIB and CBO will expand until 2022. WB experiences a constant decline and increase in equity multiplier between 2007 and 2010. AIB, BOA, DB, NIB, UB, and WB's equity multiplier performance was consistent until the study years. Financing its assets can be done by the bank with less debt. The lower the equity multiplier the better.

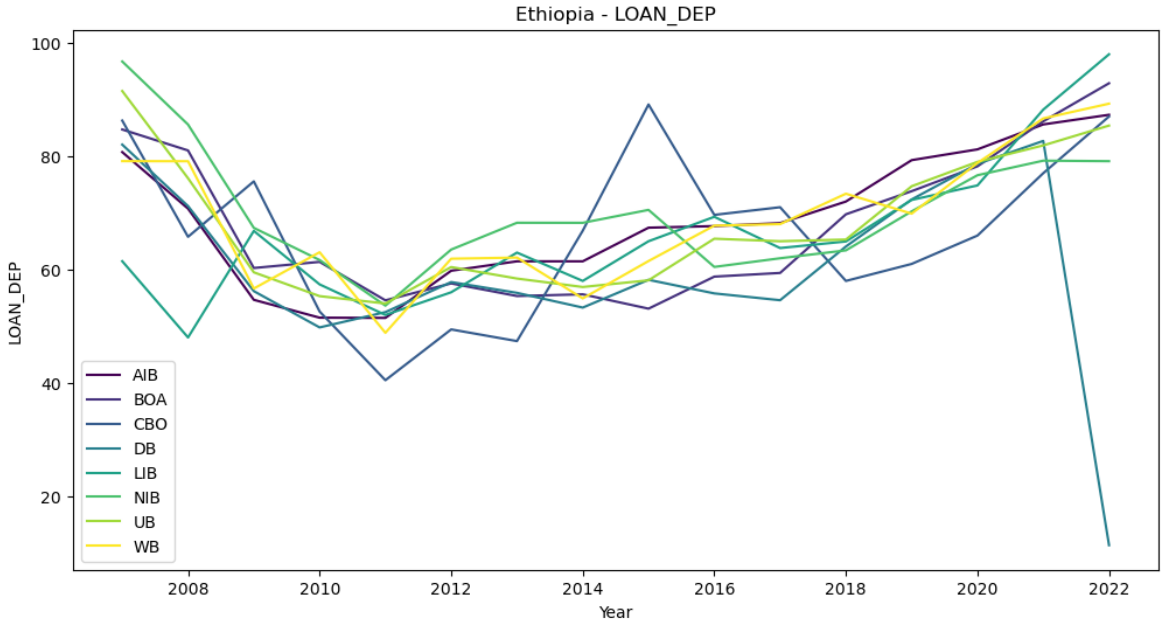
5.2.2. Asset Quality: Loan to Deposit

Liquidity is usually associated with the Loan to Deposit Ratio because it measures the number of loans compared to deposits. Although, it may be considered as Asset Quality in certain analyses because it reflects the bank's lending activities and potential risk exposure (Liaqat & Alem, 2019). A balance sheet with high cash holdings and an asset structure based on equity financing helps protect the bank against credit loss risks, which can be generally associated with high asset quality. That is, banks' high cash reserves and low use of leverage are generally considered an indicator of high asset quality

Table 5.6. Loan to Deposit Ratio

Years/Banks	AIB	BOA	CBO	DB	NIB	UB	WB	LIB
2007	80.72	84.71	86.28	82.04	96.70	91.49	79.13	61.48
2008	70.75	81.01	65.78	71.20	85.58	76.11	79.11	48.03
2009	54.67	60.28	75.56	56.20	67.36	59.52	56.66	66.82
2010	51.52	61.36	52.61	49.80	61.69	55.32	63.06	57.39
2011	51.48	54.58	40.49	52.50	53.64	54.02	48.85	52.00
2012	59.80	57.56	49.45	57.80	63.53	60.45	61.92	56.00
2013	61.46	55.34	47.39	55.90	68.26	58.42	62.12	63.00
2014	61.46	55.64	66.86	53.30	68.25	56.93	54.92	58.00
2015	67.39	53.11	89.12	58.20	70.53	58.11	61.51	65.00
2016	67.67	58.76	69.65	55.80	60.47	65.45	67.75	69.31
2017	68.20	59.41	71.00	54.60	62.00	65.00	68.02	63.80
2018	72.00	69.75	58.00	64.07	63.39	65.30	73.38	64.96
2019	79.30	73.83	61.00	72.37	70.27	74.70	69.87	72.29
2020	81.20	78.21	66.00	78.64	76.64	79.00	78.80	74.84
2021	85.60	86.15	77.00	82.69	79.21	81.90	86.66	88.21
2022	87.30	92.86	87.00	11.40	79.12	85.40	89.26	97.97

Figure 5.2. Loan to Deposit Ratio



As depicted in Table 5.6. and Figure 5.2 reveals that the majority of banks in the LDR except CBO fall drastically up to fiscal year of 2011. From 2007 to 2012, CBO experienced a decrease, but then decreased from 2012 to 2022. CBO witnessed an impressive increase from 2013 to 2015, but it decelerated from 2015 to 2018, and then rebounded from 2021 to 2022. The DB reveals a staggering drop from 2021 to 2022, dropping from 82.69 to 11.40 in the LDR trend. However, there was a significant increased for other banks between 2013 and 2022. An excessive loan deposit ratio could result in the bank not having enough cash to meet any unexpected fund policies. In contrast, if the ratio is too low, it could indicate that the bank is not generating sufficient income.

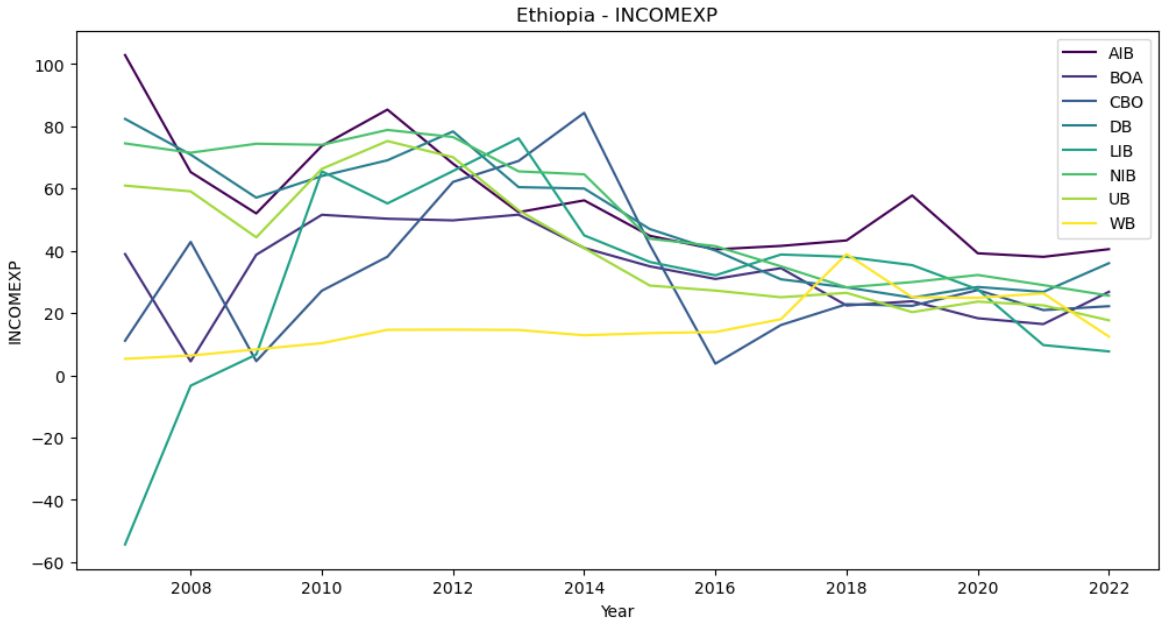
5.2.3. Management Quality: Income to Expense

The effectiveness and efficiency of the bank's asset management and liability control are measured by this ratio. This ratio determines the amount of revenue a bank can generate by exploiting its assets and liabilities.

Table 5.7. Income to Expense Ratio

Years/Banks	AIB	BOA	CBO	DB	NIB	UB	WB	LIB
2007	102.87	38.95	11.11	82.37	74.50	60.95	5.29	-54.34
2008	65.29	4.47	42.85	70.91	71.51	59.09	6.35	-3.33
2009	52.00	38.73	4.54	57.07	74.39	44.33	8.32	6.66
2010	73.70	51.56	27.17	64.02	74.05	66.33	10.33	65.52
2011	85.36	50.30	38.10	69.08	78.83	75.26	14.61	55.22
2012	67.98	49.78	62.12	78.35	76.55	70.06	14.67	65.63
2013	52.40	51.60	68.86	60.44	65.51	52.99	14.56	76.13
2014	56.20	40.92	84.32	60.00	64.57	40.87	12.86	44.95
2015	44.82	35.01	41.93	46.99	43.89	28.83	13.56	36.41
2016	40.46	30.95	3.74	40.07	41.50	27.22	13.90	32.12
2017	41.57	34.43	16.16	30.84	35.01	25.07	18.03	38.80
2018	43.33	22.43	22.84	28.25	28.25	26.49	38.94	38.06
2019	57.78	23.79	22.32	24.94	29.94	20.29	25.09	35.40
2020	39.20	18.33	27.38	28.38	32.23	23.67	24.90	27.60
2021	38.06	16.45	20.95	26.78	28.98	22.47	26.32	9.71
2022	40.52	26.82	22.20	36.01	25.59	17.67	12.44	7.67

Figure 5.3. Income to Expense Ratio



The income to expense ratio of commercial bank can be seen in Table 5.7. Figure 5.3. above, the most outstanding bank here is the AIB. It showed an incredible increase from 2007 to 2009 and 2012, but then decreased significantly from 2012 to 2018, then showed an unchanged variation from 2018 to 2022. BOA and CBO were in opposite directions from 2007 to 2009, but then they increased together and remained stable. On the flip side, LIB demonstrates a great progress from 2007-2014, then drop from 2014 to 2016. WB was the only bank stayed the same until 2017, but then it grew. Moreover, every bank remained viable from 2018 to 2022. Banks can earn enough income to pay for their operating expenses if their income expense ratio is higher.

5.2.4. Earning Quality: Return On Asset

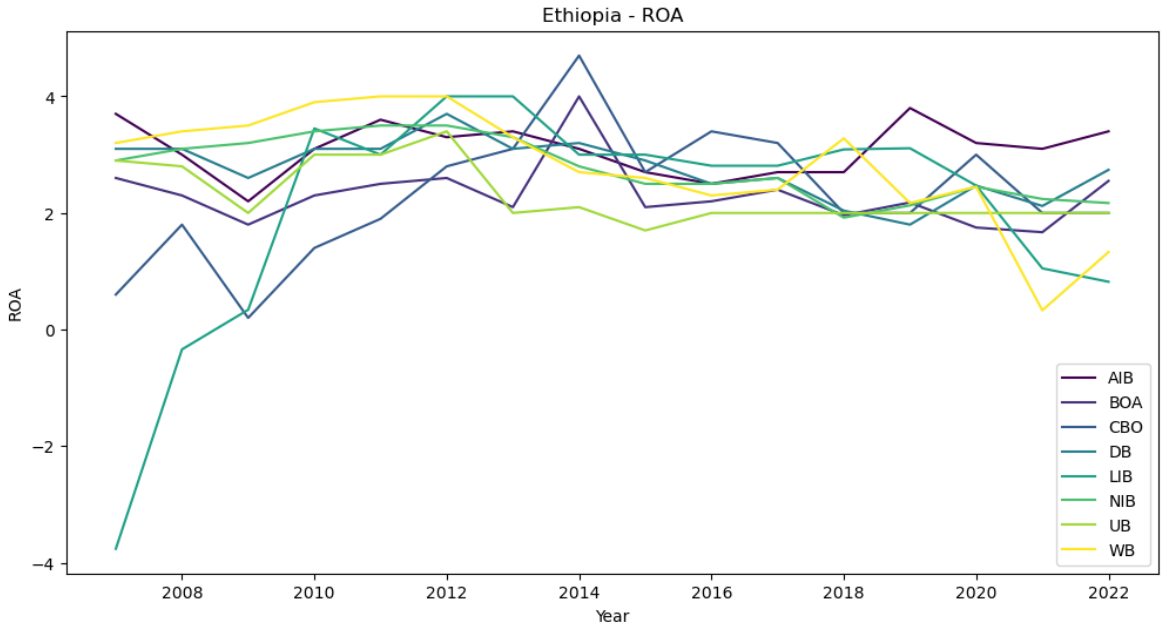
The ratio measures the bank's profitability by attracting more deposits and providing loans to customers. In other words, ROA indicates the bank's ability to generate revenues from its assets. This ratio is commonly used to assess the profitability of the bank's total assets. The bank's profitability is higher if its ROA is higher.

