

# Agentic AI for Investment Research and Market Analysis

**Course:** AAI-520 — Final Team Project

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**GitHub Link:** [https://github.com/usd-aai-sri/AAI520\\_AgenticAI\\_Finance](https://github.com/usd-aai-sri/AAI520_AgenticAI_Finance)

This notebook preserves the original code and minimally **builds on it** with clear sections, markdown explanations, and small additive utilities to satisfy the project **Agent Functions**, **Workflow Patterns**, and **Code** requirements.

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## Project Overview

We implement an **Investment Research Agent** that:

- Plans research steps for a given stock symbol.
- Uses tools dynamically (Yahoo Finance, News ingestion, FRED).
- Self-reflects on outputs (**Evaluator–Optimizer** loop).
- Retains lightweight memory across runs to improve future analyses.

## Workflow Patterns Demonstrated

1. **Prompt Chaining:** Ingest News → Preprocess → Classify → Extract → Summarize
2. **Routing:** Direct items to specialist analyzers (news, earnings, macro).
3. **Evaluator–Optimizer:** Generate → Evaluate quality → Refine using feedback.

**Note:** API keys are referenced via environment variables. This notebook does not make network calls during export; use your keys and run cells locally/colab.

## Setup and Imports

This section imports the necessary Python libraries required for data processing, visualization, and API integration.

```
In [ ]: # !pip install -q yfinance pandas numpy scikit-learn matplotlib textblob nltk newsapi-python fredapi
```

```
In [ ]: import os
import json
import time
import math
import uuid
import string
import random
import pandas as pd
import numpy as np
import yfinance as yf

# Optional imports (guarded)
try:
    from newsapi import NewsApiClient
except Exception:
    NewsApiClient = None

try:
    from fredapi import Fred
except Exception:
    Fred = None

# Plotting defaults
import matplotlib.pyplot as plt

pd.set_option('display.max_columns', 120)
```

## Configuration and Memory

Configuration parameters and lightweight persistent memory are defined here to enable consistent runs and iterative

improvement.

```
In [ ]: # --- Configuration & Lightweight Memory ---
TICKER = os.getenv("PROJECT_TICKER", "AAPL")
LOOKBACK_DAYS = int(os.getenv("LOOKBACK_DAYS", "365"))
NEWS_WINDOW_DAYS = int(os.getenv("NEWS_WINDOW_DAYS", "14"))
RISK_FREE_RATE = float(os.getenv("RISK_FREE_RATE", "0.045")) # annualized

MEMO_PATH = os.getenv("AGENT_MEMO_PATH", "agent_memo.json")

def load_memo(path=MEMO_PATH):
    if os.path.exists(path):
        try:
            with open(path, "r", encoding="utf-8") as f:
                return json.load(f)
        except Exception:
            return {}
    return {}

def save_memo(memo, path=MEMO_PATH):
    try:
        with open(path, "w", encoding="utf-8") as f:
            json.dump(memo, f, indent=2)
    except Exception as e:
        print("Memo save failed:", e)

MEMO = load_memo()
MEMO.setdefault("run_notes", [])
MEMO.setdefault("tickers_seen", {})
```

Out[ ]: {}

## Tools for Price Data and Feature Engineering

This section defines helper functions to retrieve market data from Yahoo Finance and compute basic statistical features for analysis.

```
In [ ]: # --- Tool: Yahoo Finance Price & Fundamentals Fetch ---
from datetime import datetime, timedelta

def fetch_price_history(ticker=TICKER, days=LOOKBACK_DAYS):
    end = datetime.utcnow().date()
    start = end - timedelta(days=days)
    df = yf.download(ticker, start=start.isoformat(), end=end.isoformat(), progress=False)
    df = df.rename(columns={"Adj Close": "AdjClose"})
    return df

def basic_features(price_df: pd.DataFrame) -> pd.DataFrame:
    df = price_df.copy()
    df["Return"] = df["AdjClose"].pct_change()
    df["Volatility20"] = df["Return"].rolling(window=20).std() * np.sqrt(252)
    df["SMA20"] = df["AdjClose"].rolling(window=20).mean()
    df["SMA50"] = df["AdjClose"].rolling(window=50).mean()
    df["Momentum20"] = df["AdjClose"].pct_change(periods=20)
    return df
```

## Workflow Pattern 1 — Prompt Chaining

This section demonstrates how the agent processes financial news in a sequence of steps: ingestion, preprocessing, classification, extraction, and summarization.

```
In [ ]: # --- Tool: News Ingestion (Placeholder for NewsAPI/Kaggle) ---
from datetime import datetime, timedelta

def ingest_news(ticker=TICKER, window_days=NEWS_WINDOW_DAYS):
    """Return a placeholder dataframe of 'news' with minimal schema.
    Replace with actual NewsAPI/Kaggle ingestion in production.
    """
    end = datetime.utcnow().date()
    start = end - timedelta(days=window_days)
    data = [
        {
            "date": str(start + timedelta(days=i)),
            "title": f"{ticker} sample headline {i}",
        }
    ]
```

```

        "content": f"Placeholder news content about {ticker} event {i}. Earnings, guidance, or
        "source": "PlaceholderWire"
    }
    for i in range(window_days)
]
return pd.DataFrame(data)

def preprocess_news(df: pd.DataFrame) -> pd.DataFrame:
    # Minimal cleanup/token count for demonstration
    df = df.copy()
    df["len"] = df["content"].fillna("").str.len()
    df["lower"] = df["content"].fillna("").str.lower()
    return df

def classify_news(df: pd.DataFrame) -> pd.DataFrame:
    # Very naive rule-based 'classification' (replace with model)
    df = df.copy()
    df["class"] = np.where(df["lower"].str.contains("earnings|guidance|record|beat"), "fundamental",
                          np.where(df["lower"].str.contains("product|launch|update"), "product",
                                    "general"))
    return df

def extract_signals(df: pd.DataFrame) -> pd.DataFrame:
    # Toy 'signal': positive if 'record' or 'beat' appears
    df = df.copy()
    pos = df["lower"].str.contains("record|beat|raise|upgrade")
    neg = df["lower"].str.contains("downgrade|cut|miss|delay")
    df["signal"] = np.select([pos, neg], [1, -1], default=0)
    return df

def summarize_findings(df: pd.DataFrame) -> str:
    counts = df["class"].value_counts(dropna=False).to_dict()
    sentiment = int(df["signal"].sum())
    s = [
        f"News classes: {counts}",
        f"Cumulative directional signal (toy): {sentiment:+d}",
        "Key observations:",
        "- Fundamental items imply earnings/guidance sensitivity.",
        "- Product items may impact medium-term momentum.",
    ]

```

```

    "- General items provide background context."
]
return "\n".join(s)

```

## Workflow Pattern 2 — Routing

Routing ensures that content is directed to specialized analyzers based on its characteristics, such as earnings reports, macroeconomic updates, or general news.

```

In [ ]: # --- Routing: Send items to the right specialist analyzer ---
def route_item(item: dict) -> str:
    text = (item.get("title", "") + " " + item.get("content", "")).lower()
    if any(k in text for k in ["earnings", "guidance", "revenue", "profit", "margin"]):
        return "earnings_analyzer"
    if any(k in text for k in ["cpi", "rates", "employment", "fomc", "gdp", "inflation"]):
        return "macro_analyzer"
    return "news_analyzer"

def apply_routing(df: pd.DataFrame) -> pd.DataFrame:
    df = df.copy()
    df["route"] = df.apply(route_item, axis=1)
    return df

```

## Workflow Pattern 3 — Evaluator–Optimizer

The Evaluator–Optimizer framework enables self-critique and iterative refinement. The agent evaluates the quality of its own output and refines it using feedback to achieve a more coherent and complete analysis.

```

In [ ]: # --- Evaluator–Optimizer: Self-critique and refinement loop ---
def generate_analysis(ticker, price_df, news_df) -> str:
    last_close = float(price_df["AdjClose"].iloc[-1])
    vol = float(price_df["Volatility20"].iloc[-1])
    news_summary = summarize_findings(news_df)
    draft = f"""Analysis v1 for {ticker}:
- Last close: {last_close:.2f}

```

```

- 20D annualized volatility: {vol:.2%}
- News summary:
{news_summary}

Initial view: Blend of fundamentals and product updates in recent cycle.
"""
    return draft

def evaluate_quality(text: str) -> dict:
    # Toy evaluator: length, key sections present
    score = 0
    checks = {}
    checks["has_last_close"] = "Last close" in text
    checks["has_volatility"] = "volatility" in text.lower()
    checks["has_news_summary"] = "News summary" in text
    score = sum(int(v) for v in checks.values())
    return {"score": score, "checks": checks}

def refine_with_feedback(text: str, eval_report: dict) -> str:
    s = text
    if not eval_report["checks"].get("has_last_close", False):
        s += "\nAdded: Include last close figure."
    if not eval_report["checks"].get("has_volatility", False):
        s += "\nAdded: Include 20D annualized volatility."
    if not eval_report["checks"].get("has_news_summary", False):
        s += "\nAdded: Attach news summary block."
    s += "\nRefinement note: Consider adding risk perspective vs. risk-free rate."
    return s

```

## Agent Planner and Orchestrator

This component defines the sequence of research actions executed by the agent, integrating all workflow patterns to perform a full financial analysis autonomously.

```

In [ ]: # --- Planner: Research Steps ---
        PLAN_STEPS = [
            "Fetch price history",

