Title - Data Driven Analysis of Turkish Banking Sector Stocks: Returns, Volatility, and Portfolio Optimization

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Abstract:

This project investigates the performance of a bank portfolio in comparison to the BIST 100 Index, which represents the overall Turkish stock market. Using historical price and return data, the study evaluates both absolute and risk-adjusted performance through metrics such as mean return, volatility, Sharpe ratio, and beta.

The analysis further compares two investment strategies - a traditional buy-and-hold approach and a moving average (MA) strategy - to determine which yields superior performance at the portfolio level. Finally, a factor regression (OLS) model is applied to assess the portfolio's sensitivity to market movements and to quantify its alpha (excess return) and beta (systematic risk).

Results reveal that the bank portfolio significantly outperforms the BIST 100 in terms of annualized returns, while maintaining comparable or slightly better risk-adjusted performance. The portfolio exhibits a **low and slightly negative beta**, suggesting **weak correlation** with the overall market - a desirable diversification trait. However, the **moving average strategy underperforms** the buy-and-hold approach, indicating limited benefit from market-timing techniques in this context.

Overall, this study demonstrates that a **diversified bank portfolio** can offer strong returns and stable risk performance, acting as a **resilient and potentially market-neutral investment** relative to the broader BIST 100 index.

Introduction:

The banking sector plays a crucial role in the financial markets, influencing both economic growth and investor sentiment. In Turkey, major banks such as **Akbank**, **Garanti BBVA**, **İş Bankası**, **Yapı Kredi**, and others are among the most actively traded stocks on the **Borsa İstanbul (BIST)**. Understanding their price behavior, risk characteristics, and relationship with the **BIST 100 Index** is essential for investors seeking both returns and diversification.

This project aims to analyze the **performance, risk, and market dynamics** of leading Turkish banks using quantitative finance techniques. The study covers several key aspects:

- **Return & Risk Analysis:** Measuring daily, weekly, and monthly return distributions for each bank.
- **Risk-Adjusted Performance:** Comparing banks based on **Sharpe ratios**, **volatility**, and **beta** values.
- **Market Behavior & Patterns:** Detecting patterns such as **volume spikes**, **weekday effects**, and **volatility trends** over time.
- **Leader–Follower Relationships:** Using **Granger causality** to identify if smaller banks follow the price movements of larger ones.
- **Portfolio & Strategy Testing:** Evaluating the performance of an **equal-weighted bank portfolio** versus the **BIST 100 Index**, and comparing **buy-and-hold** vs. **moving average (MA)** strategies.
- **Factor Regression Analysis:** Estimating the portfolio's sensitivity to market movements (beta) and its excess return (alpha).

Through this comprehensive analysis, the project provides insights into how Turkish banks behave individually and collectively, their relationship to the broader market, and which investment strategies may deliver superior long-term results.

Objectives:

The primary goal of this project is to **analyze the performance, volatility, and interrelationships** of major Turkish banks listed on **Borsa İstanbul (BIST)** and compare their behavior with the **BIST 100 Index**.

To achieve this, the study focuses on the following specific objectives:

1. **Return & Volatility Analysis**
    - Compute and visualize **daily, monthly, and annualized returns** for each bank.
    - Measure **volatility trends** and assess whether they have increased or decreased over time.
2. **Market Behavior Patterns**
    - Detect **seasonal or weekday effects** (e.g., lower returns on Mondays, higher on Fridays).
    - Identify **outlier days** with abnormal returns or trading volumes and analyze potential causes.
3. **Cross-Bank Relationships**
    - Examine **correlations** among banks to understand market co-movements.
    - Use **Granger causality tests** to explore **leader–follower dynamics**, determining whether smaller banks follow price trends of larger banks.
4. **Portfolio Performance Evaluation**

- Construct an **equal-weighted bank portfolio** and compare its performance to the **BIST 100 Index**.

- Evaluate **risk-adjusted performance** using **Sharpe ratios** and **beta analysis**.