Table 5.8. Return on Assets

Year/Banks	AIB	BOA	CBO	DB	NIB	UB	WB	LIB
2007	3.70	2.60	0.60	3.10	2.90	2.90	3.20	-3.76
2008	3.00	2.30	1.80	3.10	3.10	2.80	3.40	-0.34
2009	2.20	1.80	0.20	2.60	3.20	2.00	3.50	0.34
2010	3.10	2.30	1.40	3.10	3.40	3.00	3.90	3.45
2011	3.60	2.50	1.90	3.10	3.50	3.00	4.00	3.00
2012	3.30	2.60	2.80	3.70	3.50	3.40	4.00	4.00
2013	3.40	2.10	3.10	3.10	3.30	2.00	3.30	4.00
2014	3.10	4.00	4.70	3.20	2.80	2.10	2.70	3.00
2015	2.70	2.10	2.70	2.90	2.50	1.70	2.60	3.00
2016	2.50	2.20	3.40	2.50	2.50	2.00	2.30	2.81
2017	2.70	2.40	3.20	2.60	2.60	2.00	2.40	2.81
2018	2.70	1.96	2.00	2.04	1.92	2.00	3.28	3.09
2019	3.80	2.18	2.00	1.80	2.13	2.00	2.17	3.11
2020	3.20	1.75	3.00	2.47	2.45	2.00	2.45	2.47
2021	3.10	1.67	2.00	2.12	2.24	2.00	0.33	1.05
2022	3.40	2.55	2.00	2.74	2.17	2.00	1.33	0.82

Table 5.8. and Figure 5.4. demonstrate that the performance of all banks in ROA, except for LIB, CBO, exhibits variations throughout their operation period. The study period witnessed a swing of increase in LIB's ROA performance from 2007 to 2014, between 2014 and 2021 it began to decrease, but then it rises again from 2021 to 2022. The CBO variation was boosted between 2007 and 2014, then decreased from 2014 to 2021, and then increased from 2021 to 2022. The ROA of AIB, BOA, DB, NIB, UB, and WB was steady from 2007 to 2015, but then started to decline from 2015 to 2021. From 2021 to 2022, all of them will have increase. When ROA increases, it means that a company is productive and efficient in managing assets to create profits, while when it decreases, it means that they need to upgrade or improve.

Figure 5.4. Return on Asset



5.2.5. Liquidity: Cash to Deposit Ratio (CDR)

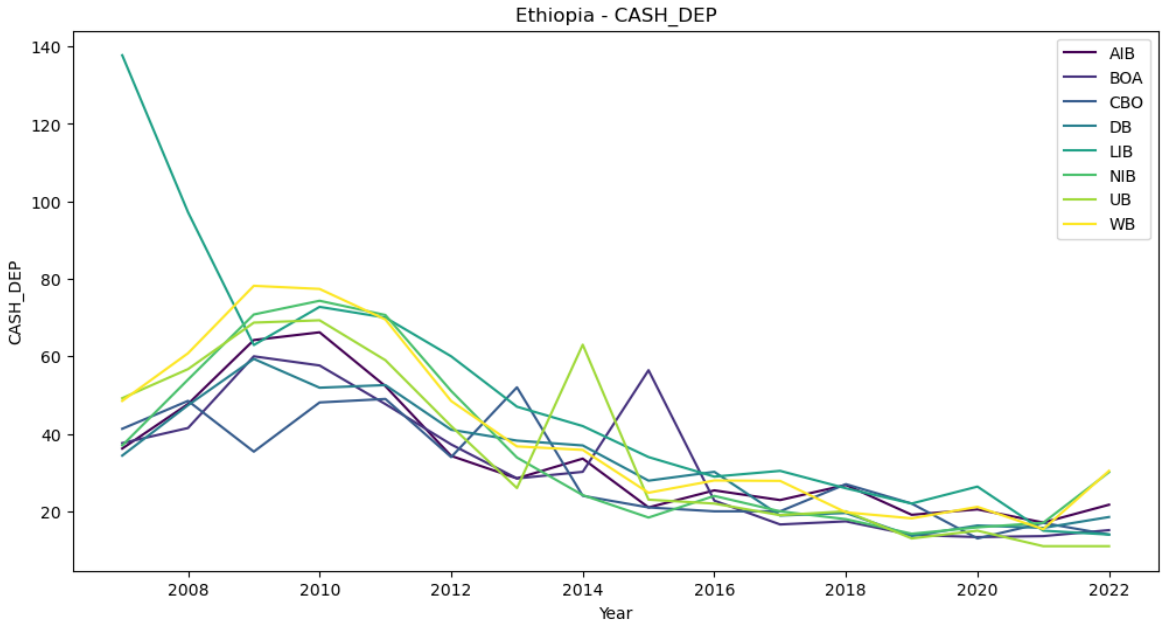
The ratio is used to calculate the amount of money a bank can offer based on the deposits that's collected. A bank with a higher CDR is more liquid than the bank with lower CDR. Depositors' confidence in a bank increase with a higher CDR.

Table 5.9. Cash to Deposit Ratio

Years/Banks	AIB	BOA	CBO	DB	NIB	UB	WB	LIB
2007	36.20	37.60	41.30	34.38	37.00	49.20	48.50	137.7
2008	47.70	41.50	48.50	47.39	54.00	56.70	60.80	97.2
2009	64.20	60.00	35.40	59.34	70.80	68.70	78.20	62.92
2010	66.20	57.64	48.10	51.90	74.34	69.30	77.39	72.77
2011	52.30	47.67	49.00	52.58	70.66	59.00	69.51	70.00
2012	34.30	37.26	34.00	41.05	51.06	42.00	48.47	60.00
2013	28.50	28.49	52.00	38.24	33.88	26.00	36.75	47.00
2014	33.60	30.19	24.00	37.00	24.18	63.00	35.85	42.00
2015	21.00	56.42	21.00	27.91	18.39	23.00	24.79	34.00
2016	25.40	22.76	20.00	30.19	23.97	22.00	27.96	28.95
2017	22.90	16.61	20.00	18.91	19.99	19.00	27.85	30.44
2018	26.80	17.41	27.00	19.57	17.97	20.00	19.74	25.94
2019	19.10	13.91	22.00	13.62	14.21	13.00	18.18	22.01
2020	20.50	13.35	13.00	16.34	15.86	15.00	21.15	26.38
2021	17.10	13.60	17.00	15.72	17.05	11.00	15.39	15.00
2022	21.70	15.14	14.00	18.53	30.11	11.00	30.44	14.00

Table 5.9 and Figure 5.5. show that the banks studied in this study, except for LIB, experienced a significant drop in their CDR trend. LIB experience a continuous extreme decrease in CDR throughout the study period. While, BOA, UB, and CBO experienced a variety of fluctuations in their CDR, varying from 2013 to 2014 and 2015 respectively. The other banks, such as AIB, BOA, CBO, DB, NIB, UB and WB were making gains from 207 up to 2010, but then increased thereafter until 2021. From 2021 to 2022, it appears that some banks are expending. The bank's liquidity is reduced by the decrease in CDR compared to another bank. As a result, the banks are unable to provide a loan using the collected deposit.

Figure 5.5. Cash to Deposit Ratio



5.3. Türkiye Private Bank's Ratio Analysis

In this section, the performance of selected private banks from the Turkish Banking System is analyzed using CAMEL ratios.

5.3.1. Capital Adequacy: Equity Multiplier

Table 5.10. Equity Multiplier

Years/Banks	Akbank	Anadolubank	Fibabanka	Şekerbank	Turkish Bank	TEB	Türkiye İş Bankası	YKB
2007	6.45	8.26	10.99	7.04	7.63	12.99	7.58	10.31
2008	7.63	6.67	8.2	8.26	5.65	10.31	10.31	9.26
2009	6.71	6.06	8.77	7.14	6.76	9.17	8.4	7.81
2010	6.45	5.95	8.4	8.13	6.58	10.53	7.75	8.2
2011	7.63	6.9	10.64	9.8	5.85	9.01	9.01	9.26
2012	7.09	5.43	10.2	7.94	5.78	9.09	7.75	7.25
2013	8.62	7.09	13.33	9.09	6.54	10.1	8.93	8.62
2014	8.2	7.69	13.7	8.85	7.52	10.64	8.13	9.43
2015	8.77	8.06	10.75	9.71	6.41	10.31	8.62	9.52
2016	8.85	8.2	11.9	9.43	7.75	10.2	8.7	9.71
2017	7.81	8.55	13.7	11.49	7.87	9.52	8.4	9.9
2018	7.46	6.13	15.63	13.16	7.35	10	8.4	8.93
2019	6.62	6.33	13.16	15.38	6.9	10.99	7.94	9.43
2020	7.09	7.87	14.49	14.29	7.69	12.35	8.77	9.71
2021	9.35	7.87	19.23	16.95	10.2	14.29	10.64	11.63
2022	6.99	5.68	11.36	13.51	12.05	10.87	7.35	8.77