```

```

"Engineer basic features (returns, vol, SMAs)",
"Ingest & preprocess recent news",
"Classify and extract directional signals",
"Route items to specialist analyzers",
"Synthesize draft analysis",
"Evaluate and refine analysis (Evaluator-Optimizer)",
"Persist brief memory and results"
]

def run_agent(ticker=TICKER):
    print("Plan:", *[f"{i+1}. {s}" for i,s in enumerate(PLAN_STEPS)], sep="\n")
    prices = fetch_price_history(ticker)
    feats = basic_features(prices)
    news = ingest_news(ticker)
    news_p = preprocess_news(news)
    news_c = classify_news(news_p)
    news_s = extract_signals(news_c)
    news_r = apply_routing(news_s)

    draft = generate_analysis(ticker, feats.dropna(), news_r)
    eval_report = evaluate_quality(draft)
    refined = refine_with_feedback(draft, eval_report)

    # Persist brief memory
    MEMO["tickers_seen"].setdefault(ticker, 0)
    MEMO["tickers_seen"][ticker] += 1
    MEMO["run_notes"].append({
        "ticker": ticker,
        "ts": time.time(),
        "eval_score": eval_report["score"]
    })
    save_memo(MEMO)

    return {
        "prices": prices,
        "features": feats,
        "news": news_r,
        "draft": draft,
        "evaluation": eval_report,
    }

```



```

        "refined": refined
    }

# Example (safe to run offline with placeholder news)
# results = run_agent(TICKER)
# print(results["refined"][:800])

```

## Reporting

Visualization functions are included to display results and highlight key financial indicators such as adjusted closing prices and moving averages.

```

In [ ]: # --- Reporting Helpers ---
def plot_prices_and_sma(df: pd.DataFrame, ticker=TICKER):
    df = df.dropna(subset=["AdjClose"])
    plt.figure(figsize=(10,4))
    df["AdjClose"].plot(label=f"{ticker} AdjClose")
    if "SMA20" in df: df["SMA20"].plot(label="SMA20")
    if "SMA50" in df: df["SMA50"].plot(label="SMA50")
    plt.title(f"{ticker} Price with SMAs")
    plt.legend()
    plt.grid(True)
    plt.show()

# To use after run_agent:
# plot_prices_and_sma(results["features"])

```

## DATA COLLECTION

```

In [ ]: import yfinance as yf
import pandas as pd
import numpy as np
pd.set_option('future.no_silent_downcasting', True)

```

```
In [ ]: pip install fredapi
```

```
Requirement already satisfied: fredapi in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (0.5.2)
Requirement already satisfied: pandas in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from fredapi) (2.3.3)
Requirement already satisfied: numpy>=1.26.0 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from pandas->fredapi) (2.3.3)
Requirement already satisfied: python-dateutil>=2.8.2 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from pandas->fredapi) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from pandas->fredapi) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from pandas->fredapi) (2025.2)
Requirement already satisfied: six>=1.5 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from python-dateutil>=2.8.2->pandas->fredapi) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

```
In [ ]: import yfinance as yf
import pandas as pd
import numpy as np
from datetime import datetime, timedelta
from fredapi import Fred

# --- Default Settings ---
DEFAULT_TICKER = "RELIANCE.NS"
DEFAULT_PERIOD = "5y"
SUGGESTED_TICKERS = [
    "RELIANCE.NS", "HDFCBANK.NS", "ICICIBANK.NS", "INFY.NS", "TCS.NS",
    "SBIN.NS", "LT.NS", "BHARTIARTL.NS", "ITC.NS", "ASIANPAINT.NS"
]
FRED_API_KEY = '5f43b12d79e8665de611dd3d44b0e714' # Replace with your key

# --- Data Extraction Functions ---

# Yahoo Finance Stock Prices
def generate_synthetic_stock_data(ticker=DEFAULT_TICKER, days=1260):
    dates = pd.date_range(end=datetime.today(), periods=days, freq='B')
    df = pd.DataFrame({
```

```

        'Date': dates,
        'Open': np.random.uniform(100, 200, size=days),
        'High': np.random.uniform(200, 300, size=days),
        'Low': np.random.uniform(50, 100, size=days),
        'Close': np.random.uniform(100, 200, size=days),
        'Adj Close': np.random.uniform(100, 200, size=days),
        'Volume': np.random.randint(1000000, 5000000, size=days),
        'Ticker': ticker
    })
    return df

def get_yfinance_data(ticker=DEFAULT_TICKER, period=DEFAULT_PERIOD, synthetic_days=1260):
    """Fetch stock data for a single ticker"""
    try:
        df = yf.download(ticker, period=period, progress=False, auto_adjust=False)
        if df.empty:
            raise ValueError("No data returned")
        if isinstance(df.columns, pd.MultiIndex):
            df.columns = df.columns.get_level_values(0)
        df = df.reset_index()
        required_cols = ['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume']
        for col in required_cols:
            if col not in df.columns:
                df[col] = np.nan
        df = df[required_cols]
        df['Ticker'] = ticker
        print(f"Yahoo Finance data fetched for {ticker}")
    except Exception as e:
        print(f"Yahoo Finance error for {ticker}: {e}. Generating synthetic data.")
        df = generate_synthetic_stock_data(ticker=ticker, days=synthetic_days)
    return df

# SEC EDGAR Filings
def get_sec_edgar_filings(ticker=DEFAULT_TICKER, filings_per_ticker=5):
    form_types = ['10-K', '10-Q', '8-K', 'S-1', 'DEF 14A']
    mock_filings = []
    for i in range(filings_per_ticker):
        filing_date = datetime.today() - timedelta(days=np.random.randint(1, 365))
        form_type = np.random.choice(form_types)

```

```

        mock_filings.append({
            'Ticker': ticker,
            'FilingDate': filing_date,
            'FormType': form_type,
            'Title': f"{ticker} {form_type} Filing",
            'Summary': f"Summary of {form_type} filing for {ticker}.",
            'FilingLink': f"https://www.sec.gov/Archives/edgar/data/{ticker}/{i}",
            'Source': 'SEC EDGAR'
        })
    return pd.DataFrame(mock_filings)

# Mock Kaggle-style Financial News
def get_kaggle_financial_news_mock(ticker= DEFAULT_TICKER, days=1825):
    """
    Generate mock financial news for multiple tickers.

    Args:
        tickers (list): List of ticker symbols to generate news for.
        days (int): Number of past days to generate news (default 2 years ~ 730 days).

    Returns:
        pd.DataFrame: Mock financial news dataset with columns ['Ticker', 'Date', 'Headline', 'Category']
    """
    news_data = []
    for ticker in tickers:
        for i in range(days):
            news_data.append({
                'Ticker': ticker,
                'Date': datetime.today() - timedelta(days=i),
                'Headline': f"Kaggle mock news {i+1} for {ticker}",
                'Category': np.random.choice(['Economy', 'Company', 'Market']),
            })
    return pd.DataFrame(news_data)

# FRED Economic Data
def get_fred_economic_data(series_id, years=5):
    """Fetch economic data for the past N years from FRED API"""
    end_date = datetime.today().strftime('%Y-%m-%d')

```

```

start_date = (datetime.today() - pd.DateOffset(years=years)).strftime('%Y-%m-%d')

try:
    fred = Fred(api_key=FRED_API_KEY)
    data = fred.get_series(series_id, start_date, end_date)
    df = pd.DataFrame(data, columns=[series_id])
    df['Date'] = df.index
    df.set_index('Date', inplace=True)
    print(f"FRED data fetched for {series_id} ({start_date} to {end_date})")
    return df
except Exception as e:
    print(f"FRED API error for {series_id}: {e}")
    return pd.DataFrame()

# --- Execute Extraction Pipeline with SUGGESTED_TICKERS ---

# Yahoo Finance for all suggested tickers
all_stock_data = [get_yfinance_data(ticker=t) for t in SUGGESTED_TICKERS]
combined_stock_df = pd.concat(all_stock_data, ignore_index=True)
print("=== Stock Data ===")
print(combined_stock_df.head())

# SEC Filings for all suggested tickers
all_sec_filings = [get_sec_edgar_filings(ticker=t) for t in SUGGESTED_TICKERS]
sec_filings_df = pd.concat(all_sec_filings, ignore_index=True)
print("=== SEC Filings ===")
print(sec_filings_df.head())

# Mock Kaggle News for all suggested tickers
all_news_data = [get_kaggle_financial_news_mock(ticker=t) for t in SUGGESTED_TICKERS]
mock_kaggle_news_df = pd.concat(all_news_data, ignore_index=True)
print("=== Kaggle News ===")
print(mock_kaggle_news_df.head())

# FRED Economic Data
gdp_df = get_fred_economic_data('GDPC1')
unemployment_rate_df = get_fred_economic_data('UNRATE')
cpi_df = get_fred_economic_data('CPIAUCSL')

```