5. **Investment Strategy Comparison**

    - Test whether a **moving average (MA) trading strategy** outperforms a **buy-and-hold approach** at the portfolio level.

6. **Factor & Regression Analysis**

    - Perform **OLS regression** to measure the relationship between the portfolio's returns and the BIST 100 market returns.

    - Estimate **alpha** (excess return) and **beta** (market sensitivity) for the portfolio.

Data Description:

This study utilizes historical stock price and trading volume data for major **Turkish banks** listed on the **Borsa İstanbul (BIST)**, along with the **BIST 100 Index** for market comparison.

1. Bank Stock Data

- **Source:** Publicly available financial data (e.g., Yahoo Finance / Kaggle dataset).
- **Period Covered:** *January 2020 – November 2025*
- **Frequency:** Daily trading data
- **Banks Included:**

- Akbank
- Garanti BBVA
- İş Bankası
- Yapı Kredi
- Vakıfbank
- Halk Bankası
- Şekerbank
- T.S.K.B (Industrial Development Bank of Turkey)
- Albaraka Türk

2. BIST 100 Index Data

- **File:** bist100.csv (uploaded separately in Kaggle under *Data → Add file*)
- **Source:** Yahoo Finance (^XU100)

Data Preprocessing:

Before conducting statistical and econometric analyses, several **data preprocessing** steps were performed to ensure data consistency, reliability, and comparability across all banks and the BIST 100 Index.

1. Data Cleaning

- **Handling Missing Values:**

  Missing prices or volumes (due to market holidays or incomplete records) were forward-filled where appropriate, or rows with insufficient data were removed.

- **Duplicate Records:**

  Duplicate entries (same date and stock name) were checked using:

```
df = df.drop_duplicates(subset=['date', 'stock_name'])
```

  ensuring each date-stock pair was unique.

- **Consistency Checks:**

  Ensured all prices were non-negative and chronological order was maintained.

2. Date Formatting

To ensure time-series consistency:

```
df['date'] = pd.to_datetime(df['date'])

df = df.sort_values(['stock_name', 'date'])
```

All date columns were converted into datetime format and sorted to maintain accurate temporal order across all banks.

3. Return Calculation

Daily returns were calculated as the **percentage change in closing prices**:

```
df['daily_return'] =
df.groupby('stock_name')['close'].pct_change() * 100
```

This standardized measure allowed comparison of performance across banks regardless of price levels.

4. Volume Normalization

To make trading activity comparable between large and small banks:

- Raw volumes were scaled using millions of shares.
- Z-scores were calculated to detect unusually high or low trading activity:

```
 df['vol_z'] =
df.groupby('stock_name')['volume'].transform(lambda x: (x -
x.mean()) / x.std())
```

5. Integration with BIST 100 Index

The bist100.csv dataset was merged with the bank dataset to include market-level movements:

```
bist_df['date'] = pd.to_datetime(bist_df['Date'])

bist_df['bist_return'] = bist_df['Adj Close'].pct_change()
* 100

merged_df = pd.merge(df, bist_df[['date', 'bist_return']],
on='date', how='left')
```

This allowed for regression and beta analyses against the market benchmark.

6. Outlier Detection

Outliers were identified using **Z-scores** for returns and volumes:

```
df['return_z'] =
df.groupby('stock_name')['daily_return'].transform(lambda
x: (x - x.mean()) / x.std())

outliers = df[(abs(df['return_z']) > 3) | (abs(df['vol_z'])
> 3)]
```

Outlier days typically coincided with:

- **Earnings announcements**
- **Macroeconomic events**
- **Political or central bank policy changes**

7. Portfolio Construction

An **equal-weighted portfolio** was created by averaging the daily returns of all banks:

```
equal_weighted_return =
df.groupby('date')['daily_return'].mean().reset_index(name=
'portfolio_return')
```

This provided a balanced view of the overall banking sector's daily performance.

Methodology:

This section outlines the analytical framework, quantitative models, and techniques used to assess the financial performance, risk, and interrelationships among the selected Turkish banks and the BIST 100 index.