Figure 5.6. Equity Multiplier

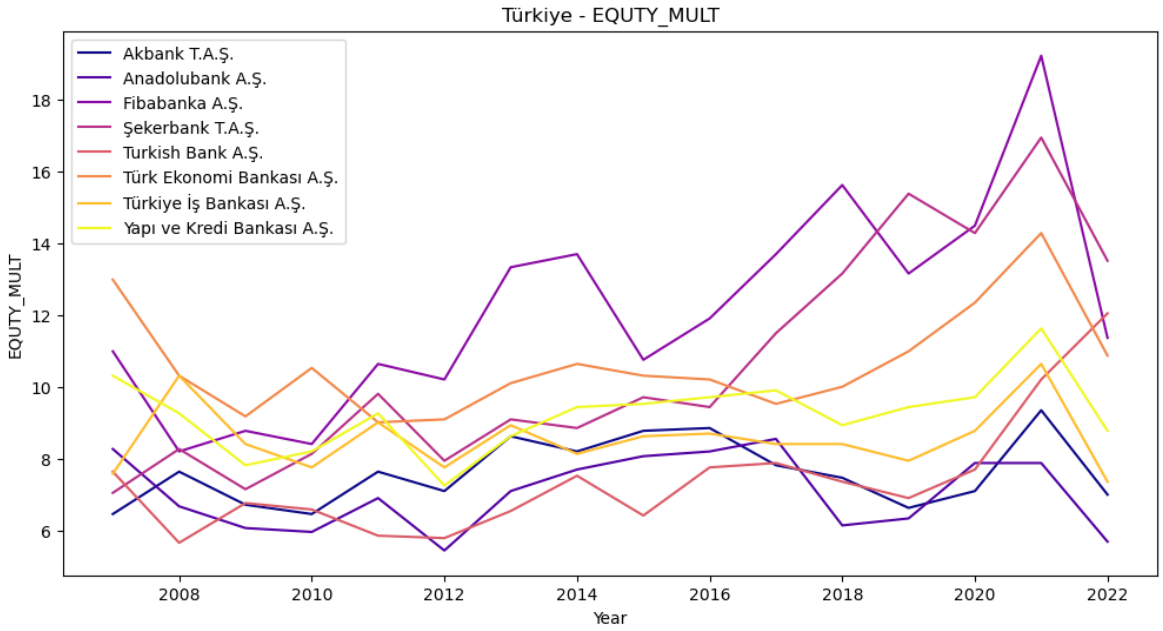


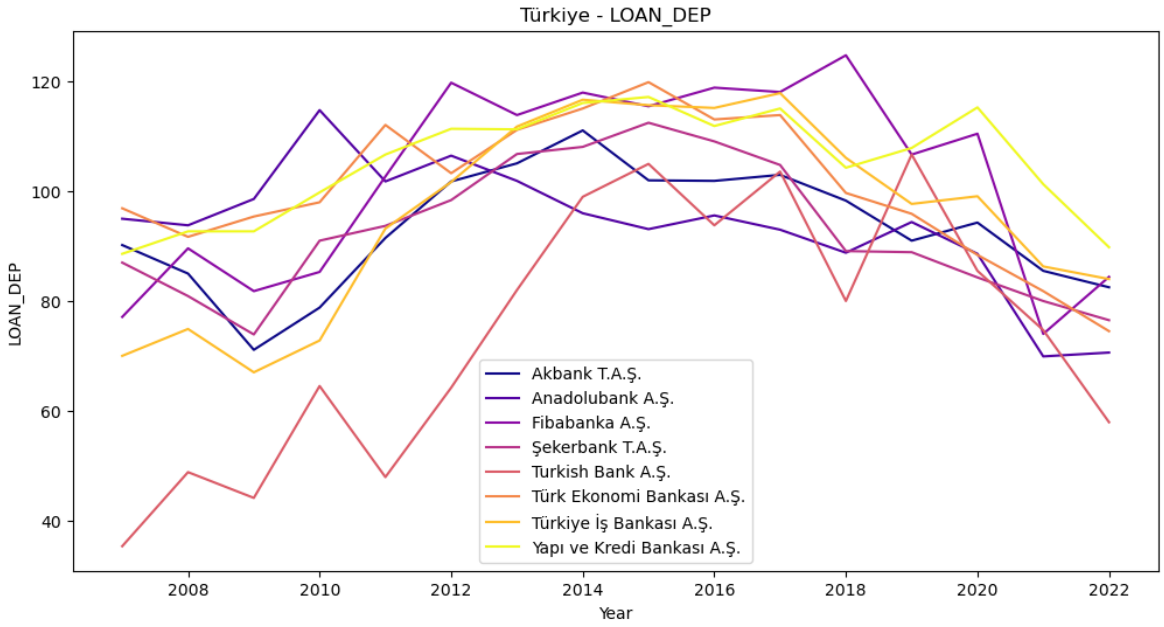
Table 5.10. and Figure 5.6. reveal the equity multiplier for every private bank in Türkiye from 2007 to 2022. In 2007, Fibabank began to increase and then experienced a fluctuation until 2022. There is a significant decrease from 2021 to 2022. Şekerbank experienced a shift between 2015 and 2016, with a rise from 2016 to 2021, followed by a fall from 2021 to 2022. From 2007 to 2020, the rest of the banks, including Akbank, Anadolubank, Turkish Bank, Türk Ekonomi Bankası, Turkiye İş Bankası, and Yapi ve Kedi Bankası, experienced low fluctuations, but the increase was favorable before falling significantly.

5.3.2. Asset Quality: Loan to Deposit

Table 5.11. Loan to Deposit Ratio

Years/Banks	Akbank	Anadolubank	Fibabanka	Şekerbank	Turkish Bank	TEB	Türkiye İş Bankası	YKB
2007	90.2	95	77.1	87	35.3	96.9	70	88.6
2008	85	93.8	89.6	80.9	48.8	91.7	74.9	92.7
2009	71.1	98.6	81.8	73.9	44.1	95.4	67	92.7
2010	78.8	114.8	85.3	91	64.5	98	72.8	99.8
2011	91.5	101.8	102.7	93.7	47.9	112.1	93.2	106.7
2012	101.8	106.5	119.8	98.4	64.2	103.3	101.7	111.4
2013	105.1	101.9	113.9	106.8	82	111.2	111.8	111.3
2014	111.1	96	118	108.1	99	115.1	116.7	116.1
2015	102	93.1	115.5	112.5	105	119.9	115.7	117.2
2016	101.9	95.6	118.9	109.1	93.8	113.1	115.2	111.9
2017	103	93	118.1	104.8	103.6	113.9	117.9	115.1
2018	98.3	88.8	124.8	89.1	80	99.7	106.1	104.3
2019	91	94.4	106.7	88.9	106.7	95.9	97.7	107.9
2020	94.3	88.6	110.5	84.3	85.5	88.4	99.1	115.3
2021	85.5	69.9	74	80	74.7	81.8	86.3	101.3
2022	82.5	70.6	84.4	76.5	57.9	74.5	84	89.8

Figure 5.7. Loan to Deposit Ratio



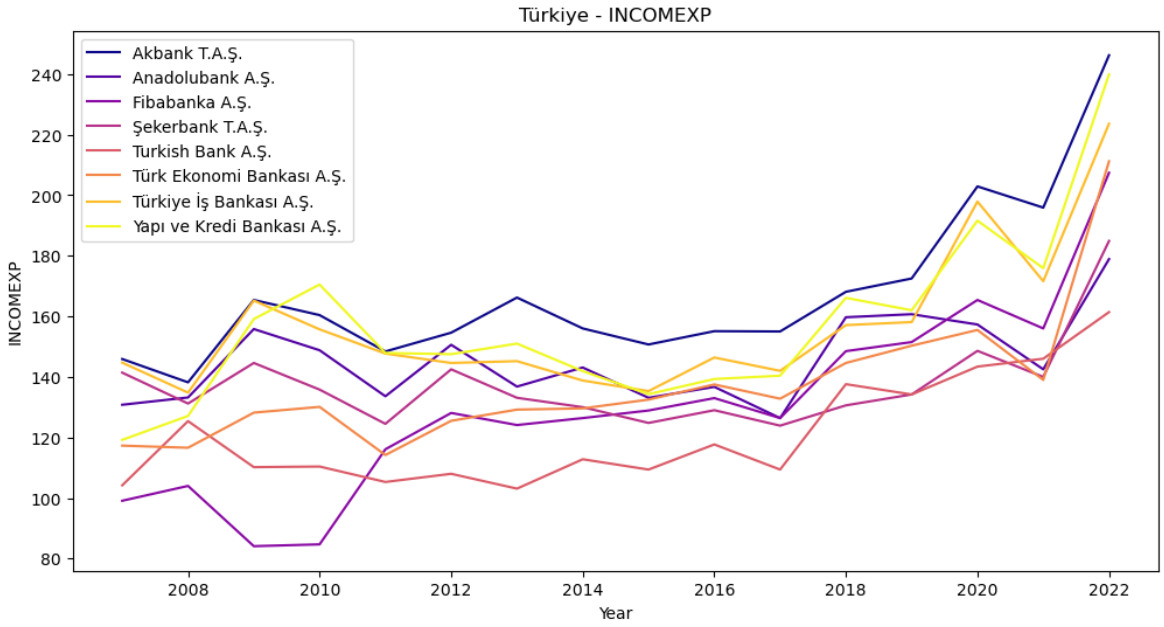
The Table 5.11. and Figure 5.7. show the bank's performance in LDR. It is clear from the graph that the Turkish Bank is the most outstanding. In 2007, the loan to deposit ratio was 35.8, but it quickly grew until 2015. Afterwards, it will decrease from 2015 to 2022. Since 2007, Turkiye İş Bankası was the with lowest LDR, but it rose until 2015 and then went down from 2018 to 2022. Fibabank began with 77.1 and experienced fluctuation from 2012-2015-2020, but ultimately dropped. Akbank, Anadolubank, Şekerbank, Türk Ekonomi Bankası and Yapi ve Kredi Bankası, among other banks, experienced a constant shift in their LDR during the same period. In general, it's apparent that all banks have decreased by 2022.

5.3.3. Management Quality: Income to Expense

Table 5.12. Income to Expense Ratio

Years/Banks	Akbank	Anadolubank	Fibabanka	Şekerbank	Turkish Bank	TEB	Türkiye İş Bankası	YKB
2007	145.9	130.8	99.1	141.4	104.2	117.3	144.7	119.2
2008	138.2	133.2	104	131.2	125.4	116.6	134.8	127.1
2009	165.4	155.8	84.1	144.6	110.2	128.2	165.2	159.1
2010	160.4	148.8	84.7	135.8	110.4	130.1	155.7	170.5
2011	148.4	133.6	116.1	124.5	105.3	114.2	147.7	147.9
2012	154.6	150.6	128.1	142.5	108	125.5	144.6	147.5
2013	166.2	136.8	124.1	133.1	103.1	129.2	145.2	151
2014	156	143.1	126.4	130	112.8	129.6	138.8	141.9
2015	150.7	133.1	128.9	124.8	109.4	132.5	135.3	134.3
2016	155.1	136.7	133	129	117.7	137.5	146.4	139.3
2017	155	126.4	126.4	123.9	109.4	132.8	142	140.4
2018	168.1	159.7	148.5	130.6	137.6	144.6	157.1	166.1
2019	172.5	160.7	151.5	134.2	134.2	150.3	158.1	162
2020	202.9	157.3	165.4	148.6	143.4	155.5	197.9	191.6
2021	195.9	142.5	156	140	146	139	171.6	175.9
2022	246.2	178.9	207.4	184.9	161.4	211.2	223.6	239.9

Figure 5.8. Income Expense Ratio



During the study period, Table 5.12. and Figure 5.8. show the performance of banks' income expense ratio in Türkiye between year 2007 to 2022. Fibabank is the bank that is somewhat noticeable on the graph. It decreased from 2007 to 2009, but then increased in 2009, there were no change in 2010. From 2010 to 2021, you will observe changes and an increase in 2022. The remaining banks, Anodolubank, Şekerbank, Turkish bank, Türk Ekonomi Bankası, Türkiye İş Bankası, and Yapı ve Kredi Bankası, have experienced similar ups and downs since 2007. From 2021 to 2022, there is an incredible escalation.

5.3.4. Earning Quality: Return On Asset

Table 5.13. Return on Asset Ratio

Years/Banks	Akbank	Anadolubank	Fibabanka	Şekerbank	Turkish Bank	TEB	Türkiye İş Bankası	YKB
2007	3.2	2.5	-0.3	2.4	0.2	1.3	2.2	1.4
2008	2.2	2.7	0.2	2	1.3	1.2	1.7	1.8
2009	3	3.3	-1.6	1.8	0.1	1.4	2.3	2.1
2010	2.7	2.9	-1.5	1.7	0.3	1.8	2.4	2.8
2011	1.9	1.7	0.3	0.9	0.1	0.7	1.8	1.9
2012	2	2.8	1.4	1.7	0.2	1.2	2	1.7
2013	1.7	1.3	0.8	1.3	0	1.1	1.6	2.4
2014	1.6	1.7	1	1.1	0.4	1.1	1.5	1.1
2015	1.4	1.4	0.8	0.5	0.3	1.3	1.2	0.9
2016	1.8	1.5	0.9	0.5	0.4	1.2	1.6	1.2
2017	2.1	1.1	0.9	0.4	0.3	1.3	1.6	1.3
2018	1.8	2.1	1	0.3	0.4	1.1	1.7	1.4
2019	1.6	2.4	1	-2.2	0	1	1.4	1
2020	1.6	1.9	0.9	0.2	0	1	1.3	1.2
2021	2.1	1.8	1.1	0.6	0.3	1.1	1.8	1.8
2022	6.7	5.2	4.5	2.6	0.9	4.8	5.3	5.7

Figure 5.9. Return on Asset

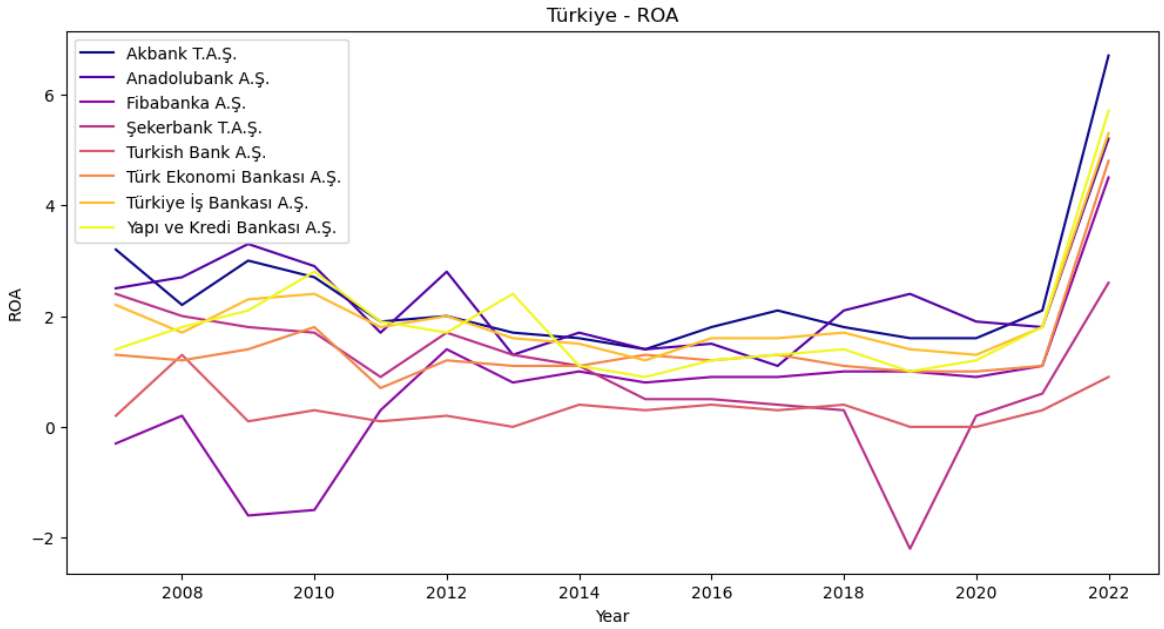


Table 5.13 and Figure 5.9. above display the performance of private bank in Türkiye in ROA. Fibabank experience has been up and down from 2007 to 2012. The variation remained steady from 20012 to 2021, but it rapidly increased from 2021 to 2022. Şekerbank's performance fluctuated between 2007 and 2018, but it experienced a hard period from 2018 to 2022 and then rebounded to 2022. Despite minor highs and lows from 2007 to 2021, the banks such as Akbank, Anadolubank, Türk Ekonomi Bankası, Turkiye İş Bankası, and Yapı ve Kredi Bankası banks' all saw a swift rise in 2021 to 2022. The Turkish Bank started well from 2007 to 2008, but then fell off until 2021, but then started to increase again, unlike the other banks.