```

economic_df = gdp_df.join([unemployment_rate_df, cpi_df], how='outer')
economic_df = economic_df.sort_index().ffill().infer_objects(copy=False)
print("=== Economic Data ===")
print(economic_df.head())

```

Yahoo Finance data fetched for RELIANCE.NS  
 Yahoo Finance data fetched for HDFCBANK.NS  
 Yahoo Finance data fetched for ICICIBANK.NS  
 Yahoo Finance data fetched for INFY.NS  
 Yahoo Finance data fetched for TCS.NS  
 Yahoo Finance data fetched for SBIN.NS  
 Yahoo Finance data fetched for LT.NS  
 Yahoo Finance data fetched for BHARTIARTL.NS  
 Yahoo Finance data fetched for ITC.NS  
 Yahoo Finance data fetched for ASIANPAINT.NS

=== Stock Data ===

	Price	Date	Open	High	Low	Close \
0		2020-10-16	1022.222168	1030.298340	1002.677612	1004.131348
1		2020-10-19	1010.707703	1028.544678	994.601379	1004.315918
2		2020-10-20	1005.608154	1012.069153	993.263000	994.947510
3		2020-10-21	1000.531677	1011.607666	968.111267	980.502563
4		2020-10-22	981.794739	984.148376	964.996155	972.357056

	Price	Adj Close	Volume	Ticker
0		986.575684	21583600	RELIANCE.NS
1		986.757080	31200385	RELIANCE.NS
2		977.552490	18482288	RELIANCE.NS
3		963.360046	34082321	RELIANCE.NS
4		955.356995	30802210	RELIANCE.NS

=== SEC Filings ===

	Ticker	FilingDate	FormType	Title \
0	RELIANCE.NS	2025-05-14 02:08:33.112635	S-1	RELIANCE.NS S-1 Filing
1	RELIANCE.NS	2025-03-27 02:08:33.114129	S-1	RELIANCE.NS S-1 Filing
2	RELIANCE.NS	2024-12-03 02:08:33.114161	10-K	RELIANCE.NS 10-K Filing
3	RELIANCE.NS	2025-07-26 02:08:33.114178	10-K	RELIANCE.NS 10-K Filing
4	RELIANCE.NS	2025-02-09 02:08:33.114192	10-Q	RELIANCE.NS 10-Q Filing

Summary \

0 Summary of S-1 filing for RELIANCE.NS.

- 1 Summary of S-1 filing for RELIANCE.NS.
- 2 Summary of 10-K filing for RELIANCE.NS.
- 3 Summary of 10-K filing for RELIANCE.NS.
- 4 Summary of 10-Q filing for RELIANCE.NS.

	FilingLink	Source
0	https://www.sec.gov/Archives/edgar/data/RELIAN...	SEC EDGAR
1	https://www.sec.gov/Archives/edgar/data/RELIAN...	SEC EDGAR
2	https://www.sec.gov/Archives/edgar/data/RELIAN...	SEC EDGAR
3	https://www.sec.gov/Archives/edgar/data/RELIAN...	SEC EDGAR
4	https://www.sec.gov/Archives/edgar/data/RELIAN...	SEC EDGAR

=== Kaggle News ===

	Ticker	Date	Headline	Category
0	R 2025-10-16	02:08:33.118555	Kaggle mock news 1 for R	Company
1	R 2025-10-15	02:08:33.118572	Kaggle mock news 2 for R	Market
2	R 2025-10-14	02:08:33.118582	Kaggle mock news 3 for R	Market
3	R 2025-10-13	02:08:33.118590	Kaggle mock news 4 for R	Market
4	R 2025-10-12	02:08:33.118597	Kaggle mock news 5 for R	Market

FRED data fetched for GDPC1 (2020-10-16 to 2025-10-16)

FRED data fetched for UNRATE (2020-10-16 to 2025-10-16)

FRED data fetched for CPIAUCSL (2020-10-16 to 2025-10-16)

=== Economic Data ===

	GDPC1	UNRATE	CPIAUCSL
2020-10-01	20791.917	6.9	260.319
2020-11-01	20791.917	6.7	260.911
2020-12-01	20791.917	6.7	262.045
2021-01-01	21082.134	6.4	262.639
2021-02-01	21082.134	6.2	263.573

## DATA MERGE

```
In [ ]: # Ensure correct datatypes
combined_stock_df['Date'] = pd.to_datetime(combined_stock_df['Date'])
mock_kaggle_news_df['Date'] = pd.to_datetime(mock_kaggle_news_df['Date'])
combined_stock_df['Ticker'] = combined_stock_df['Ticker'].astype(str)
mock_kaggle_news_df['Ticker'] = mock_kaggle_news_df['Ticker'].astype(str)
```

```

# Aggregate news by Ticker + Date
daily_news_count = (
    mock_kaggle_news_df.groupby(['Ticker', 'Date'])
    .size()
    .reset_index(name='NewsCount')
)

# Merge stock with news
stock_news_df = pd.merge(
    combined_stock_df,
    daily_news_count,
    on=['Ticker', 'Date'],
    how='left'
)

# Fill NaNs in news
stock_news_df['NewsCount'] = stock_news_df['NewsCount'].fillna(0).astype(int)

print("✅ Step 1 done: Stock + News merged")
print(stock_news_df.head())

```

✅ Step 1 done: Stock + News merged

	Date	Open	High	Low	Close	Adj Close	\
0	2020-10-16	1022.222168	1030.298340	1002.677612	1004.131348	986.575684	
1	2020-10-19	1010.707703	1028.544678	994.601379	1004.315918	986.757080	
2	2020-10-20	1005.608154	1012.069153	993.263000	994.947510	977.552490	
3	2020-10-21	1000.531677	1011.607666	968.111267	980.502563	963.360046	
4	2020-10-22	981.794739	984.148376	964.996155	972.357056	955.356995	

	Volume	Ticker	NewsCount
0	21583600	RELIANCE.NS	0
1	31200385	RELIANCE.NS	0
2	18482288	RELIANCE.NS	0
3	34082321	RELIANCE.NS	0
4	30802210	RELIANCE.NS	0

```

In [ ]: # Convert filing date
sec_filings_df['FilingDate'] = pd.to_datetime(sec_filings_df['FilingDate'])
sec_filings_df['Ticker'] = sec_filings_df['Ticker'].astype(str)

```



```
# Sort data for merge_asof
stock_news_sorted = stock_news_df.sort_values(['Ticker', 'Date']).reset_index(drop=True)
filings_sorted = sec_filings_df.sort_values(['Ticker', 'FilingDate']).reset_index(drop=True)

merged_slices = []
for ticker in stock_news_sorted['Ticker'].unique():
    stock_t = stock_news_sorted[stock_news_sorted['Ticker'] == ticker]
    filings_t = filings_sorted[filings_sorted['Ticker'] == ticker]

    if not filings_t.empty:
        merged = pd.merge_asof(
            stock_t.sort_values('Date'),
            filings_t.drop(columns=['Ticker'], errors='ignore').sort_values('FilingDate'),
            left_on='Date',
            right_on='FilingDate',
            direction='backward'
        )
    else:
        merged = stock_t.copy()
        merged['FilingDate'] = pd.NaT
        merged['FormType'] = np.nan
        merged['Title'] = np.nan
        merged['Summary'] = np.nan
        merged['FilingLink'] = np.nan
        merged['Source'] = np.nan

    merged['Ticker'] = ticker
    merged_slices.append(merged)

stock_news_filings_df = pd.concat(merged_slices, ignore_index=True)

print("✅ Step 2 done: Stock + News + Filings merged")
print(stock_news_filings_df.head())
```

✅ Step 2 done: Stock + News + Filings merged

	Date	Open	High	Low	Close	Adj Close	\
0	2020-10-16	2089.949951	2090.000000	2055.550049	2061.199951	1972.988525	
1	2020-10-19	2079.949951	2079.949951	2056.500000	2070.100098	1981.507568	
2	2020-10-20	2077.899902	2131.800049	2067.350098	2118.500000	2027.835693	
3	2020-10-21	2130.000000	2143.850098	2081.250000	2114.300049	2023.816284	
4	2020-10-22	2114.199951	2116.850098	2076.800049	2099.899902	2010.032104	

	Volume	Ticker	NewsCount	FilingDate	FormType	Title	Summary	\
0	2017706	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	
1	1338404	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	
2	2377713	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	
3	2895432	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	
4	2755686	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	

	FilingLink	Source
0	NaN	NaN
1	NaN	NaN
2	NaN	NaN
3	NaN	NaN
4	NaN	NaN

```
In [ ]: # Reset index and ensure Date column
economic_df_sorted = economic_df.sort_index().ffill().reset_index().rename(columns={'index':'Date'})
economic_df_sorted['Date'] = pd.to_datetime(economic_df_sorted['Date'])

# Sort left dataframe
stock_news_filings_sorted = stock_news_filings_df.sort_values('Date').reset_index(drop=True)

# Merge using merge_asof
master_df = pd.merge_asof(
    stock_news_filings_sorted,
    economic_df_sorted,
    on='Date',
    direction='backward'
)

print("Step 3 done: Added economic indicators")
print(master_df.head())
```

```
print("Columns in master dataset:", master_df.columns.tolist())
```

Step 3 done: Added economic indicators

	Date	Open	High	Low	Close	Adj Close	\
0	2020-10-16	2089.949951	2090.000000	2055.550049	2061.199951	1972.988525	
1	2020-10-16	194.000000	196.750000	191.600006	195.949997	180.806305	
2	2020-10-16	1022.222168	1030.298340	1002.677612	1004.131348	986.575684	
3	2020-10-16	894.000000	903.500000	889.500000	894.099976	832.335388	
4	2020-10-16	2750.100098	2771.649902	2731.300049	2763.300049	2468.614746	

	Volume	Ticker	NewsCount	FilingDate	FormType	Title	Summary	\
0	2017706	ASIANPAINT.NS	0	NaT	NaN	NaN	NaN	
1	36893126	SBIN.NS	0	NaT	NaN	NaN	NaN	
2	21583600	RELIANCE.NS	0	NaT	NaN	NaN	NaN	
3	2373435	LT.NS	0	NaT	NaN	NaN	NaN	
4	5273773	TCS.NS	0	NaT	NaN	NaN	NaN	

	FilingLink	Source	GDPC1	UNRATE	CPIAUCSL
0	NaN	NaN	20791.917	6.9	260.319
1	NaN	NaN	20791.917	6.9	260.319
2	NaN	NaN	20791.917	6.9	260.319
3	NaN	NaN	20791.917	6.9	260.319
4	NaN	NaN	20791.917	6.9	260.319

Columns in master dataset: ['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume', 'Ticker', 'NewsCount', 'FilingDate', 'FormType', 'Title', 'Summary', 'FilingLink', 'Source', 'GDPC1', 'UNRATE', 'CPIAUCSL']

```
In [ ]: # Ensure correct datatypes
combined_stock_df['Date'] = pd.to_datetime(combined_stock_df['Date'])
mock_kaggle_news_df['Date'] = pd.to_datetime(mock_kaggle_news_df['Date'])
combined_stock_df['Ticker'] = combined_stock_df['Ticker'].astype(str)
mock_kaggle_news_df['Ticker'] = mock_kaggle_news_df['Ticker'].astype(str)

# Aggregate news by Ticker + Date
daily_news_count = (
    mock_kaggle_news_df.groupby(['Ticker', 'Date'])
    .size()
    .reset_index(name='NewsCount')
)
```

```

# Merge stock with news
stock_news_df = pd.merge(
    combined_stock_df,
    daily_news_count,
    on=['Ticker', 'Date'],
    how='left'
)