The overall methodology is divided into **four major stages**:

1. **Descriptive & Exploratory Analysis**
2. **Statistical & Correlation Analysis**
3. **Portfolio & Performance Evaluation**
4. **Econometric & Factor Modeling**

1. Descriptive and Exploratory Analysis

The first step involved understanding the behavior of stock prices and trading volumes:

- **Price and Volume Trends:**
  Time series plots were generated to visualize long-term growth, cyclical movements, and trading activity patterns.
- **Return Distributions:**
  Daily, weekly, and monthly return distributions were analyzed using histograms and boxplots to assess skewness, kurtosis, and volatility clustering.
- **Volatility Analysis:**
  Rolling standard deviations and annualized volatilities were calculated to identify periods of high uncertainty or market stress.

```
df['rolling_volatility'] =
df.groupby('stock_name')['daily_return'].transform(lambda
x: x.rolling(30).std())
```

2. Statistical and Correlation Analysis

To understand interdependencies between banks:

- **Return Correlation Matrix:**
  Pairwise Pearson correlations among banks' daily returns were computed to detect co-movement and systemic risk exposure.

```
corr_matrix = df.pivot(index='date', columns='stock_name', values='daily_return').corr()
```

- **Leader–Follower (Granger Causality) Analysis:**
  Granger causality tests identified whether large banks like **Akbank** or **Garanti BBVA** statistically influence smaller banks' price movements.

```
from statsmodels.tsa.stattools import grangercausalitytests

grangercausalitytests(data[['small_bank', 'major_bank']], maxlag=5)
```

- **Outlier Detection:**
  Abnormally high returns or trading volumes were flagged using Z-scores, helping connect spikes to economic or geopolitical events.

3. Portfolio Construction and Performance Evaluation

An **equal-weighted portfolio** of all banks was created to represent the sector:

- **Portfolio Return Calculation:**
  The daily mean return of all banks formed the portfolio's daily performance measure.

```
equal_weighted_return =
```

```
df.groupby('date')['daily_return'].mean().reset_index(name='portfolio_return')
```

- **Risk and Return Metrics:**
    - **Mean Return (%):** Average daily gain.
    - **Volatility (%):** Standard deviation of daily returns.
    - **Sharpe Ratio:** Risk-adjusted performance.
    - **Beta vs. BIST:** Systematic risk relative to the market.

    sharpe = mean_return / volatility

- **Moving Average (MA) Strategy:**

    A simple trading rule was tested — holding the portfolio only when the short-term (20-day) average was above the long-term (50-day) average — to compare with a buy-and-hold approach.

```
df['MA20'] = df['portfolio_return'].rolling(20).mean()

df['MA50'] = df['portfolio_return'].rolling(50).mean()

df['signal'] = np.where(df['MA20'] > df['MA50'], 1, 0)
```

4. Econometric and Factor Analysis

To evaluate market sensitivity and risk factors:

- **CAPM Regression (Single-Factor Model):**

    The relationship between the portfolio return and the BIST 100 market return

was estimated using Ordinary Least Squares (OLS):

```
import statsmodels.api as sm

X = sm.add_constant(bist_df['bist_return'])

model = sm.OLS(equal_weighted_return['portfolio_return'],
X).fit()
```

  - **Intercept (α):** Portfolio's excess return independent of the market.

  - **Slope (β):** Portfolio's responsiveness to market movements.

- **Performance Attribution:**

  The regression results helped identify whether returns were driven by market risk, sector-specific momentum, or other factors such as volume or volatility.

Business Insights:

This section translates the statistical and econometric findings into actionable insights relevant to **investors, financial analysts, and policymakers**. It emphasizes how the results reflect the structure, risk dynamics, and profitability of the **Turkish banking sector** and its relationship with the **broader BIST 100 market**.

1. **Portfolio-Level Insights**
   - The **equal-weighted banking portfolio** demonstrated an **average annualized return of ~54.8%**, significantly outperforming the **BIST 100 Index**, which yielded about **20.0%**.

- ***Interpretation:*** The Turkish banking sector has shown a strong recovery phase, driven by rising interest margins and digital banking adoption.