5.3.5. Liquidity: Cash to Deposit Ratio (CDR)

Table 5.14. Cash to Deposit Ratio

Years/Banks	Akbank	Anadolubank	Fibabanka	Şekerbank	Turkish Bank	TEB	Türkiye İş Bankası	YKB
2007	42.8	23.9	32.7	30.9	77.4	36.4	45.9	9.8
2008	21.4	17.8	22.7	18.2	70.3	31.6	41.3	13.1
2009	39	16.2	28.7	25.2	73.1	29.6	38.6	14.3
2010	45.2	13	25	25.4	54.9	33.3	33.2	16.2
2011	41.6	20.4	13.4	32.3	64.5	28.3	28.6	19.6
2012	39.7	27.9	16.3	19.6	51.8	26.9	25.7	26.4
2013	31.2	27.1	21.1	16.5	47	23.9	26.2	26.5
2014	31.8	20.4	21.4	17.6	31.7	23.5	28	25.8
2015	33	33.3	20.3	19.5	25.3	22.3	27.4	24.1
2016	31.4	24.3	23.7	13.4	27.1	25.9	26.5	21.8
2017	29.8	22	26.3	23.6	17.7	22.8	24.9	24.8
2018	14.9	16	14.7	11.9	30.1	20.5	11.7	16.5
2019	12.9	16.8	14.8	13.1	18.1	19.9	14.1	19.2
2020	12.9	13.8	15.5	13.9	32.8	21.2	14.2	14.7
2021	20.2	25.2	32.2	22.4	38.4	24.4	22.2	19.5
2022	14.9	24.8	25.8	18.4	47.8	22	15.8	15.6

Figure 5.10. Cash to Deposit Ratio

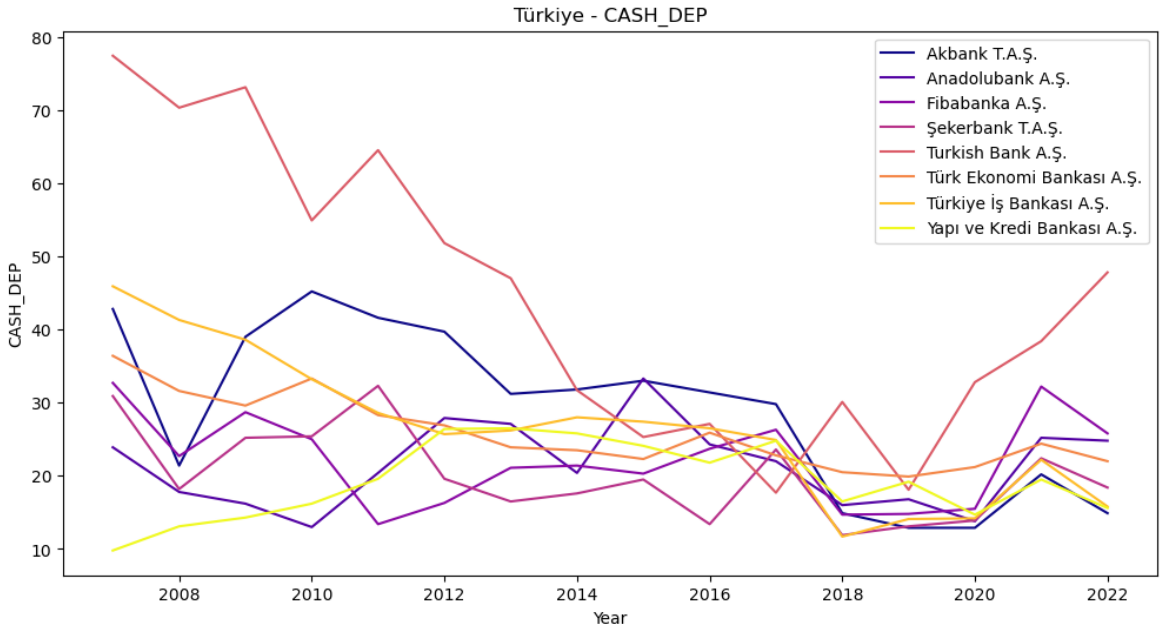


Table 5.14. and Figure 5.10. reveal how CDR affects banks in Türkiye. The Turkish bank's experience was unique compared to the other banks. It began at a high level of 77.4 in 2007, then dropped sharply to 17.7 in 2017, but then showed an incredible rise from 2017 to 2022 in CDR. Starting and ending the year with 9,8, the Yapı ve Kredi Bank had the lowest score, but it gradually increased until 2014 and then shrank more until 2022. Türkiye İş Bankası experience a rise and fall from 2007 to 2010, then a decline until 2022. The rest of the bank as Akbank, Anadolubank, Türk Ekonomi Bankası, Fibabank, and Şekerbank experience growth and decrease from 2007 to 2022.

5.4. Comparative Analysis of Bank Performance of Ethiopia and Türkiye

After performing a comparative analysis of each private bank ratio within the countries, this section presents a comparative analysis of private bank ratios across countries. The following line graphs illustrate the results of the CAMEL ratio evaluation for the bank ratios of Ethiopia and Türkiye between 2007 and 2022.

5.4.1. Capital Adequacy: Equity Multiplier

Figure 5.11. Equity Multiplier Ratio

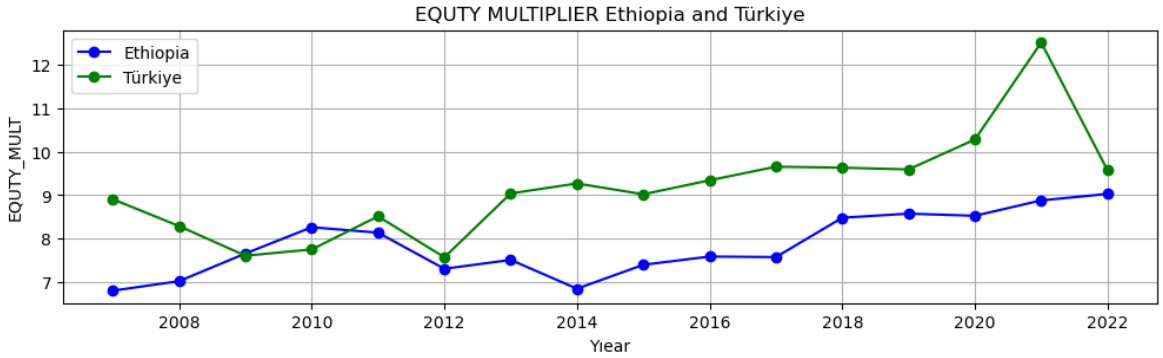


Figure 5.11. describes the performance of Ethiopia and Türkiye's equity multiplier from 2007 to 2022. Four intersecting lines are visible in this figure. The first one was in 2009, followed by 2013, 2015, and the last one in 2021. We noticed that the banks were too close to each other in this ratio.

5.4.2. Asset Quality: Loan to Deposit

Figure 5.12. Loan to Deposit Ratio

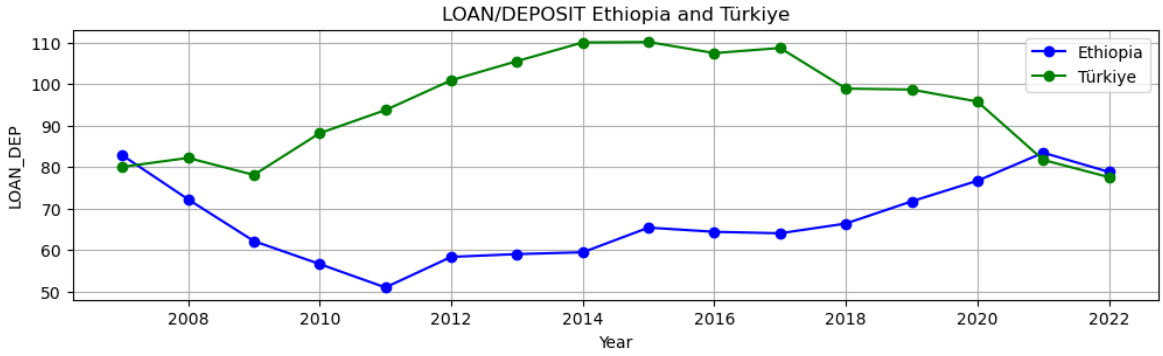
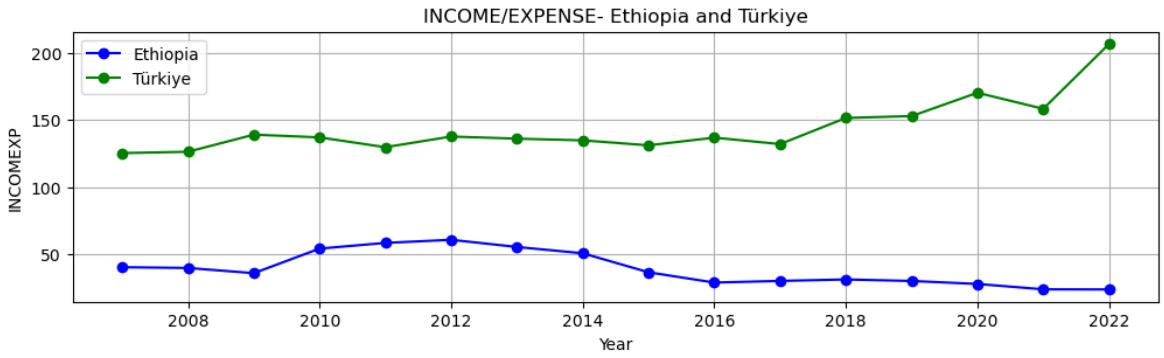


Figure 5.12. displays the loan-to-deposit ratio performance in both countries' banks from 2007 to 2022. In 2007, it was evident that the two banks were getting close to an intersection. Between 2008 and 2022, there was a significant gap between the two countries in LDR. Türkiye's bank had a much more advanced infrastructure than Ethiopia's bank. From 2021 to 2022, we observed that the LDRs of the two countries were similar, but Türkiye's bank still held an advantage over Ethiopia's bank.

5.4.3. Management Quality: Income to Expense

Figure 5.13. Income Expense Ratio



The operating income and expense ratio of banks in Ethiopia and Türkiye from 2007 to 2022 is depicted in Figure 5.13. It can be concluded that the Income to Expense Ratio of Türkiye received a greater boost than the Ethiopian' IERs throughout the years.