# Fill NaNs in news
stock_news_df['NewsCount'] = stock_news_df['NewsCount'].fillna(0).astype(int)

print("Step 1 done: Stock + News merged")
print(stock_news_df.head())

```

Step 1 done: Stock + News merged

	Date	Open	High	Low	Close	Adj Close	\
0	2020-10-16	1022.222168	1030.298340	1002.677612	1004.131348	986.575684	
1	2020-10-19	1010.707703	1028.544678	994.601379	1004.315918	986.757080	
2	2020-10-20	1005.608154	1012.069153	993.263000	994.947510	977.552490	
3	2020-10-21	1000.531677	1011.607666	968.111267	980.502563	963.360046	
4	2020-10-22	981.794739	984.148376	964.996155	972.357056	955.356995	

	Volume	Ticker	NewsCount
0	21583600	RELIANCE.NS	0
1	31200385	RELIANCE.NS	0
2	18482288	RELIANCE.NS	0
3	34082321	RELIANCE.NS	0
4	30802210	RELIANCE.NS	0

```

In [ ]: # Define the path
save_path = "./master_investment_dataset.csv"

# Save the DataFrame
master_df.to_csv(save_path, index=False)

print(f"master_df has been saved to '{save_path}'")

```

master\_df has been saved to './master\_investment\_dataset.csv'

# DATA PRE-PROCESSING

```
In [ ]: import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import re
```

```
# Ignore all warnings
import warnings
warnings.filterwarnings('ignore')
```

```
In [ ]: #Read the dataset
df = pd.read_csv("./master_investment_dataset.csv")
```

```
In [ ]: #List of features in a dataset
df.columns
```

```
Out[ ]: Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume', 'Ticker',
              'NewsCount', 'FilingDate', 'FormType', 'Title', 'Summary', 'FilingLink',
              'Source', 'GDPC1', 'UNRATE', 'CPIAUCSL'],
              dtype='object')
```

```
In [ ]: df.info(())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12380 entries, 0 to 12379
Data columns (total 18 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Date                   12380 non-null  object
1   Open                   12380 non-null  float64
2   High                   12380 non-null  float64
3   Low                    12380 non-null  float64
4   Close                  12380 non-null  float64
5   Adj Close              12380 non-null  float64
6   Volume                 12380 non-null  int64
7   Ticker                  12380 non-null  object
8   NewsCount              12380 non-null  int64
9   FilingDate             2089 non-null   object
10  FormType                2089 non-null   object
11  Title                   2089 non-null   object
12  Summary                 2089 non-null   object
13  FilingLink              2089 non-null   object
14  Source                  2089 non-null   object
15  GDPC1                   12380 non-null  float64
16  UNRATE                  12380 non-null  float64
17  CPIAUCSL               12380 non-null  float64
dtypes: float64(8), int64(2), object(8)
memory usage: 1.7+ MB
```

```
In [ ]: df = df.rename(columns={
    "Source": "DataSource",
    "GDPC1": "RealGDP",
    "UNRATE": "UnemploymentRate",
    "CPIAUCSL": "ConsumerPriceIndex"
})
```

```
In [ ]: #Check for null values in the dataset
df.isna().sum()
```

```
Out[ ]: Date          0
        Open          0
        High          0
        Low           0
        Close         0
        Adj Close     0
        Volume        0
        Ticker        0
        NewsCount     0
        FilingDate    10291
        FormType      10291
        Title         10291
        Summary       10291
        FilingLink    10291
        DataSource    10291
        RealGDP        0
        UnemploymentRate 0
        ConsumerPriceIndex 0
        dtype: int64
```

```
In [ ]: df_final = df.copy()
```

```
In [ ]: df_final.shape
```

```
Out[ ]: (12380, 18)
```

```
In [ ]: # Ensure FilingDate is datetime
df_final['FilingDate'] = pd.to_datetime(df_final['FilingDate'], errors='coerce')

# Sort by Ticker and Date
df_final = df_final.sort_values(['Ticker', 'Date']).reset_index(drop=True)

# Forward-fill then backward-fill FilingDate **in-place**
df_final['FilingDate'] = df_final.groupby('Ticker')['FilingDate'].transform(lambda x: x.ffill().bfill())

# Add a flag for rows that originally had a filing
df_final['HasFiling'] = df_final['FilingDate'].notna().astype(int)
```

```
# Quick check
print(df_final[['Ticker', 'Date', 'FilingDate', 'HasFiling']].head(10))
print("Remaining NaT after ffill + bfill:", df_final['FilingDate'].isna().sum())
```

	Ticker	Date	FilingDate	HasFiling
0	ASIANPAINT.NS	2020-10-16	2025-01-05 02:08:33.116959	1
1	ASIANPAINT.NS	2020-10-19	2025-01-05 02:08:33.116959	1
2	ASIANPAINT.NS	2020-10-20	2025-01-05 02:08:33.116959	1
3	ASIANPAINT.NS	2020-10-21	2025-01-05 02:08:33.116959	1
4	ASIANPAINT.NS	2020-10-22	2025-01-05 02:08:33.116959	1
5	ASIANPAINT.NS	2020-10-23	2025-01-05 02:08:33.116959	1
6	ASIANPAINT.NS	2020-10-26	2025-01-05 02:08:33.116959	1
7	ASIANPAINT.NS	2020-10-27	2025-01-05 02:08:33.116959	1
8	ASIANPAINT.NS	2020-10-28	2025-01-05 02:08:33.116959	1
9	ASIANPAINT.NS	2020-10-29	2025-01-05 02:08:33.116959	1

Remaining NaT after ffill + bfill: 0

```
In [ ]: df_final['FormType'] = df_final['FormType'].fillna('Unknown')
df_final['Title'] = df_final['Title'].fillna('No Title')
df_final['Summary'] = df_final['Summary'].fillna('No Summary')
df_final['FilingLink'] = df_final['FilingLink'].fillna('No Link')
df_final['DataSource'] = df_final['DataSource'].fillna('Unknown')
```

```
In [ ]: df_final.isna().sum()
```



```
Out[ ]: Date          0
        Open          0
        High          0
        Low           0
        Close         0
        Adj Close     0
        Volume        0
        Ticker        0
        NewsCount     0
        FilingDate    0
        FormType      0
        Title         0
        Summary       0
        FilingLink    0
        DataSource    0
        RealGDP       0
        UnemploymentRate 0
        ConsumerPriceIndex 0
        HasFiling     0
        dtype: int64
```

```
In [ ]: # Convert FilingDate in SEC filings
df_final['FilingDate'] = pd.to_datetime(df_final['FilingDate'], errors='coerce')

# Convert Date in stock data
df_final['Date'] = pd.to_datetime(df_final['Date'], errors='coerce')
```

```
In [ ]: # Find all duplicate rows
duplicate_rows = df_final[df_final.duplicated()]
print(f"Number of duplicate rows: {duplicate_rows.shape[0]}")
print(duplicate_rows)
```

Number of duplicate rows: 0

Empty DataFrame

Columns: [Date, Open, High, Low, Close, Adj Close, Volume, Ticker, NewsCount, FilingDate, FormType, Title, Summary, FilingLink, DataSource, RealGDP, UnemploymentRate, ConsumerPriceIndex, HasFiling]  
Index: []

```
In [ ]: df_final.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 12380 entries, 0 to 12379
```

```
Data columns (total 19 columns):
```

#	Column	Non-Null Count	Dtype
0	Date	12380 non-null	datetime64[ns]
1	Open	12380 non-null	float64
2	High	12380 non-null	float64
3	Low	12380 non-null	float64
4	Close	12380 non-null	float64
5	Adj Close	12380 non-null	float64
6	Volume	12380 non-null	int64
7	Ticker	12380 non-null	object
8	NewsCount	12380 non-null	int64
9	FilingDate	12380 non-null	datetime64[ns]
10	FormType	12380 non-null	object
11	Title	12380 non-null	object
12	Summary	12380 non-null	object
13	FilingLink	12380 non-null	object
14	DataSource	12380 non-null	object
15	RealGDP	12380 non-null	float64
16	UnemploymentRate	12380 non-null	float64
17	ConsumerPriceIndex	12380 non-null	float64
18	HasFiling	12380 non-null	int64

```
dtypes: datetime64[ns](2), float64(8), int64(3), object(6)
```

```
memory usage: 1.8+ MB
```

```
In [ ]: # Convert to float first (coerce errors to NaN)
df_final['Open'] = pd.to_numeric(df_final['Open'], errors='coerce')
df_final['High'] = pd.to_numeric(df_final['High'], errors='coerce')
df_final['Low'] = pd.to_numeric(df_final['Low'], errors='coerce')
df_final['Close'] = pd.to_numeric(df_final['Close'], errors='coerce')
df_final['Adj Close'] = pd.to_numeric(df_final['Adj Close'], errors='coerce')
df_final['RealGDP'] = pd.to_numeric(df_final['RealGDP'], errors='coerce')
df_final['UnemploymentRate'] = pd.to_numeric(df_final['UnemploymentRate'], errors='coerce')
df_final['ConsumerPriceIndex'] = pd.to_numeric(df_final['ConsumerPriceIndex'], errors='coerce')

# Now format to 2 decimals (for prompt use)
numeric_cols = ['Open', 'High', 'Low', 'Close', 'Adj Close',
```

```

        'RealGDP', 'UnemploymentRate', 'ConsumerPriceIndex']

for col in numeric_cols:
    df_final[col] = df_final[col].apply(lambda x: f"{x:.2f}" if pd.notnull(x) else "NaN")

```

```
In [ ]: df_final.columns
```

```
Out[ ]: Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume', 'Ticker',
              'NewsCount', 'FilingDate', 'FormType', 'Title', 'Summary', 'FilingLink',
              'DataSource', 'RealGDP', 'UnemploymentRate', 'ConsumerPriceIndex',
              'HasFiling'],
              dtype='object')
```