- ***Practical Impact:*** Investors focusing on sector-specific ETFs or diversified bank portfolios could capture above-market returns during expansion cycles.

- However, portfolio **volatility (~2.49%)** was higher than the market's **(0.99%)**, suggesting **higher sector-specific risk**.

    - *Interpretation:* The high fluctuations reflect sensitivity to macroeconomic policy shifts (interest rate changes, currency volatility, inflation).

    - *Insight:* While returns are attractive, risk management through diversification or hedging (e.g., futures or cross-sector exposure) is necessary.

2. Strategy Comparison: Moving Average vs. Buy & Hold

Metric	**Buy & Hold**	**MA Strategy**	**Business Interpretation**
Mean Return (%)	0.217	0.160	Buy & Hold yielded higher average returns due to sustained market rallies.
Volatility (%)	2.49	2.15	MA Strategy

			lowered risk by avoiding sharp downturns.
Sharpe Ratio	1.38	1.18	Risk-adjusted performance slightly better for Buy & Hold, but MA provided smoother returns.
Cumulative Return	10.26	5.55	MA underperformed due to missed upside in trending markets.

- ***Interpretation:***

  The Buy & Hold strategy outperformed because Turkish banks experienced strong positive momentum over the sample period, where staying invested was more profitable than timing entries/exits.

- ***Investor Takeaway:***

  In trending bull markets, Buy & Hold captures upside momentum, while Moving Average (MA) strategies are better suited for volatile or uncertain conditions to reduce drawdowns.

3. Regression (Factor) Insights – Market Sensitivity

From the **CAPM regression:**

Statistic	Interpretation
Alpha (0.226)	Positive and significant → portfolio earns an excess return independent of the market.
Beta (-0.11)	Slightly negative → inverse or weak relation to market movements.
R^2 (0.002)	Very low → only 0.2% of portfolio variance is explained by BIST returns, indicating unique sectoral dynamics.

- ***Interpretation:***

  Banking stocks appear **weakly correlated** with the general market index (BIST 100). Their performance may depend more on **domestic monetary policy, credit expansion, and sectoral profitability** than on broad market sentiment.

- ***Business Implication:***

  - Banking sector returns offer **diversification benefits** for institutional portfolios.
  - Risk exposure is more **idiosyncratic** (sector-specific) than **systematic** (market-wide).
  - Monetary tightening or easing cycles can directly impact sector performance.

4. **Correlation and Risk Structure:**
   - The **correlation matrix** showed high inter-bank dependencies among major institutions like **Garanti BBVA, Akbank, and Isbank** - reflecting shared

macroeconomic drivers.

- During crises, high correlations imply **systemic risk**—losses in one bank often signal sector-wide stress.

- However, during stable periods, these correlations help create **predictable co-movement**, useful for pair trading and hedging strategies.

5. Investor & Policy Implications:

- **For Investors:**

  - Diversification across **different sectors (e.g., banking, energy, manufacturing)** is more effective than holding multiple banks.

  - Short-term moving average strategies may **reduce drawdowns**, but long-term holding remains **more profitable** in bullish markets.

- **For Policymakers:**

  - The weak link between the banking sector and the general market underscores the **importance of sectoral stability policies**, independent of general market performance.

  - Regulatory measures (interest rate control, capital adequacy) have **direct and measurable impacts** on banking stock returns.

- **For Portfolio Managers:**

- The portfolio's **positive alpha** indicates potential for **active management gains**.

- However, the low explanatory power (R^2) calls for integrating **multi-factor models** (e.g., interest rate spread, inflation, liquidity ratios) to better explain bank performance.

6. Real-World Context:

- The observed trends align with **Turkey's post-2020 financial restructuring** period, where banks benefited from **credit growth and digital transformation**.

- Market volatility was likely influenced by **inflationary pressures**, **lira fluctuations**, and **policy rate adjustments** by the **Central Bank of the Republic of Türkiye (CBRT)**.

- The findings suggest that **macroeconomic variables**, more than market sentiment, are the key return drivers for Turkish banking equities.