5.4.4. Earning Quality: Return On Asset

Figure 5.14. Return on Asset

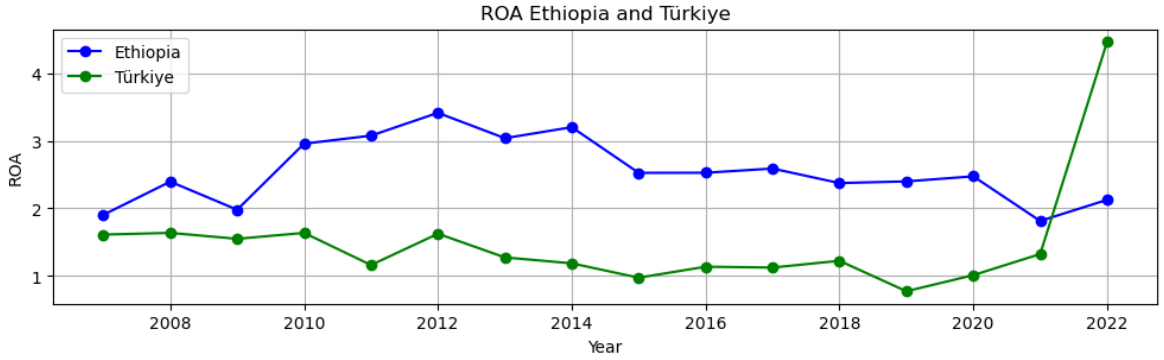
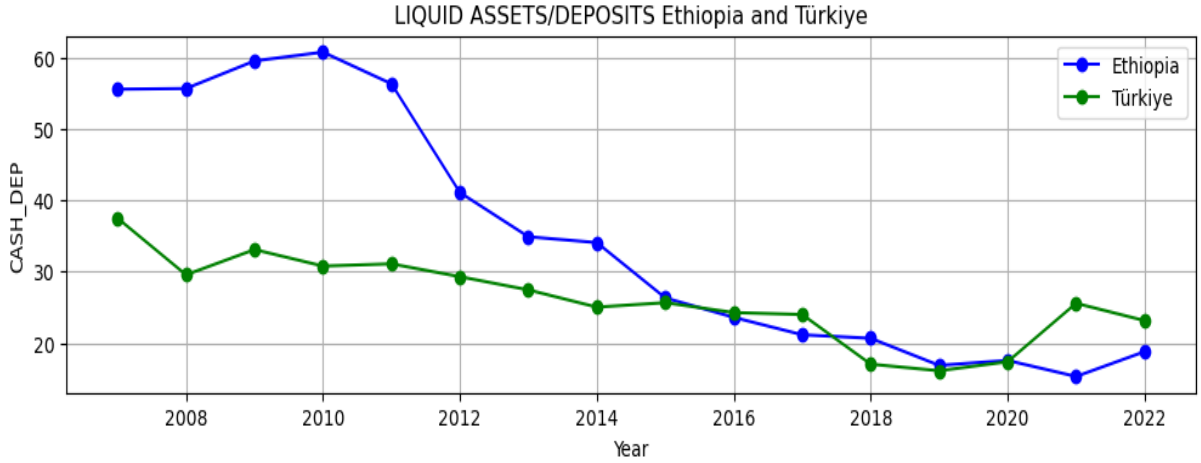


Figure 5.14. shows how Ethiopia and Türkiye private banks performed in return on asset from 2007 to 2022. Between 2007 and 2009, it can be observed that both banks in both countries were too close to each other. We can observe two opposing trends from 2009 to 2022, Türkiye's ROA is higher than Ethiopia's ROA. The ROA of the country's banks intersected and then shifted in 2021, with Ethiopia's ROA increasing and Türkiye's decreasing.

5.4.5. Liquidity: Cash to Deposit Ratio (CDR)

Figure 5.15. Cash to Deposit Ratio



The cash to deposit ratio for private banks in both Ethiopia and Türkiye from 2007 to 2022 can be seen in Figure 5.15. above. It is evident from 2007 to 2014 that Türkiye's CDR is higher than Ethiopia's CDR. Three intersections were observed afterward, the first one being from 2015, which suggests that Ethiopia's CDR gain more than the Türkiye one. In 2016, Türkiye's ROA increased, which led to the second intersection. And the third one occurred in 2020 when Ethiopia's bank took back the Türkiye spot. It looks like there might be another intersection in 2022 due to both countries' CDRs being close to each other

5.5. Exploratory Data Analysis - EDA

This section of the study presents an explanatory data analysis (EDA) of financial performance indicators of private banks in Ethiopia and Türkiye. The analysis covers five key metrics, namely Return on Assets (ROA), Cash Deposit Ratio (CASH_DEP), Loan Deposit Ratio (LOAN_DEP), Income Expense Ratio (INCOMEXP) and Equity Multiplier (EQUTY_MULT). The datasets for both countries are characterized by descriptive statistics reflecting the financial condition of 8 banks based on 128 observations for the period 2007-2022. In addition to descriptive statistics, correlation heatmaps are also analyzed to examine the relationships between these financial metrics.

Table 5.15. Descriptive Statistics of Private Banks in Ethiopia

	ROA	CASH_DEP	LOAN_DEP	INCOMEXP	EQUTY_MULT
count	128	128	128	128	128
mean	2.55	36.13	67.00	39.11	7.85
std	0.99	20.98	13.03	23.79	1.88
min	-3.76	11.00	11.40	-54.34	1.97
25%	2.03	19.93	57.95	23.46	6.70
50%	2.60	30.15	65.38	38.06	7.94
75%	3.10	48.62	76.73	57.25	8.83
max	4.70	137.70	97.97	102.87	13.00

Table 5.15. shows the descriptive statistics of private banks in Ethiopia. The average ROA value is 2.55%, which indicates the rate of profitability of banks on their assets. The standard deviation of ROA is 0.99, indicating that this ratio has a relatively high variance. The minimum and maximum values (-3.76 and 4.70) indicate that some banks experience negative profitability, while others achieve very high profitability. The average cash-to-deposit ratio is 36.13%, while the average loan-to-deposit ratio is 67%. The wide spreading of these ratios indicates that there are significant differences in banks' liquidity management strategies. The income and expense ratio has a very high mean (39.11) and a wide standard deviation (23.79), indicating that there are significant differences in income management across banks. The equity multiplier indicates the leverage level of banks and has a mean value of 7.85. The range of the distribution of this ratio (between 1.97 and 13.00) indicates that banks' capital structures are diverse.

Table 5.16. Descriptive Statistics of Private Banks in Türkiye

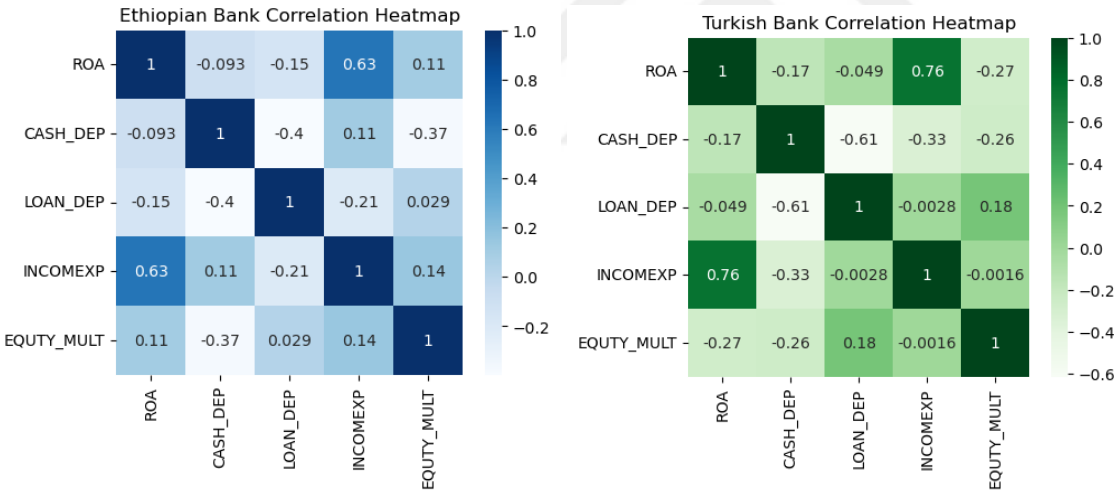
	ROA	CASH_DEP	LOAN_DEP	INCOMEXP	EQUTY_MULT
count	128	128	128	128	128
mean	1.48	26.05	94.83	144.12	9.16
std	1.25	12.18	17.21	27.04	2.48
min	-2.20	9.80	35.30	84.10	5.43
25%	0.90	17.78	85.23	128.98	7.62
50%	1.40	24.00	95.95	141.65	8.66
75%	1.90	30.30	107.08	155.85	10.23
max	6.70	77.40	124.80	246.20	19.23

Table 5.16. shows the descriptive statistics of private banks in Türkiye. The average ROA is 1.48%, indicating a lower level of profitability compared to Ethiopian banks. The

standard deviation is higher (1.25), indicating greater variability in profitability. Banks in Türkiye have a lower cash deposit ratio (26.05%) than Ethiopian banks, but a higher loan deposit ratio (94.83%). This indicates that Turkish banks exhibit a higher credit expansion and are potentially less liquid. The income expense ratio has a fairly high mean (144.12) and shows a narrower standard deviation than Ethiopian banks (27.04), which may indicate a more stable management of revenues compared to expenses. The average value of the equity multiple is 9.16, indicating that Turkish banks use a higher leverage and borrow more to finance their assets than Ethiopian banks.

The correlation analysis between Ethiopian and Turkish private banks is supported by heat maps that visualize the relationships between financial metrics. These heat maps that are illustrated in Figure 5.16. show the strength and direction of linear relationships between metrics and provide insights into which areas of the banking sector are more strongly related to each other for both countries.

Figure 5.16. Correlation Heatmap of Ethiopian and Turkish Banks



The correlation heatmap for selected financial metrics of Ethiopian banks indicates that between ROA and INCOMEXP (Operating Expenditure to Operating Income), there is a strong positive correlation (0.63). This suggests that as the income efficiency of a bank increases, the Return on Assets also increases. This is expected since better management of income and expenses should lead to higher profitability. However, between CASH_DEP (Cash to Deposits Ratio) and LOAN_DEP (Loan to Deposit Ratio) there is a moderate negative correlation (-0.4), which might indicate that as banks hold more cash in comparison to their deposits, they have fewer loans in comparison to those deposits. This could suggest a more conservative liquidity position. CASH_DEP (Cash to Deposit) and EQUITY_MULT

(Equity Multiplier) there is a moderate negative correlation (-0.37), which could suggest that banks with more cash relative to deposits tend to use less leverage. This shows that banks maintain higher levels of cash and may not need to rely as heavily on borrowed funds. The correlation between LOAN_DEP and INCOMEXP is slightly negative (-0.21), implying that banks with a higher Loan to Deposit ratio may have a lower Income to Expense ratio, but the relationship is not very strong.

There is a strong positive correlation (0.76) between ROA (Return on Assets) and INCOMEXP in correlation heat map of Turkish banks. This suggests that as the bank's efficiency in managing income and expenses increases, so does its profit on assets. This may reflect the direct impact of management efficiency on profitability. The correlation between CASH_DEP and LOAN_DEP shows a moderate strong negative correlation (-0.61). This suggests that when banks hold more cash compared to deposits, the loan to deposit ratio falls. This may indicate that banks are managing their liquidity positions more conservatively. There is a weak negative correlation (-0.26) between CASH_DEP and EQUITY_MULT (Equity Multiplier). This may indicate that banks holding more cash generally have a lower leverage ratio, meaning they may be using equity more. LOAN_DEP and EQUITY_MULT have a weak positive correlation (0.18).

Comparing the correlation analyses of financial metrics of private banks in Ethiopia and Türkiye, there is a strong positive correlation between Return on Assets (ROA) and Operating Income to Operating Expenses Ratio (INCOMEXP) in both countries, indicating that increased efficiency of revenue and expense management positively affects ROA. However, there is a moderate negative correlation between the Cash Deposit Ratio (CASH_DEP) and the Loan Deposit Ratio (LOAN_DEP) in Ethiopian banks (-0.4), while for banks in Türkiye this correlation is stronger (-0.61) and negative, suggesting that Turkish banks may have a more conservative liquidity management. The moderately negative correlation between CASH_DEP and EQUITY_MULT in Ethiopian banks (-0.37) suggests that banks are less leveraged and have high cash reserves, while the weaker negative correlation in Türkiye (-0.26) suggests that Turkish banks follow a similar trend but the relationship is less pronounced than in Ethiopian banks. Moreover, the slightly negative correlation between LOAN_DEP and INCOMEXP in Ethiopian banks (-0.21) is almost zero in Türkiye (-0.0028), suggesting that different market dynamics and banking practices may be at play.