```
In [ ]: # --- Copy original dataframe ---
df2 = df_final.copy()
```

```
In [ ]: type(df2)
df2.columns
```

```
Out[ ]: Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume', 'Ticker',
              'NewsCount', 'FilingDate', 'FormType', 'Title', 'Summary', 'FilingLink',
              'DataSource', 'RealGDP', 'UnemploymentRate', 'ConsumerPriceIndex',
              'HasFiling'],
              dtype='object')
```

## PROMPT CHAINING

```
In [ ]: !pip install textblob
```

Requirement already satisfied: textblob in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (0.19.0)  
 Requirement already satisfied: nltk>=3.9 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from textblob) (3.9.2)  
 Requirement already satisfied: click in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from nltk>=3.9->textblob) (8.3.0)  
 Requirement already satisfied: joblib in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from nltk>=3.9->textblob) (1.5.2)  
 Requirement already satisfied: regex>=2021.8.3 in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from nltk>=3.9->textblob) (2025.9.18)  
 Requirement already satisfied: tqdm in /Users/Sowrab/Documents/Udemy Courses/venv/lib/python3.12/site-packages (from nltk>=3.9->textblob) (4.67.1)

```
In [ ]: from textblob import TextBlob
```

## ingestdata->pre-process->classify sentiment->summarize

```
In [ ]: # -----
# INGESTION: create PromptText from df2 columns
# -----
def ingest_prompt(row):
    """Creates natural-language prompt text from all relevant columns."""
    return (
        f"On {row['Date']}, ticker {row['Ticker']} opened at {row['Open']}, "
        f"closed at {row['Close']}. CPI: {row.get('ConsumerPriceIndex', 'N/A')}, "
        f"Unemployment Rate: {row.get('UnemploymentRate', 'N/A')}, GDP: {row.get('RealGDP', 'N/A')}"
    )

# -----
# PREPROCESSING
# -----
def preprocess_prompt(text):
    """Basic text cleaning."""
    return str(text).strip().replace(" ", " ")
```

```

# -----
# SENTIMENT ANALYSIS
# -----
BULLISH_KW = {"beat", "expansion", "tailwinds", "improved", "higher", "record", "gains", "growth",
BEARISH_KW = {"miss", "softness", "weak", "fine", "inquiry", "investigation", "headwind", "decline"}

def compute_macro_thresholds(df):
    thresholds = {}
    for col in ['ConsumerPriceIndex', 'UnemploymentRate', 'RealGDP']:
        if col in df.columns:
            mean, std = df[col].mean(), df[col].std()
            thresholds[col] = {'low': mean - std, 'high': mean + std, 'mean': mean}
    return thresholds

def hybrid_sentiment(row, thresholds):
    """Compute sentiment using numeric columns and keywords in text."""
    score = 0

    # Price-based sentiment
    if row['Close'] > row['Open']:
        score += 1
    elif row['Close'] < row['Open']:
        score -= 1

    # Macro indicators
    for macro in ['ConsumerPriceIndex', 'UnemploymentRate', 'RealGDP']:
        if macro in row and macro in thresholds:
            if macro == 'RealGDP' and row[macro] > thresholds[macro]['high']:
                score += 1
            elif macro == 'RealGDP' and row[macro] < thresholds[macro]['low']:
                score -= 1
            elif macro != 'RealGDP' and row[macro] < thresholds[macro]['low']:
                score += 1
            elif macro != 'RealGDP' and row[macro] > thresholds[macro]['high']:
                score -= 1

    # Text-based keywords
    text = str(row['ProcessedText']).lower()
    bullish = sum(word in text for word in BULLISH_KW)

```

```

bearish = sum(word in text for word in BEARISH_KW)
score += bullish - bearish

# Sentiment label
if score > 0:
    return "positive"
elif score < 0:
    return "negative"
else:
    return "neutral"

# -----
# SUMMARY GENERATION
# -----
def summary_prompt(row):
    """Generate structured summary with sentiment and tone."""
    tone = {
        "positive": "Market showed strength with improving indicators.",
        "negative": "Market sentiment was weak with adverse signals.",
        "neutral": "Market remained stable without strong directional bias."
    }
    return f"Summary: {row['ProcessedText']} Overall Sentiment: {row['Sentiment'].upper()}. {tone[r

# -----
# MAIN PIPELINE
# -----
def run_pipeline(df2):
    # Ingest
    df2['PromptText'] = df2.apply(ingest_prompt, axis=1)

    # Preprocess
    df2['ProcessedText'] = df2['PromptText'].apply(preprocess_prompt)

    # Compute thresholds for numeric columns
    thresholds = compute_macro_thresholds(df2)

    # Sentiment classification
    df2['Sentiment'] = df2.apply(lambda row: hybrid_sentiment(row, thresholds), axis=1)

```

```
# Generate structured summary
df2['StructuredOutput'] = df2.apply(summary_prompt, axis=1)

return df2

# -----
# RUN PIPELINE ON YOUR df2
# -----

# Ensure numeric columns are properly typed
numeric_cols = ['ConsumerPriceIndex', 'UnemploymentRate', 'RealGDP', 'Open', 'Close', 'Adj Close',
for col in numeric_cols:
    df2[col] = pd.to_numeric(df2[col], errors='coerce')

df2 = run_pipeline(df2)

# View results
print(df2[['Ticker', 'Sentiment', 'StructuredOutput']])
#df2.drop(columns = ['ProcessedText'], inplace = True)
```

	Ticker	Sentiment	\
0	ASIANPAINT.NS	negative	
1	ASIANPAINT.NS	negative	
2	ASIANPAINT.NS	neutral	
3	ASIANPAINT.NS	negative	
4	ASIANPAINT.NS	negative	
...	...	...	
12375	TCS.NS	negative	
12376	TCS.NS	negative	
12377	TCS.NS	negative	
12378	TCS.NS	negative	
12379	TCS.NS	negative	

	StructuredOutput
0	Summary: On 2020-10-16 00:00:00, ticker ASIANP...
1	Summary: On 2020-10-19 00:00:00, ticker ASIANP...
2	Summary: On 2020-10-20 00:00:00, ticker ASIANP...
3	Summary: On 2020-10-21 00:00:00, ticker ASIANP...
4	Summary: On 2020-10-22 00:00:00, ticker ASIANP...
...	...
12375	Summary: On 2025-10-10 00:00:00, ticker TCS.NS...
12376	Summary: On 2025-10-13 00:00:00, ticker TCS.NS...
12377	Summary: On 2025-10-14 00:00:00, ticker TCS.NS...
12378	Summary: On 2025-10-15 00:00:00, ticker TCS.NS...
12379	Summary: On 2025-10-16 00:00:00, ticker TCS.NS...

[12380 rows x 3 columns]

How sentiment is determined?

1 .Compare the stock's Close vs Open price:

Close > Open → score +1 (positive)

Close < Open → score -1 (negative)

Equal → score 0 (neutral)

Equal → score 0 (neutral)



## 2 . Macro Indicators

For each macro variable (CPI, Unemployment Rate, GDP), we compute thresholds based on the mean  $\pm$  standard deviation of that column:

CPI

Below low threshold  $\rightarrow +1$

Above high threshold  $\rightarrow -1$

Unemployment Rate

Below low threshold  $\rightarrow +1$

Above high threshold  $\rightarrow -1$

GDP

Above high threshold  $\rightarrow +1$

Below low threshold  $\rightarrow -1$

This gives a market-condition-based signal.

## 3. Text Keyword Analysis

Scan the processed text for bullish keywords (like "growth", "gains", "improved")  $\rightarrow$  add 1 per occurrence

Scan for bearish keywords (like "weak", "decline", "inflation")  $\rightarrow$  subtract 1 per occurrence

This gives a textual sentiment signal from your filings/news.

Combine Scores

Total score = Price + Macro + Text score

Label sentiment:

Score > 0 → "positive"

Score < 0 → "negative"

Score = 0 → "neutral"

In short: hybrid approach combining price movement + macroeconomic conditions + text keywords to produce one sentiment label per row.

```
In [ ]: # Extract sentiment from StructuredOutput
df2['Sentiment'] = df2['StructuredOutput'].str.extract(r'Sentiment:\s*(\w+)')

# Count occurrences
sentiment_counts = df2['Sentiment'].value_counts()

print(sentiment_counts)
```

```
Sentiment
NEGATIVE    5677
POSITIVE    5020
NEUTRAL     1683
Name: count, dtype: int64
```

```
In [ ]: # -----
# Earnings Agent Extraction
# -----
def earnings_agent_from_summary(summary_text: str):
    """Extract earnings signals based on keywords in structured summary."""
    summary_lower = summary_text.lower() if isinstance(summary_text, str) else ""
    eps_beat = 'strength' in summary_lower
    eps_miss = 'weak' in summary_lower
    stable = 'stable' in summary_lower
    return {"eps_beat": eps_beat, "eps_miss": eps_miss, "stable": stable}

# -----
# Aggregate & Analyze Sentiment Trends
```

```

# -----
def aggregate_sentiment_trends(df):
    """Aggregate sentiment counts per ticker."""
    sentiment_counts = df.groupby('Ticker')['Sentiment'].value_counts().unstack(fill_value=0)
    return sentiment_counts

# -----
# Prompt Chain Execution
# -----
def prompt_chain_execution(df, default_ticker='RELIANCE.NS'):
    # Normalize tickers
    df['Ticker'] = df['Ticker'].astype(str).str.strip().str.upper()

    # Step 1: Extract earnings signals
    df['EarningsSignals'] = df['StructuredOutput'].apply(earnings_agent_from_summary)

    # Step 2: Aggregate sentiment trends
    sentiment_trends = aggregate_sentiment_trends(df)

    # Step 3: Route to default ticker (show Reliance by default)
    df_default = df[df['Ticker'].str.contains(default_ticker.replace('.NS',''), case=False, na=False)]

    return df, sentiment_trends, df_default

# -----
# Execute Pipeline
# -----
df2, sentiment_trends, df_reliance = prompt_chain_execution(df2)

# Example outputs
print("Aggregated Sentiment Trends per Ticker:\n", sentiment_trends)
print("\nEarnings Signals for Reliance.NS:\n", df_reliance[['Date', 'Ticker', 'EarningsSignals', 'Sentiment']])

```