Numerical Interpretation:

This section summarizes and interprets all the numerical outputs from portfolio performance, strategy comparison, and regression analysis.

1. Portfolio vs. Market Performance

Metric	Bank Portfolio	BIST 100 Index	Interpretation

Annualized Mean Return (%)	**54.80**	**20.03**	The portfolio's average yearly return is **2.7× higher** than the market benchmark.
Standard Deviation (%)	**2.49**	**0.99**	The portfolio is about **2.5× more volatile** than the overall market.
Sharpe Ratio	**1.38**	**1.25**	Despite higher risk, the portfolio generates **better risk-adjusted returns**.
Beta vs. BIST	**-0.11**	**1.00**	The portfolio has a **weak and slightly inverse relationship** with the market.

Numerical Insight:

- The portfolio achieves higher returns at higher volatility, resulting in a superior Sharpe ratio (>1.3).
- The negative beta implies **defensive or non-market-dependent performance**.
- The **standard deviation difference (2.49 vs. 0.99)** indicates that stock-level factors drive portfolio risk more than overall market movements.

2. Moving Average (MA) Strategy vs. Buy & Hold

Metric	Buy & Hold	MA Strategy	Difference	Interpretation

Mean Return (%)	**0.217**	**0.160**	**-0.057**	Buy & Hold outperformed by 26.3%.
Volatility (%)	**2.49**	**2.15**	**-0.34**	MA strategy reduced total risk by **~14%**.
Sharpe Ratio	**1.38**	**1.18**	**-0.20**	Buy & Hold had slightly better risk-adjusted returns.
Cumulative Return	**10.26**	**5.55**	**-4.71**	Buy & Hold doubled the cumulative profit of the MA strategy.

Numerical Insight:

- The MA strategy **sacrificed return for lower volatility**, evident from the reduced cumulative and mean returns.
- The **Sharpe ratio drop (1.38 → 1.18)** shows slightly poorer performance per unit risk.
- The MA strategy works better in volatile or sideways markets but lags in trending (bullish) conditions.

3. Regression (Factor) Analysis

OLS Regression Equation:

$$Portfolio\ Return\ =\ 0.2261\ -\ 0.1097\ *\ BIST\ Return$$

Statistic	Value	Interpretation
Alpha (α)	**0.2261**	Positive and significant → portfolio earns **0.23% excess daily return** independent of market.
Beta (β)	**-0.1097**	Slight negative sensitivity → when market rises by 1%, portfolio decreases by 0.11%.
R^2	**0.002**	Only **0.2%** of portfolio variance explained by BIST → returns are mostly **idiosyncratic**.
p-value (β)	**0.124**	Not statistically significant → market factor does not significantly drive portfolio returns.
F-statistic (2.373)	Insignificant	Confirms weak model explanatory power.

Numerical Insight:

- The **low R^2** and **insignificant β** imply that **banking stocks move independently** of market trends.
- The **positive α (0.226)** shows strong standalone performance due to internal sector factors like profitability and interest margin expansion.

- **Durbin-Watson (1.823)** indicates mild positive autocorrelation, suggesting minor persistence in daily returns.

4. Risk Metrics Summary

Metric	Portfolio Value	Interpretation
Mean Daily Return (%)	**0.217**	Portfolio grows on average 0.22% per day.
Volatility (σ)	**2.49%**	Daily fluctuation of ±2.5%.
Sharpe Ratio	**1.38**	Good risk-adjusted return (>1).
Beta (vs BIST)	**-0.11**	Slightly contrarian to market.
Alpha	**0.226**	Generates excess returns beyond market movements.

Numerical Insight:

- The strong **positive Sharpe ratio** and **alpha** confirm a **profitable, skill-based portfolio**.
- However, higher **volatility** means greater exposure to short-term fluctuations.

5. Correlation Matrix Summary (Example Interpretation)

Stock Pair	Correlation	Interpretation
Akbank – Isbank	0.82	Very high → move together due to similar financial structures.
Garanti – Yapi Kredi	0.75	Moderate → similar exposure to credit market.
Portfolio – BIST	-0.11	Weak, slightly inverse → independent from broad index movements.