5.6. Methods and Models Used

This study examines the impact on profitability of private banks in Ethiopia and Türkiye between 2007 and 2022 using CAMEL ratios as performance indicators. The objective of the study is to understand the impact of different dynamics in the banking sectors of these two countries on profitability and in particular to assess the role of financial ratios in decision-making processes. CAMEL ratios will be used to provide a comprehensive assessment of the financial health of banks and their impact on profitability over time will be assessed using fixed effect panel data regression analysis (Fixed Effect OLS) and machine learning techniques (Random Forest). Through these analyses, the effects of banking policies on the sector are examined in detail, providing a basis for a comparative analysis of the banking sector in two economies at different levels of development and offering important insights for the design of financial stability policies.

5.6.1. Panel Data Regression

Panel data, which enables the use of both cross-sectional and time series in the investigation of economic events, enables effective econometric estimation due to the higher number of observations compared to other data types. Hsiao (2003) and Klevmarken (1989) explained various benefits of panel data. They stated that panel data takes into account the different structures of the units in the horizontal cross-section, allows for more explanatory and effective results, has fewer multicollinearity problems among variables, and has higher degrees of freedom.

A panel data regression differs from a normal time series or cross-section regression in that its variables have double sub-indices. Here t is the time series and i is the horizontal cross-section. α is the constant term and X_{it} is the explanatory variables at observation *it*.

$$y_{it} = \alpha_0 + X'_{it}\beta + \mu_i \qquad \text{t= 1…….T ve i= 1……N} \tag{1}$$

In most panel data applications, one-way error component model is used for error terms and either time effect or cross-sectional effect is included in the model. The two-sided error components model includes both time and cross-sectional effects. These effects are revealed in the model by using dummy variables.

In the one-way error component model, $\mu_i$denotes unobservable unit-specific differences and v_{it} denotes both cross-sectional and time-varying error terms.

$$u_{it} = \mu_i + v_{it} \tag{2}$$

In the two-way error component model, $\mu_i$denotes unobserved unit-specific differences, γ_t denotes unobserved time effects and v_{it} denotes both cross-sectional and time-varying error terms (Baltagi & Baltagi, 2008).

$$u_{it} = \mu_i + \gamma_t + v_{it} \tag{3}$$

In panel data analyses, "fixed" and "random" effect models can be applied with different assumptions about error term properties and coefficient variation. Models are constructed using various dummy variables in cross-sectional and time dimension. The fixed effects model is used when μ_i,is estimated as a fixed parameter and it is assumed that differences in units and time will lead to changes in the coefficients. In the model, the difference arising from units or time period is explained by the difference in the constant term. The number of units is taken into account in determining the fixed effects model. If the cross-sections are selected from a certain group, it is thought that the fixed effects model should be preferred. If the number of units is too high, there is a view that the fixed effects model is not suitable because of the loss of (N-1) degrees of freedom and multicollinearity problems will arise as a result of the dummy variables used (Baltagi & Baltagi, 2008).

In the random effects model, it is assumed that the difference arising from the units or time period is a component of the error terms. The random effects model is preferred when the units are randomly selected within a certain group. In this case, N is usually very high (Baltagi & Baltagi, 2008). In his 1990 study, Greene explained that the most important distinction between fixed and random effects is not whether the unobserved individual effect is stochastic or not, but whether it is correlated with the independent variables in the model or not. Mundlak (1978) argued that the random effects model is exogenous with all regressors and random cross-sectional effects, while the fixed effects model is endogenous with regressors and this effect. The Hausman Test, which is frequently used in research, is related to the existence of correlation between cross-sectional effects and regressors, and the limits of the Hausman Test in the selection of fixed and random effects models are discussed in the literature. It is emphasized that basing model selection only on this test may lead to biased results.

In panel models, it is generally assumed that observations between horizontal sections are independent. However, there may be common shocks that affect all individuals (banks) in the horizontal cross-section. Economic theories predict that individuals take measures against situations that lead to interdependence among themselves. Unlike time series data, horizontal cross-section data do not have a certain order. Especially when the number of time series observations is smaller than the number of horizontal cross-sections, cross-sectional dependence should be estimated by appropriate modeling (Pesaran, 2004).

For all variables used in the study, cross-sectional dependence was tested before the unit root tests to check for stationarity. If there is cross-sectional dependence, this violates the assumptions of unit root tests because unit root tests are generally based on the assumption of independent and identically distributed data. Cross-section dependency violates this independence assumption because there may be interactions between observations.

Before applying unit root tests in the presence of horizontal cross-section dependence, appropriate tests that take this dependence into account should be used. For example, there are methods specifically designed to test for cross-sectional dependence, such as Pesaran's CD (Cross-sectional Dependence) test. In cross-sectional dependence tests, H_0 is defined as there is no cross-sectional dependence. A statistically significant test result indicates the presence of the cross-sectional effect. In this study, the tests of Breusch and Pagan (1980) and Pesaran (2004) are utilized.

In panel data analysis, fixed effects model is a method that is frequently used. The model assumes that every cross-section (bank) has a fixed effect, and these effects are removed from it. The objective of this method is to pinpoint the effect of fixed effects in the data and to better comprehend the variability over time.

As a result of the tests that are mentioned above, the model has taken the following form.

$$ROA_{it} = \beta_0 + \beta_1 \text{CASH\_DEP}_{it} + \beta_2 \text{LOAN\_DEP}_{it} + \beta_3 \text{INCOMEXP}_{it} + \beta_4 \text{EQUTY\_MULT}_{it} + \varepsilon_{it} \quad (4)$$

where ROA is the dependent variable CASH_DEP, LOAN_DEP, INCOMEXP and EQUTY_MULT are independent variables.

5.6.2. Machine Learning: Random Forest

Machine learning can be defined as the process of increasing the capacity of algorithms and statistical models to learn from and predict data sets with a minimum need for intervention by humans (Hastie et al., 2009). It supports decision-making processes with higher predictability.

Machine learning includes different types of techniques and algorithms, categorized based on the type of learning method or task being done. there are three types of ML which can be counted as Supervised, Unsupervised and Semi Supervised Learning. Supervised Learning refers to the process of training a model based on labeled data. The model learns the mapping relationship between input and output, predicting for unseen data. These categories include regression, support vector machines (SVM), k-Nearest Neighbor (k-NN) and artificial neural networks. Unsupervised learning takes on unlabeled data and seeks to find hidden structures or groups in the information. Such tasks include clustering and dimension reduction. Some of these are K-means, hierarchical clustering and Principal Component Analysis (PCA). Semi-supervised learning involves the training of a model with both labeled and unlabeled data. As a rule, this approach is applied when annotated data resources are insufficient. The model generalizes assuming the assumption of having a large unlabeled part in dataset (Murphy, 2012).

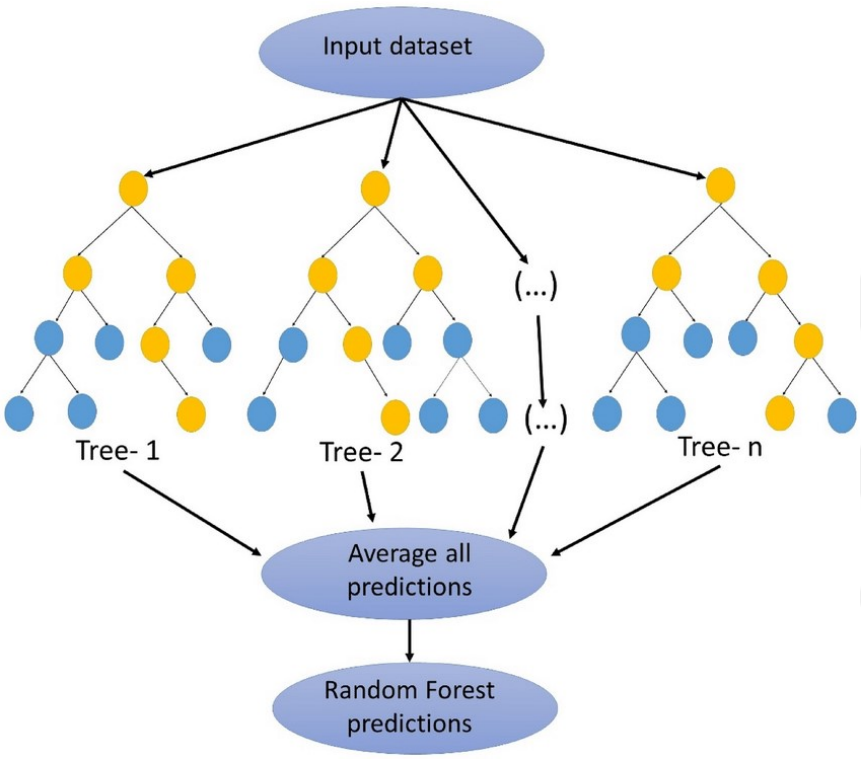
In machine learning, the Random Forest method is part of the supervised learning class and makes strong and robust predictions by combining many decision trees. The training of each decision tree is carried out on various subsets of the dataset, and predictions are obtained by aggregating the outputs of these trees. The use of this model enabled the modeling of complex relationships in dataset and the creation of highly accurate predictions.

The Random Forest was developed by Leo Breiman (2001). It is a group of unpruned classification or regression trees built by randomly selecting samples of training data. Random features are selected in the reasoning process. Prediction is done by summing the ensemble's predictions (majority vote for classification or average for regression).

Random Forest has a similarity to the bagging algorithms uses decision trees as the base models, and only a subset of randomly selected independent variable (features) are used for each node’s branching possibilities, unlike bagging, where every feature is taken into account when splitting a node. Using bootstrapped samples taken from the original training

data, a decision tree is created on each bootstrapped training dataset by taking into account only a subset of features at each split. The final prediction is made by either voting or averaging after combining the results of all the decision trees. When it comes to regression problems, the final prediction is determined by taking the average of all predictions from different decision trees. Each tree is grown as described below:

Figure 5.17. Schematic Diagram of the Random Forest Algorithm



Source:https://www.researchgate.net/figure/Schematic-diagram-of-the-random-forest algorithm_fig3_355828449 [accessed 14 Jan, 2024]

5.7. Performance Metrics and Evaluation Methods

This chapter discusses the various statistical tools and methods developed to measure the success of the models used. The critical metrics used to assess the predictive accuracy and generalizability of the models on the data are introduced and the implications of each metric on model performance are evaluated.

5.7.1. Cross-Validation

The performance of the models was evaluated with cross-validation. Cross-validation estimates the model's reliability and replicability by testing it on different groups of data. In this study, the 5-fold cross validation method was preferred.

Cross-validation is an approach used to assess the capability of a machine learning algorithm on independent datasets. This method is crucial to ensure that the model learns a general pattern rather than features specific for training data, and it doesn't overfit but can be applied for unseen new data.

In K-Fold Cross-validation, the dataset is divided randomly into k equal subsets. Each of the subsets is in turn used for testing and the other k–1 set are utilized as training data. K cycles are performed, and each time a different subset is used as the test set. As such, the model's performance on each subset is measured and averaging these performances gives an estimated overall score of its performance.

In particular, 5-Fold Cross-Validation involves training and validation of the model five times for each data subset. On each run, the model is validated on one subset and trained using the other four subsets. This approach is advantageous compared to the former more reliable ways of measuring how well a model generalizes the entire dataset. The latter method is important for the understanding of how model fits different data sets and its conformity in predictions. It also determines whether the model overfits.

5.7.2. R-Square

R^2 is a measure that indicates the extent to which the model can explain the variance in the dependent variable. The variance can be explained better by the model if the value is higher, which ranges from 0 to 1.

5.7.3. MSE and RMSE

Metrics like Mean Square Error (MSE) and Root Mean Square Error (RMSE) assess the difference between the model's predictions and the true values. MSE is the average squared error, and RMSE is determined by calculating the square root of MSE. The scale of the errors is matched to the scale of the original data by the RMSE. The formulas are given below.

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 \quad (4)$$

$$RMSE = \sqrt{MSE} \quad (5)$$

5.7.4. Feature Importance

Feature importance ratings are calculated in the Random Forest model to show how much each feature contributes to the model's decision structure. By conducting this evaluation, we were able to understand which features the model gave more importance to and how important they were for dependent variable forecasts in dataset.