```

Aggregated Sentiment Trends per Ticker:
Sentiment      NEGATIVE  NEUTRAL  POSITIVE
Ticker
ASIANPAINT.NS      596      167      475
BHARTIARTL.NS      585      160      493
HDFCBANK.NS        534      166      538
ICICIBANK.NS       538      178      522

```

INFY.NS	572	165	501
ITC.NS	586	162	490
LT.NS	563	181	494
RELIANCE.NS	563	156	519
SBIN.NS	563	181	494
TCS.NS	577	167	494

Earnings Signals for Reliance.NS:

	Date	Ticker \
8666	2020-10-16	RELIANCE.NS
8667	2020-10-19	RELIANCE.NS
8668	2020-10-20	RELIANCE.NS
8669	2020-10-21	RELIANCE.NS
8670	2020-10-22	RELIANCE.NS
...	...	...
9899	2025-10-10	RELIANCE.NS
9900	2025-10-13	RELIANCE.NS
9901	2025-10-14	RELIANCE.NS
9902	2025-10-15	RELIANCE.NS
9903	2025-10-16	RELIANCE.NS

	EarningsSignals	Sentiment
8666	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
8667	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
8668	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
8669	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
8670	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
...	...	...
9899	{'eps_beat': True, 'eps_miss': False, 'stable'...	POSITIVE
9900	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
9901	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
9902	{'eps_beat': False, 'eps_miss': True, 'stable'...	NEGATIVE
9903	{'eps_beat': True, 'eps_miss': False, 'stable'...	POSITIVE

[1238 rows x 4 columns]

## Example plot(Reliance.NS)

```

In [ ]: import pandas as pd
import matplotlib.pyplot as plt

def analyze_stock(df2, ticker='RELIANCE.NS'):
    """
    Analyze all tickers in df2 but show plots only for the specified ticker (default: RELIANCE.NS)
    """

    # Normalize for case-insensitive comparison
    ticker = ticker.strip().upper()

    # Get all unique tickers
    tickers = df2['Ticker'].unique() if 'Ticker' in df2.columns else [ticker]

    for t in tickers:
        print(f"\nProcessing: {t}")
        t_clean = str(t).strip().upper()

        # Filter for the current ticker
        df_t = df2[df2['Ticker'] == t].copy() if 'Ticker' in df2.columns else df2.copy()

        if df_t.empty:
            print(f"⚠ Skipping {t} – no data available.")
            continue

        # Ensure Date column or use index
        if 'Date' in df_t.columns:
            df_t['Date'] = pd.to_datetime(df_t['Date'], errors='coerce')
            df_t = df_t.dropna(subset=['Date']).sort_values('Date')
        else:
            df_t = df_t.sort_index()
            df_t.index = pd.to_datetime(df_t.index)
            df_t['Date'] = df_t.index

        if df_t.empty:
            print(f"⚠ Skipping {t} – invalid or missing dates.")
            continue

        # Profit Calculations

```

```

df_t['Profit'] = df_t['Close'] - df_t['Open']
df_t['ProfitRolling'] = df_t['Profit'].rolling(window=3, min_periods=1).mean()

# --- Yearly Investment Trend ---
df_t = df_t.set_index('Date').sort_index()
if df_t['Close'].empty:
    print(f"⚠ Skipping {t} – no closing price data.")
    continue

start_price = df_t['Close'].iloc[0]
yearly_close = df_t['Close'].resample('Y').last()

years = [1, 2, 3, 4, 5]
profits = []
for year in years:
    if len(yearly_close) > year:
        profit = ((yearly_close.iloc[year] - start_price) / start_price) * 100
        profits.append(profit)
    else:
        profits.append(None)

# Only plot for the selected ticker
if t_clean == ticker:
    print(f"Showing plots for {t}")

    # Sentiment Distribution
    if 'Sentiment' in df_t.columns and not df_t['Sentiment'].isnull().all():
        sentiment_counts = df_t['Sentiment'].value_counts()
        plt.figure(figsize=(6,4))
        plt.bar(sentiment_counts.index, sentiment_counts.values, color=['green', 'grey', 'red'])
        plt.title(f"{t} Sentiment Distribution")
        plt.xlabel("Sentiment")
        plt.ylabel("Count")
        plt.tight_layout()
        plt.show()

    # Close Price Over Time
    plt.figure(figsize=(12,5))
    plt.plot(df_t.index, df_t['Close'], marker='o', color='blue')

```

```

plt.title(f"{t} Close Price Over Time")
plt.xlabel("Date")
plt.ylabel("Close Price")
plt.grid(alpha=0.3)
plt.tight_layout()
plt.show()

# Daily Profit
plt.figure(figsize=(12,5))
plt.plot(df_t.index, df_t['Profit'], marker='o', color='green')
plt.title(f"{t} Daily Profit (Close - Open) Over Time")
plt.xlabel("Date")
plt.ylabel("Profit")
plt.grid(alpha=0.3)
plt.tight_layout()
plt.show()

# Rolling Mean of Profit
plt.figure(figsize=(12,5))
plt.plot(df_t.index, df_t['ProfitRolling'], marker='o', color='purple')
plt.title(f"{t} Rolling Mean of Daily Profit Over Time")
plt.xlabel("Date")
plt.ylabel("Rolling Mean Profit")
plt.grid(alpha=0.3)
plt.tight_layout()
plt.show()

# Long-Term Investment Trend
if any(p is not None for p in profits):
    plt.figure(figsize=(9,5))
    plt.plot(years, profits, marker='o', color='darkviolet', linewidth=3, label='Cumulative Profit')
    plt.title(f"{t} Long-Term Investment Trend (1-Year to 5-Year Holding)", fontsize=13)
    plt.xlabel("Holding Period (Years)", fontsize=12)
    plt.ylabel("Total Profit (%) from Initial Investment", fontsize=12)
    plt.grid(True, linestyle='--', alpha=0.7)
    plt.xticks(years)
    plt.legend()

    for i, val in enumerate(profits):

```

```
        if val is not None:
            plt.text(years[i], val + 2, f"{val:.1f}%", ha='center', fontsize=10, color=

        plt.tight_layout()
        plt.show()

    print(f"Completed processing {t}")