Numerical Insight:

High within-sector correlations mean **systemic risk** is present - during crises, declines are likely to occur across all banks simultaneously.

Conclusion and Future Scope:

Conclusion:

This project analyzed Turkish banking stocks to assess their **performance, volatility, risk-adjusted returns**, and relationship with the **BIST 100 index**.

Using time-series modeling, regression, and portfolio analytics, several key conclusions emerged:

1. **Superior Portfolio Returns:**

   The **equal-weighted banking portfolio** significantly outperformed the **BIST 100**

index in terms of average and cumulative returns (54.8% vs. 20.0% annually).
This indicates that the banking sector delivered strong value creation during the study period, likely driven by **interest rate cycles**, **credit expansion**, and **sectoral resilience**.

2. **Higher Risk and Volatility:**

   Portfolio volatility (2.49%) was about **2.5× higher** than the benchmark (0.99%), showing that banking stocks are **high-beta assets** sensitive to financial and macroeconomic shocks.

3. **Stronger Risk-Adjusted Performance:**

   Despite the elevated risk, the **Sharpe ratio of 1.38** demonstrates efficient reward for each unit of risk, reflecting **good portfolio diversification and return consistency**.

4. **Weak Market Dependence (Low Beta):**

   The regression and beta analysis revealed a **negative beta (-0.11)** and $\mathbf{R^2 \approx 0.002}$, implying that portfolio returns are **largely independent of BIST 100** movements.
   This independence suggests that banking sector performance is more influenced by **sector-specific fundamentals** than by broader market trends.

5. **Buy-and-Hold vs. Moving Average:**

   The **Buy-and-Hold strategy** outperformed the **Moving Average strategy** both in mean and cumulative returns.

   While MA reduced short-term volatility, it sacrificed return potential — indicating that **trend-following rules are less effective in strong upward markets**.

6. **Regression Insights:**

   The **positive alpha (0.226)** and statistically insignificant beta highlight **idiosyncratic return drivers** — such as profit margins, credit quality, and monetary policy changes — that shape bank performance more than market sentiment.

Managerial Implications:

- **Portfolio Managers** should note that Turkish banking stocks can deliver strong returns but require active **risk control** due to volatility.

- **Long-term investors** benefit more from **buy-and-hold strategies**, as technical timing (like moving averages) may underperform in stable uptrends.

- **Diversification across financial and non-financial sectors** could further reduce risk without major return sacrifice.

- The **low market beta** suggests banks could serve as **partial hedges** in diversified Turkish equity portfolios.

Future Scope:

This study opens several promising directions for deeper and more robust analysis:

1. **Multi-Factor Modeling:**
   Extend regression using **Fama-French 3/5-factor models** to separate **size**, **value**, and **momentum** effects in bank returns.

2. **Macroeconomic Integration:**
   Include factors such as **interest rates, inflation, and GDP growth** to explain how macro conditions influence banking stock volatility.

3. **Machine Learning Forecasting:**
   Use **LSTM, Random Forest, or XGBoost** to predict returns and volatility patterns for each bank and the sectoral portfolio.

4. **Dynamic Portfolio Optimization:**
   Implement **Markowitz mean-variance optimization** or **risk parity allocation** to

improve portfolio efficiency over time.

5. **Event Study Analysis:**

   Examine market reactions to **policy rate changes, regulatory announcements, or economic shocks**, to identify high-impact dates.

6. **Real-Time Streamlit Dashboard:**

   Deploy the full pipeline as an **interactive financial analytics dashboard** to visualize live bank performance, correlations, and portfolio metrics.

Final Remark:

Overall, the project demonstrates that the **Turkish banking sector** exhibits **strong autonomous performance, moderate risk, and robust return potential**, making it a critical component for diversified investors.

However, maintaining vigilance toward **macroeconomic shifts and credit risks** remains essential for sustainable profitability and long-term value creation.