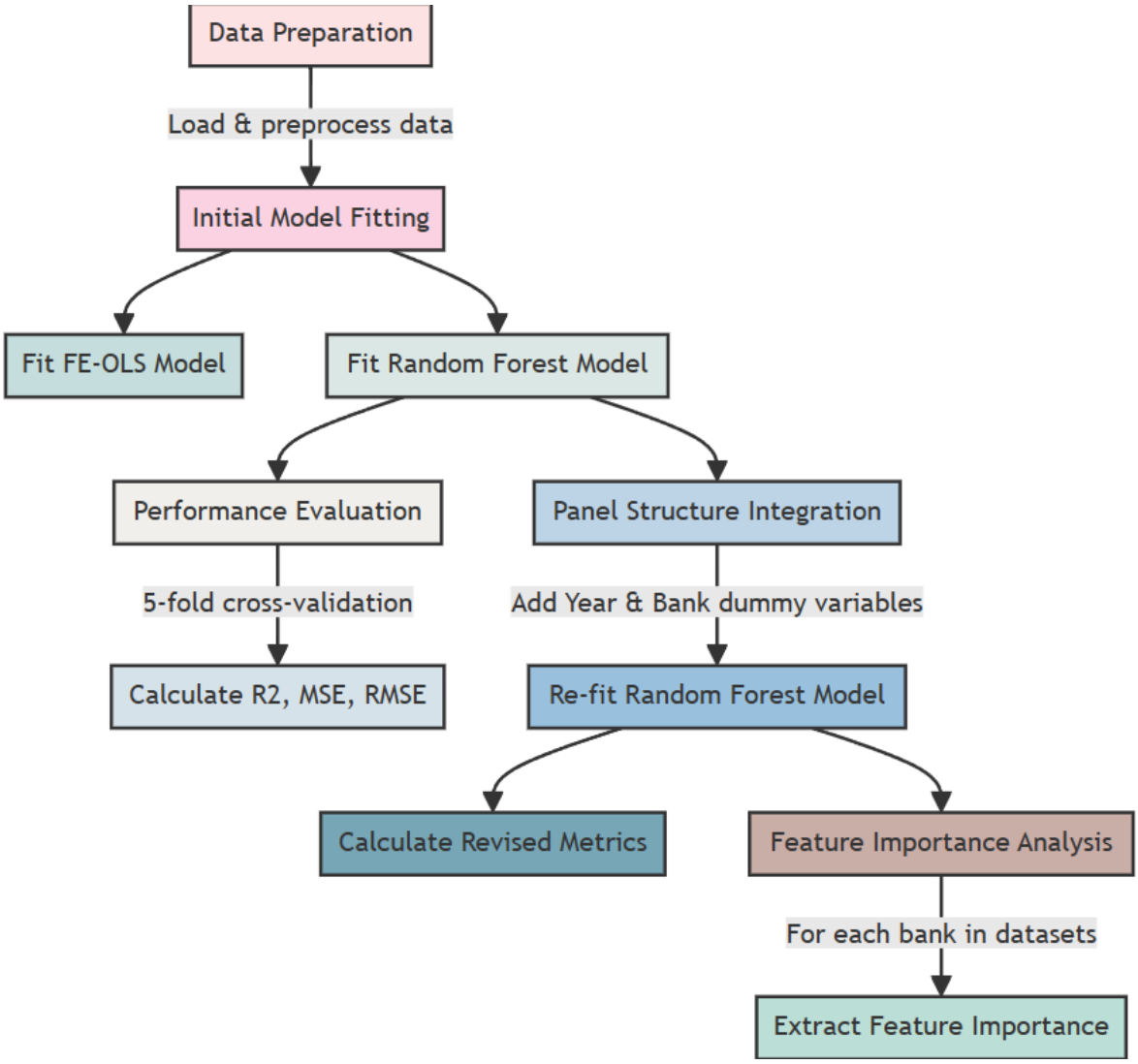
The analysis demonstrated how various models can be utilized to predict bank financial performance, taking into account time and cross-sectional dimensions in panel data sets. The performance of the models could be evaluated objectively using metrics such as R-squared, MSE, and RMSE. Additionally, the importance ratings for features helped to determine which financial indicators were given more importance by the models. Through this study, it is demonstrated that panel data analysis can be effectively and efficiently applied with various approaches and modeling techniques.

5.8. Results and Discussions

This study uses both traditional Panel Regression Analysis and Machine Learning methods to identify the factors affecting banks' profitability using data of private banks in Ethiopia and Türkiye between 2007 and 2022. First, bank data from the two countries are loaded and processed, and fixed effects model (FE-OLS) and unstructured Random Forest models are applied.

Random Forest model is evaluated with 5-fold cross-validation and performance metrics such as R-square, Mean Square Error (MSE) and Root Mean Square Error (RMSE) are calculated. Then, the Random Forest model is modified and re-fitted to take into account the panel structure by adding dummy variables such as year and bank IDs. Finally, for both data sets, a bank-by-bank attribute importance analysis is performed to identify other ratios that affect profitability. This process was carried out using the banking ratios, namely CAMEL (capital adequacy, asset quality, management quality, earnings and liquidity) ratios to understand the critical factors affecting the financial health and profitability of banks. The diagram of the models is illustrated in Figure 5.18.

Figure 5.18. Schematic Diagram of the Models



5.8.1. Fixed Effects Model Results

Before applying unit root tests for all variables used in the study, cross-sectional dependence was tested. In the presence of horizontal cross-section dependence, appropriate tests that take this dependence into account should be used. There are methods specifically designed to test for cross-sectional dependence, such as Pesaran's CD (Cross-sectional Dependence) test. In horizontal cross-section dependence tests, H_0 is presented as there is no horizontal cross-section dependence. A statistically significant test result indicates the presence of horizontal cross-section effect. Table 5.17. and 5.18. shows the cross-sectional dependency for Ethiopia and Türkiye respectively. The results of these tests indicate that certain corrections need to be made to your model estimates. The presence of heteroskedasticity indicates that the standard errors of the model, and hence the t-statistics, may be misleading. This may affect the significance of the coefficient estimates. Evidence

of cross-sectional dependence indicates that the error terms across individuals are not independent, which is particularly common in macroeconomic panel data analysis. This may require taking into account hidden interactions and common effects across cross-sections.

Table 5.17. Cross-sectional Dependency Test for Ethiopia

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	48.10677	28	0.0104
Pesaran scaled LM	2.686880		0.0072
Pesaran CD	-0.063625		0.9493

Table 5.18. Cross-sectional Dependency Test for Türkiye

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	121.0488	28	0.0000
Pesaran scaled LM	12.43417		0.0000
Pesaran CD	8.550986		0.0000

Random Forest can solve some of the problems faced by traditional statistical models because such machine learning algorithms are less dependent on certain assumptions. Random Forest can automatically handle heteroskedasticity in the data set because individual trees use different subsets of the data set and combine their results. This allows the model to absorb different variances in the error terms.

While Random Forest does not provide a direct solution to cross-sectional dependence, it can mitigate the effects of this problem by using the combined estimates of individual trees. Each tree uses a randomly selected subset of the dataset and a subset of the features, which prevents dependencies from being concentrated on a single model. Random Forest can capture non-linear relationships and interactions within the data and also reduces the risk of overfitting.

Unit root tests are used to test the stationarity of variables. The use of non-stationary series in a regression analysis may lead to biased results. Although there is no significant relationship between the variables, t-statistics may be significant and R^2 value may be high. In order to avoid this situation, which is known as "spurious regression", it is recommended that all variables in the model be stationary.

Table 5.19. Unit Root Test for Ethiopia

	Common Unit Root Test	Individual Unit Root Test		
	Levin, Lin ve Chu	Im, Pesaran ve Shin W-stat	ADF - Fisher Ki Kare	PP - Fisher Ki Kare
EQUTY_MULT	-1.69**	-1.17	23.58	30.17***
LOAN_DEP	2.05	0.59	15.18	15.61
INCOMEXP	-0.34	0.18	11.97	23.24
ROA	0.38	-0.11	16.46	35.97***
CASH_DEP	-1.10***	0.19	12.6	16.31

** denotes significance at 5%, *** denotes significance at 1% level.

In panel data analysis, such tests are used to see if the whole panel shares a common dynamic. Table 5.19. shows that EQUTY_MULT and CASH_DEP are stationary while the other variables are non-stationary. Machine learning algorithms such as Random Forest generally do not require stationarity when working on time series data. They are able to capture complex relationships and interactions in the data set.

Table 5.20. Unit Root Test for Türkiye

	Common Unit Root Test	Individual Unit Root Test		
	Levin, Lin ve Chu	Im, Pesaran ve Shin W-stat	ADF - Fisher Ki Kare	PP - Fisher Ki Kare
EQUTY_MULT	0.37	-0.61	2.,89	44.62***
LOAN_DEP	0.82	1.01	8.28	9.79
INCOMEXP	8.33	5.65	1.95	4.31
ROA	5.91	0.43	13.89	15.12
CASH_DEP	-1.57	-0.61	16.22	34.61***

** denotes significance at 5%, *** denotes significance at 1% level.

Table 5.20. shows that EQUITY_MULT and CASH_DEP can be considered stationary because at least one test for these variables showed stationarity. On the other hand, no test for LOAN_DEP, INCOMEXP and ROA variables showed stationarity, so it can be concluded that these variables are non-stationary.

Table 5.21. Linear Model Regression Results for Ethiopia and Türkiye

Dependent Variable	Independent Variables	Ethiopia	Türkiye
ROA	CASH_DEP	-0.0121***	0.0222***
	EQUTY_MULT	0.0258	-0.1799***
	INCOMEXP	0.0332***	0.0374***
	LOAN_DEP	-0.0089***	-0.0004
	Bank Fixed	✓	✓
	Time Fixed	✓	✓
	Observation	128	128
	Number of Banks	8	8
	Period	16	16
	R^2	0.58	0.74
	Fixed Test	✓	✓
	Random Test	✓	✓

** denotes significance at 5%, *** denotes significance at 1% level.

Table 5.21 shows the FE-OLS model results analyzing the financial performance of banks in Ethiopia and Türkiye. ROA is used as the dependent variable, which indicates how effectively companies are able to use their assets to generate profits. There are four main independent variables in the analysis: CASH_DEP, EQUTY_MULT, INCOMEXP and LOAN_DEP. According to the findings, cash holding has a positive effect on ROA for banks in Türkiye, while it has a negative effect in Ethiopia. The income/expense ratio has a positive effect in both countries, while the equity multiplier has a negative effect on ROA in Türkiye but not in Ethiopia. The loan-to-deposit ratio has a negative effect in Ethiopia but insignificant in Türkiye. Bank-specific and time fixed effects are also taken into account in the study. For both countries, 128 observations, 8 banks and 16 periods of data are used. Fixed and random effects of the model are tested for both countries. R-squared values indicate how much the model explains the variance of the dependent variable. For Türkiye, 0.74 indicates a higher explanatory power.

The multiple linear regression equations for ROA in Ethiopia and Türkiye are as follows:

$$ROA_{it} = 2.08 - 0.01CASHDEP_{it} - 0.01LOANDEP_{it} + 0.03\text{INCOMEXP}_{it} + 0.03\text{EQUTYMULT}_{it} + \varepsilon_{it}$$

$$ROA_{it} = -2.80 + 0.02CASHDEP_{it} - 0.00LOANDEP_{it} + 0.04\text{INCOMEXP}_{it} - 0.18\text{EQUTYMULT}_{it} + \varepsilon_{it}$$

The differences between the factors affecting the financial performance of banks in Ethiopia and Türkiye are closely related to the economic structure, regulatory frameworks and banking sector characteristics of both countries. The negative impact of the cash-to-deposit ratio in Ethiopia may reflect the challenges associated with banks' liquidity management and the high cash holding requirement. This may negatively affect ROA by increasing the costs of holding cash. In Türkiye, the positive effect of this ratio can be explained by factors such as more efficient liquidity management and access to developed financial markets. The negative effect of the equity multiplier in Türkiye indicates the risks of banks' capital structure and the use of debt, while the lack of a significant effect of this factor on ROA in Ethiopia suggests a different capital structure or a balanced financial management strategy. The positive effect of the income/expense ratio in both countries emphasizes the importance of operational efficiency. The negative effect of the loan-to-deposit ratio in Ethiopia reflects the risks and costs of lending activities, while the insignificant effect of this ratio in Türkiye indicates a more balanced loan and deposit management or an offsetting of loan returns by other factors. These analyses play an important role in understanding the factors affecting a country's banking sector performance and show that these factors work differently in each country.