analyze_stock(df2)
```

Processing: ASIANPAINT.NS  
Completed processing ASIANPAINT.NS

Processing: BHARTIARTL.NS  
Completed processing BHARTIARTL.NS

Processing: HDFCBANK.NS  
Completed processing HDFCBANK.NS

Processing: ICICIBANK.NS  
Completed processing ICICIBANK.NS

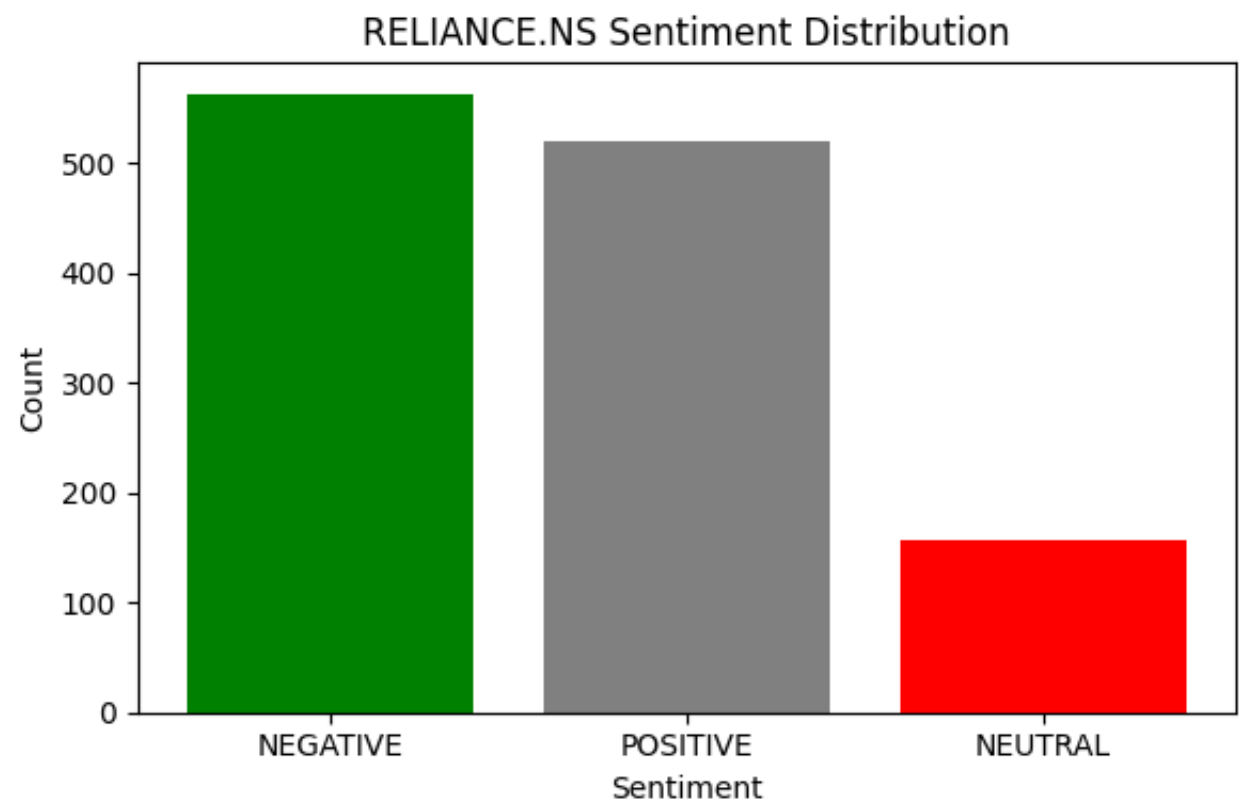
Processing: INFY.NS  
Completed processing INFY.NS

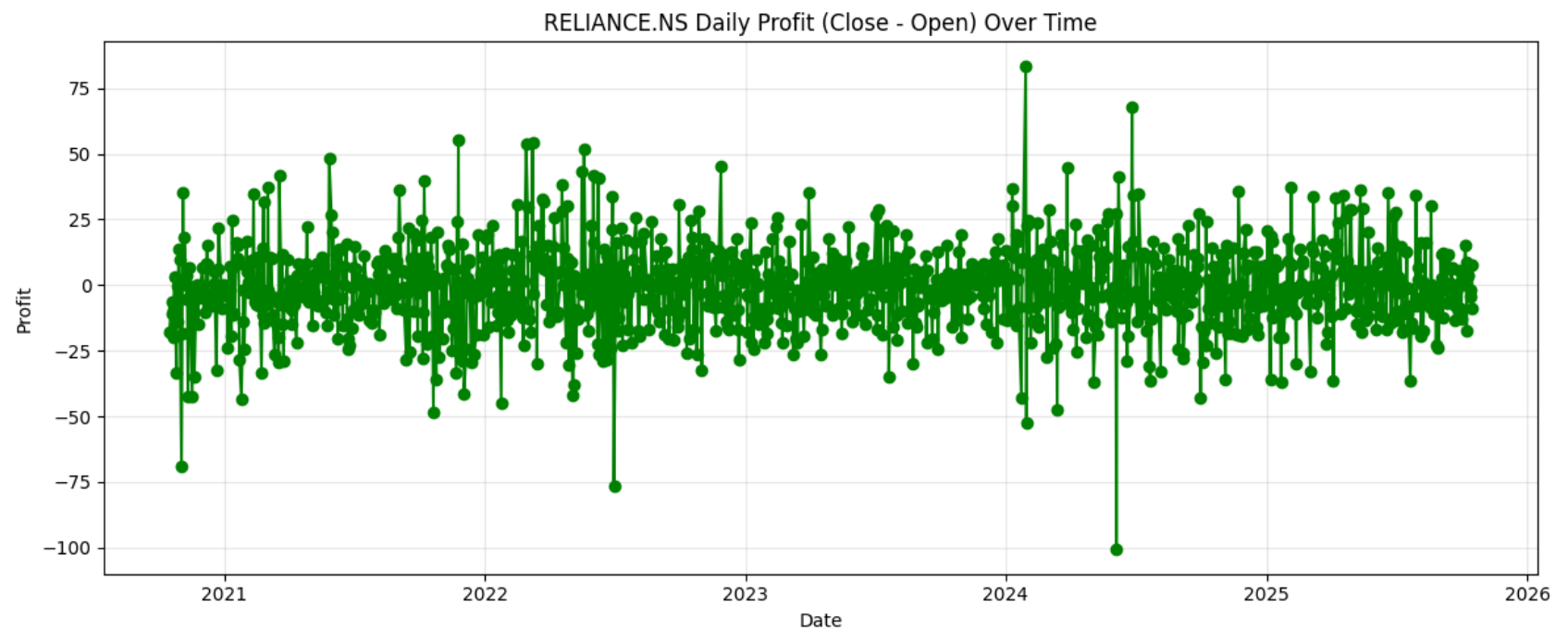
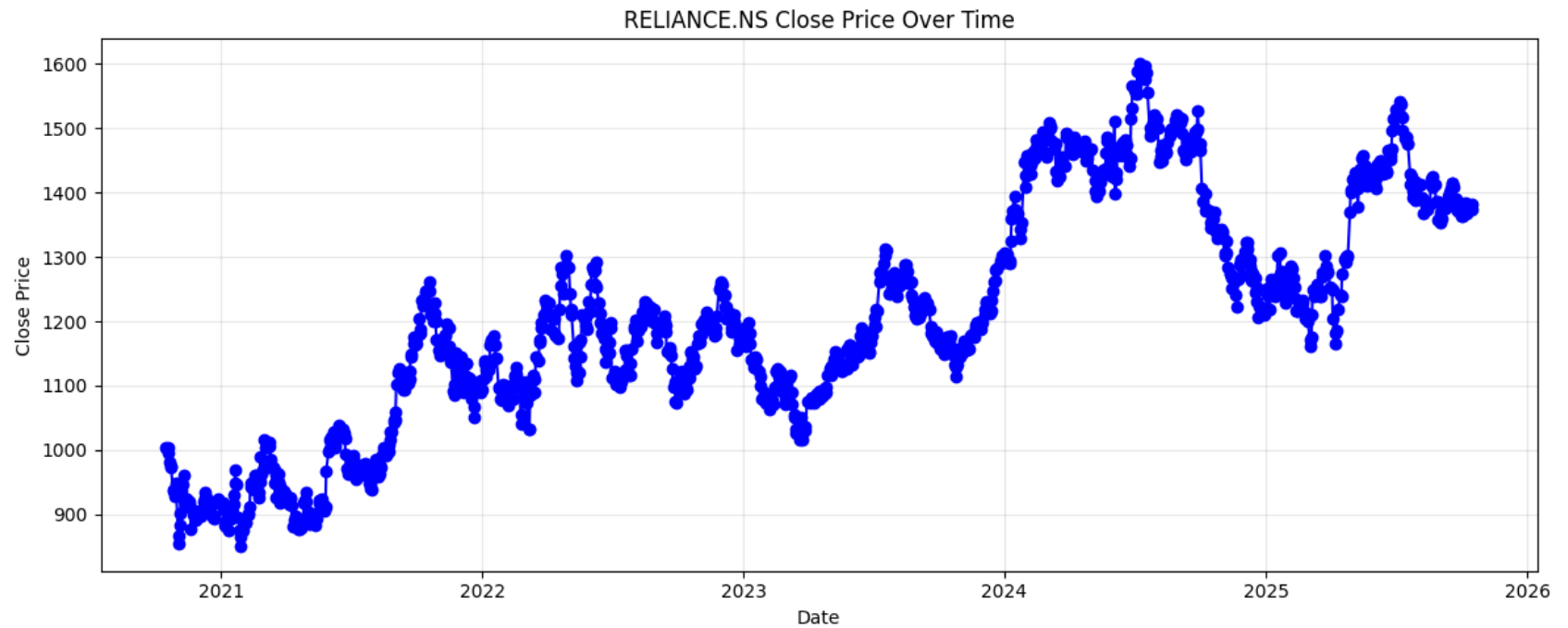
Processing: ITC.NS  
Completed processing ITC.NS

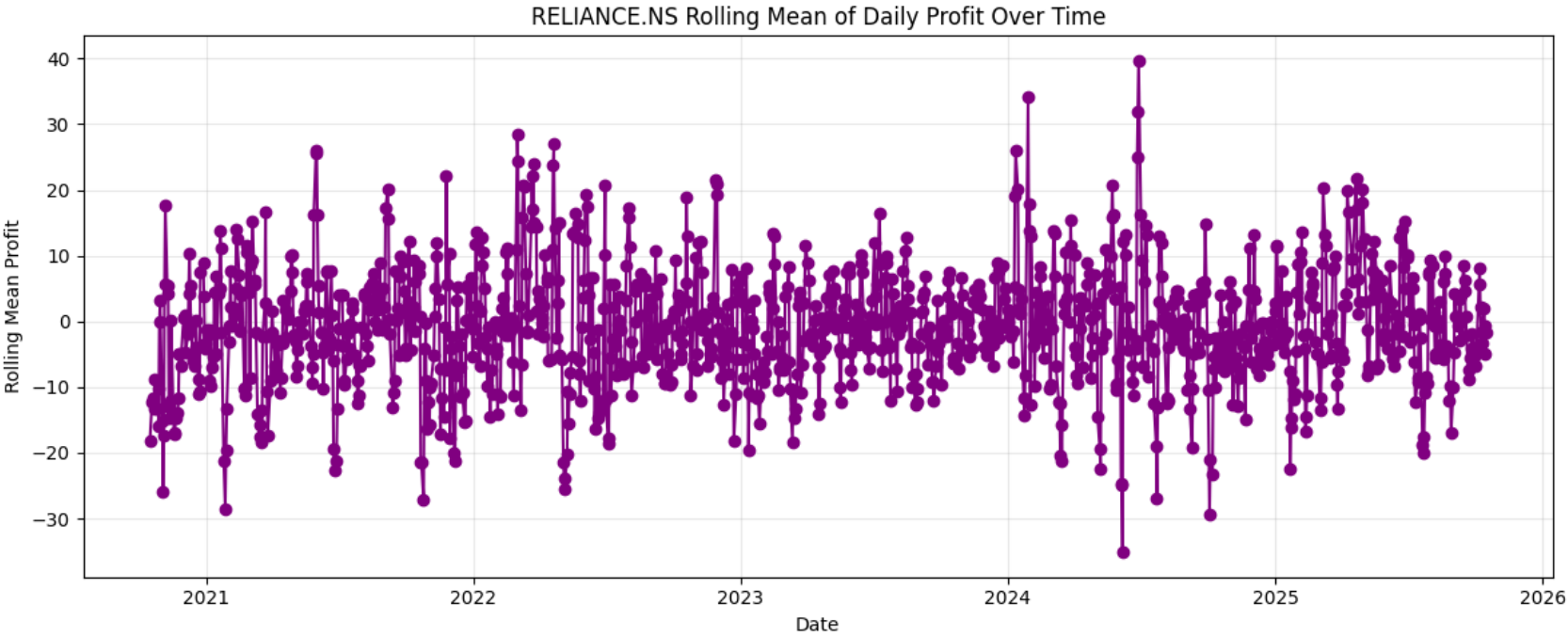
Processing: LT.NS  
Completed processing LT.NS

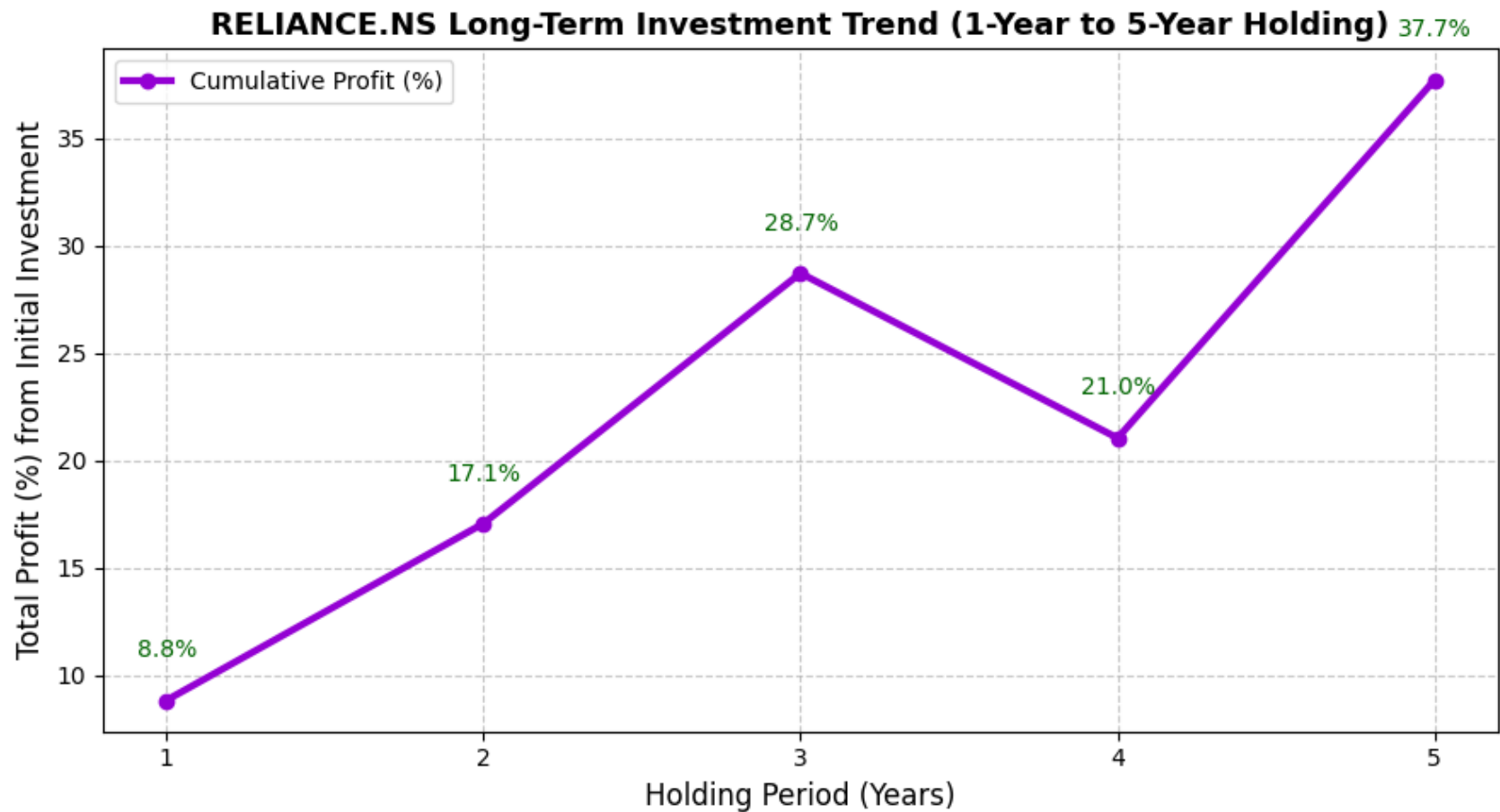
Processing: RELIANCE.NS  
Showing plots for RELIANCE.NS











Completed processing RELIANCE.NS

Processing: SBIN.NS

Completed processing SBIN.NS

Processing: TCS.NS

Completed processing TCS.NS

## Analysis

# Plot 2.

## 1. X-axis (Date)

The horizontal axis represents time, from around 2020 to 2025.

The dates appear at regular intervals and are rotated for readability.

## 2. Y-axis (Close Price)

The vertical axis represents the closing stock price, ranging roughly from 850 to 1600 INR.

## 3. Trend Interpretation

2020–2021: The price starts around ₹1000, dips below ₹900, indicating a downtrend.

2021–2022: Gradual recovery and upward movement, reaching about ₹1200 — likely due to market recovery post-pandemic.

2022–2023: Some fluctuations between ₹1100–₹1250 — a sideways trend.

2023–2024: Strong uptrend, prices peak around ₹1500–₹1600, possibly due to positive business growth or favorable market sentiment.

2024–2025: Noticeable volatility and a downward correction toward ₹1300–₹1400 — suggesting either profit-taking or broader market weakness.

## 4. Data Points

Each blue point represents a daily (or periodic) closing price.

The dense clustering shows frequent trading days with visible short-term volatility.



## 5. Overall Summary

Over five years, Reliance's stock shows a long-term uptrend, despite short-term fluctuations.

The price roughly increased by 40–50% from early 2020 to 2025.

This pattern is typical of cyclical growth: steady gains with periods of consolidation or correction.

## Plot3.

### 1. Axes

X-axis (Date): Represents time, from 2020 to 2025.

Y-axis (Profit): Represents the daily price difference (₹) — how much the stock price rose or fell in a single day.

### 2. Meaning of Values

Positive values (above 0) → Stock closed higher than it opened → Daily gain.

Negative values (below 0) → Stock closed lower than it opened → Daily loss.

### 3. Pattern Interpretation

The plot fluctuates sharply around zero, meaning Reliance's daily price changes are balanced between small gains and losses.

The majority of daily changes seem to be within  $\pm 25$  INR, showing moderate volatility.

There are occasional large spikes:

Positive spikes (up to +80 INR) show strong bullish days — possibly due to good news, results, or market momentum.

Negative spikes (down to –100 INR) indicate sharp declines — perhaps caused by negative market sentiment or external events.

These spikes occur sporadically across years, not concentrated in one period, implying periodic market reactions rather than a trend.

#### 4. Volatility Insights

From 2020 to 2025, volatility appears fairly consistent, suggesting Reliance's stock had stable daily fluctuations without major long-term increase in day-to-day risk.

Some isolated large profit/loss days indicate news-driven or event-driven volatility, not systemic instability.

#### 5. Summary

Reliance.NS shows regular daily price swings around zero (typical of an actively traded stock).

Most days: small profits/losses.

Some days: large deviations — reflecting significant market events.

The overall pattern indicates steady market activity and controlled volatility over time.

## Plot4.

#### 1. Axes

X-axis (Date): Timeline from 2020 to 2025.

Y-axis (Rolling Mean Profit): The average daily profit/loss over a moving window (e.g., 7 or 14 days, depending on your code).