5.8.2. Random Forest Results

In the model built using Python 3, a machine learning pipeline was created using the make_pipeline function, which is part of the scikit-learn library. This pipeline consists of two steps: StandardScaler and RandomForestRegressor. StandardScaler is a preprocessing program used to scale the data. Each feature is transformed into a standard normal distribution with a mean (μ) of zero and a standard deviation (σ) of on. To prevent one feature from having too much impact on the model due to its larger scale, all features in the dataset have the same scale. The following is how it is expressed mathematically:

$$z = \frac{x-\mu}{\sigma} \tag{6}$$

here

x is the original data point,

μ is the feature mean and

σ is the feature standard deviation.

RandomForestRegressor is an ensemble learning algorithm uses a combination of 500 decision tress in the model to perform ensemble learning. The training process of each decision tree involve randomly selecting subsets from the dataset, and the output of these trees is averaging or majority voting that is used to obtain predictions. The parameter n_estimators=500 determines how many decision trees need to be generated, and the random_state=42 sets the random number generator to guarantee that the model produces identical results every time it is run. The model also automatically transforms the given steps into a sequential pipeline using the make_pipeline function. Before training the model, the dataset is automatically scaled by this pipeline. This avoids errors that could result in data leakage.

By standardizing each feature in the dataset through this pipeline, the model trained uses 500 decision trees to predict ROA. The approach enhances the efficiency of machine learning models and aids in achieving more reliable outcomes.

The model's accuracy was evaluated through 5-fold cross-validation, which is comprehensive test of generalizability. In this method, five equal subsets (folds) are randomly divided from the original sample. Each iteration involved using four iterations to train the model, while a separate test set was established for testing the accuracy of the model using the remaining fold. Five times, the process was repeated, with a new floor serving as the test set every time. And each observation was only used once as a test set to assess the model's accuracy. The average score for the Root Mean Squared Error (RMSE) was used to determine model performance, while was calculating the square root of the negative values of the Mean Squared Error (MSE) from each iteration. The scikit-learn library's cross_val_scoe function was used to achieve this task. The RandomForestRegressor model had 500 tress (n_estimators=500) and a randomness seed (random_state=42). The StardardScaler transformation was incorporated into the modeling process via make_pipeline to train the model on scaled data. By using this methodology, data leakage was avoided by allowing independent evaluation of the model for each layer. The model's predictions were consistent and reliable across different data sets, as evidenced by the RMSE scores from cross-validation.

Table 5.22. Performance Metrics of the Models

Model	FE-OLS		Random Forest	
Country	**Ethiopia**	**Türkiye**	**Ethiopia**	**Türkiye**
R^2	0.5786	0.7428	0.9280	0.9563
MSE	0.4609	0.4368	0.0714	0.0673
RMSE	0.6789	0,6609	0.2672	0.2594

In Table 5.23. it is stated that for both countries, the Random Forest model performed better than the FE-OLS model. This indicates that Random Forest is able to capture complex relationships and interactions in the dataset more effectively and make more accurate predictions. MSE and RMSE values show a similar trend. In both metrics, Random Forest has lower error rates than FE-OLS. This indicates that the predictions of the Random Forest model are closer to the true values and therefore more accurate.

The performance of the Random Forest model for Türkiye is slightly better than for Ethiopia, but it clearly performs significantly better in both countries. This shows that machine learning models such as Random Forest can be more effective than traditional statistical models for complex and non-linear datasets such as financial data analysis.

Table 5.23. Overall Feature Importance

ETHIOPIA		**TÜRKİYE**	
CASH_DEP:	%25.71	**CASH_DEP:**	%5.36
LOAN_DEP:	%7.94	**LOAN_DEP:**	%5.45
INCOMEXP:	%37.04	**INCOMEXP:**	%69.93
EQUTY_MULT:	%29.31	**EQUTY_MULT:**	%19.26

Table 5.24 shows the relative importance (feature importance) of the independent variables (CASH_DEP, LOAN_DEP, INCOMEXP and EQUTY_MULT) on ROA (Return on Assets) in percentage terms in the analysis using Random Forest model for Ethiopia and Türkiye. Feature importance indicates how important each feature in a machine learning model is in the model's predictions. These values indicate how effective the variables are in the predictions made by the model and can be interpreted.

For Ethiopia, the CASH_DEP variable has a very important role in the predictions of the model with 25.71%. This shows that the cash deposit ratio has a significant impact on the ROA of financial institutions in Ethiopia. The LOAN_DEP variable, on the other hand,

has a lower impact of 7.94% but is still considered significant in the estimations of the model. INCOMEXP is calculated as the most important attribute with 37.04%. The ratio of income and expenses seems to be the most important factor affecting the ROA of financial institutions in Ethiopia. EQUTY_MULT is one of the important characteristics with 29.31%. Equity multiplier has a large impact on ROA of financial institutions in Ethiopia.

For Türkiye, CASH_DEP has less impact on ROA of financial institutions in Türkiye with 5.36%. LOAN_DEP has a similarly low impact in Türkiye with 5.45%. On the other hand, INCOMEXP is the most important factor affecting ROA of financial institutions in Türkiye with 69.93%. This ratio is much higher than in Ethiopia. EQUTY_MULT, with 19.26%, is considered as a less influential but still significant factor compared to Ethiopia.

These results indicate that the degree of importance of factors affecting ROA of financial institutions in Ethiopia and Türkiye is different. In Ethiopia, the income/expense ratio and the equity multiplier are quite important, while in Türkiye the income/expense ratio has a much more pronounced impact. These differences may reflect structural differences in the functioning of financial institutions in both countries or different economic conditions. Such information can be used in strategic planning and policymaking to optimize the performance of financial institutions.

Table 5.24. Feature Importance of Each Bank of Ethiopia

PRIVATE BANKS OF ETHIOPIA					
AIB:		CBO:		NIB:	
CASH_DEP:	%12.32	**CASH_DEP:**	%16.72	**CASH_DEP:**	%33.02
LOAN_DEP:	%27.44	**LOAN_DEP:**	%8.66	**LOAN_DEP:**	%5.86
INCOMEXP:	%43.87	**INCOMEXP:**	%40.61	**INCOMEXP:**	%54.63
EQUTY_MULT:	%16.37	**EQUTY_MULT:**	%34.01	**EQUTY_MULT:**	%6.48
BOA:		DB:		UB:	
CASH_DEP:	%18.47	**CASH_DEP:**	%12.62	**CASH_DEP:**	%7.86
LOAN_DEP:	%8.49	**LOAN_DEP:**	%4.88	**LOAN_DEP:**	%3.33
INCOMEXP:	%14.96	**INCOMEXP:**	%74.22	**INCOMEXP:**	%85.01
EQUTY_MULT:	%58.08	**EQUTY_MULT:**	%8.28	**EQUTY_MULT:**	%3.80
LIB:		WB:			
CASH_DEP:	%24.33	**CASH_DEP:**	%50.20		
LOAN_DEP:	%2.00	**LOAN_DEP:**	%27.56		
INCOMEXP:	%60.92	**INCOMEXP:**	%9.38		
EQUTY_MULT:	%12.76	**EQUTY_MULT:**	%12.86		

Table 5.25. presents the feature importance values calculated using the Random Forest model for four main financial indicators (CASH_DEP, LOAN_DEP, INCOMEXP and EQUTY_MULT) that affect the ROA of private banks in Ethiopia (AIB, CBO, NIB, BOA, DB, UB, LIB and WB). These values show that each bank's operational and financial structure is unique and that different indicators have different impacts on each bank's performance. These results show that the factors affecting ROA of different private banks in Ethiopia vary from bank to bank. In some banks, indicators such as the income/expense ratio and the equity multiplier are more important, while in others the cash-to-deposit ratio and the loan-to-deposit ratio have a more pronounced impact. This may reflect the unique business structure, market position and financial strategies of each bank.

In particular, INCOMEXP and EQUTY_MULT are highly significant for most banks, suggesting that these indicators have a significant impact on bank performance in general, while the different impact of CASH_DEP and LOAN_DEP across banks may reflect differences in bank strategies for liquidity management and lending policies.

Table 5.25. Feature Importance of Each Bank of Türkiye

PRIVIATE BANKS OF TÜRKİYE					
Akbank		Şekerbank		Türkiye İş Bankası	
CASH_DEP:	%11.85	**CASH_DEP:**	%31.52	**CASH_DEP:**	%6.95
LOAN_DEP:	%23.23	**LOAN_DEP:**	%9.52	**LOAN_DEP:**	%21.29
INCOMEXP:	%54.92	**INCOMEXP:**	%16.25	**INCOMEXP:**	%36.76
EQUTY_MULT:	%9.99	**EQUTY_MULT:**	%42.71	**EQUTY_MULT:**	%35.00
Anadolubank		Turkish Bank		Yapı Kredi Bankası	
CASH_DEP:	%6.02	**CASH_DEP:**	%11.36	**CASH_DEP:**	%2.79
LOAN_DEP:	%11.15	**LOAN_DEP:**	%11.46	**LOAN_DEP:**	%22.93
INCOMEXP:	%31.73	**INCOMEXP:**	%17.41	**INCOMEXP:**	%44.94
EQUTY_MULT:	%51.11	**EQUTY_MULT:**	%59.77	**EQUTY_MULT:**	%29.34
Fibabanka		Türk Ekonomi Bankası			
CASH_DEP:	%4.78	**CASH_DEP:**	%18.94		
LOAN_DEP:	%10.55	**LOAN_DEP:**	%20.89		
INCOMEXP:	%77.73	**INCOMEXP:**	%51.03		
EQUTY_MULT:	%6.94	**EQUTY_MULT:**	%9.14		

These results that is illustrated in Table 5.26 show that the factors affecting ROA of different private banks in Türkiye vary significantly from bank to bank. In some banks, indicators such as the INCOMEXP ratio and the equity multiplier are more important, while

in others the CASH_DEP ratio and the LOAN_DEP ratio have a more significant impact. These differences reflect the unique business structure, market position and financial strategies of each bank.

In particular, INCOMEXP and EQUTY_MULT are highly significant in some banks, indicating that these indicators have a significant impact on bank performance in general, while CASH_DEP and LOAN_DEP vary from bank to bank, suggesting that liquidity management and credit policies reflect differences in bank strategies.

6. CONCLUSION

The study examines the performance of eight private banks in Ethiopia and Türkiye for 16 years from 2007 to 2022. The CAMEL ratio analysis, such as, Equity multiplier, Cash to deposit, ROA, Loan to deposit, and Income expense ratio were used to compare the two countries financial performance.

This study analyzes the financial performance of the Ethiopian and Turkish banking sectors, focusing on the ratios that affect profitability. A detailed comparison of the banking systems of both countries is presented by using panel multiple regression analysis and random forest algorithm from machine learning techniques. For private banks operating in Ethiopia, the Income/Expense ratio for Management Quality played an important role in the model predictions with 37.04%, while Cash/Deposit variable for Liquidity was 25.71%, Loan/Deposit for Asset Quality was 7.94% and Equity Multiplier was 29.31%. For private banks operating in Türkiye, Cash/Deposit for Liquidity and Loan/Deposit ratios for Asset Quality had a lower impact (5.36% and 5.45%), while the Income and Expense ratio for Management Quality was the most influential variable with 69.93%. Equity Multiplier is a less influential but important factor with 19.26%. This study demonstrates the effectiveness of machine learning in evaluating the performance of the banking sector in countries with different economic conditions.

In both countries, the Random Forest model performed better than the FE-OLS model. This indicates that Random Forest is able to capture complex relationships and interactions in the dataset more effectively and make more accurate predictions. MSE and RMSE values show a similar trend. In both metrics, Random Forest has lower error rates than FE-OLS. This indicates that the predictions of the Random Forest model are closer to the true values and therefore more accurate.

The performance of the Random Forest model for Türkiye is slightly better than for Ethiopia, but it clearly performs significantly better in both countries. This shows that machine learning models such as Random Forest can be more effective than traditional statistical models for complex and non-linear datasets such as financial data analysis. The findings of the study can make important contributions in shaping banking sector policies and developing risk management strategies. This thesis provides future researchers with a basis for more detailed analysis of banking sectors in countries with different economic structures.

Future studies could expand the scope of the current analysis and consider macroeconomic variables. In particular, examining the impact of global events such as the COVID-19 pandemic and the Russia-Ukraine war on the banking sector is important to better understand banking performance during periods of economic recession and uncertainty. Moreover, a comparative analysis of the banking sectors of different developing countries can improve the generalizability of the model. Extending this analysis to the entire banking sector, rather than just private banks, would provide a more comprehensive understanding of the overall state of the sector. Such extended studies can improve decision-making in the banking sector by providing strategic insights for policymakers and industry professionals.

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