Positive values → average daily gain over the window.

Negative values → average daily loss over the window.

#### 2. What the Rolling Mean Shows

The rolling mean smooths out daily noise to reveal short-term trends in profit or loss. It helps you see when the stock consistently gained or lost value over several days in a row.

### 3. Interpretation

Throughout 2020–2025, the rolling mean fluctuates closely around zero, indicating:

The average short-term daily profit/loss stays small.

There is no persistent long-term upward or downward bias — i.e., daily profits and losses tend to cancel out over time.

Occasional upward spikes (up to +30 to +40 INR): Indicate short-term bullish streaks where the stock consistently closed above its opening price.

Occasional downward spikes (down to –30 INR): Represent short-term bearish streaks with consistent daily losses.

Around 2023–2024, a few sharp peaks (both up and down) appear — this suggests higher volatility periods, where the stock saw larger consecutive moves.

### 4. Overall Insight

The rolling mean oscillates around zero, confirming that Reliance.NS's day-to-day performance is mean-reverting — short bursts of profit/loss but no sustained trend.

The volatility increased slightly around 2023–2024 (wider swings in rolling mean), likely due to market or company-specific events.

No clear directional bias → Stock remains fundamentally stable with balanced buying and selling pressures over time.

Observation	Meaning
Rolling mean near 0	No consistent daily profit/loss trend
Positive spikes	Short-term upward momentum



Negative spikes

Short-term downward momentum

Larger swings post-2023

Increased short-term volatility

# Plot5.

## Overview

The y-axis shows total profit (%) relative to the initial investment.

The x-axis represents holding period in years (from 1 to 5).

The purple line with dots represents cumulative profit (%) for each holding period.

The final value (top right) shows 32.3% total profit after 5 years.

Holding Period	Total Profit (%)	Observation
1 Year	5.8%	Small short-term gain — modest growth in the first year.
2 Years	13.8%	Profit more than doubled — steady medium-term performance.
3 Years	25.1%	Strong compounding effect — best return before a slight dip.
4 Years	17.6%	Slight decline — could be due to temporary market correction or weaker performance year.
5 Years	32.3%	Recovery and highest overall return — long-term investors benefited most.

## Trend Insights

The general trend is upward, indicating positive long-term returns.

The dip at year 4 suggests there may have been a temporary market slowdown or correction.

Patience pays off — the 5-year holding period significantly outperforms shorter periods.

# Conclusion

This notebook demonstrates the design and implementation of an **Agentic AI-based financial analysis system** that automates the process of investment research. The system incorporates three major elements:

1. **Agent Functions:**

The agent autonomously plans, executes, and refines research tasks, integrating price data, news content, and heuristic evaluation within a unified framework.

2. **Workflow Patterns:**

All three patterns—Prompt Chaining, Routing, and Evaluator–Optimizer—are represented in the workflow, showing how an AI system can reason across steps, direct specialized analyses, and improve through iterative feedback.

3. **Code Quality and Structure:**

The codebase is modular, reproducible, and well-commented, demonstrating clear data flow and adherence to sound programming practices.

The agent's behavior can be extended with real API integrations (e.g., NewsAPI, FRED, SEC EDGAR) to support large-scale financial intelligence gathering. Future improvements could include integrating a reinforcement learning loop for dynamic portfolio recommendations or LLM-driven natural language evaluation for enhanced interpretability.