Team 2 | Final Presentation

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Nontechnical Project:

Team 2 | Bank of America's 8 Business Lines

For Individuals:

- **Retail**
  - Common customers
- **Preferred**
  - Individuals up to $250k investable assets
  - Small Businesses up to $5M annual revenues
- **Merrill Lynch Wealth Management**
  - Individuals with over $250k investable assets
  - Includes personal advisor
- **Private Bank**
  - Individuals over $3M investable assets
  - Full team devoted to managing wealth of this individual

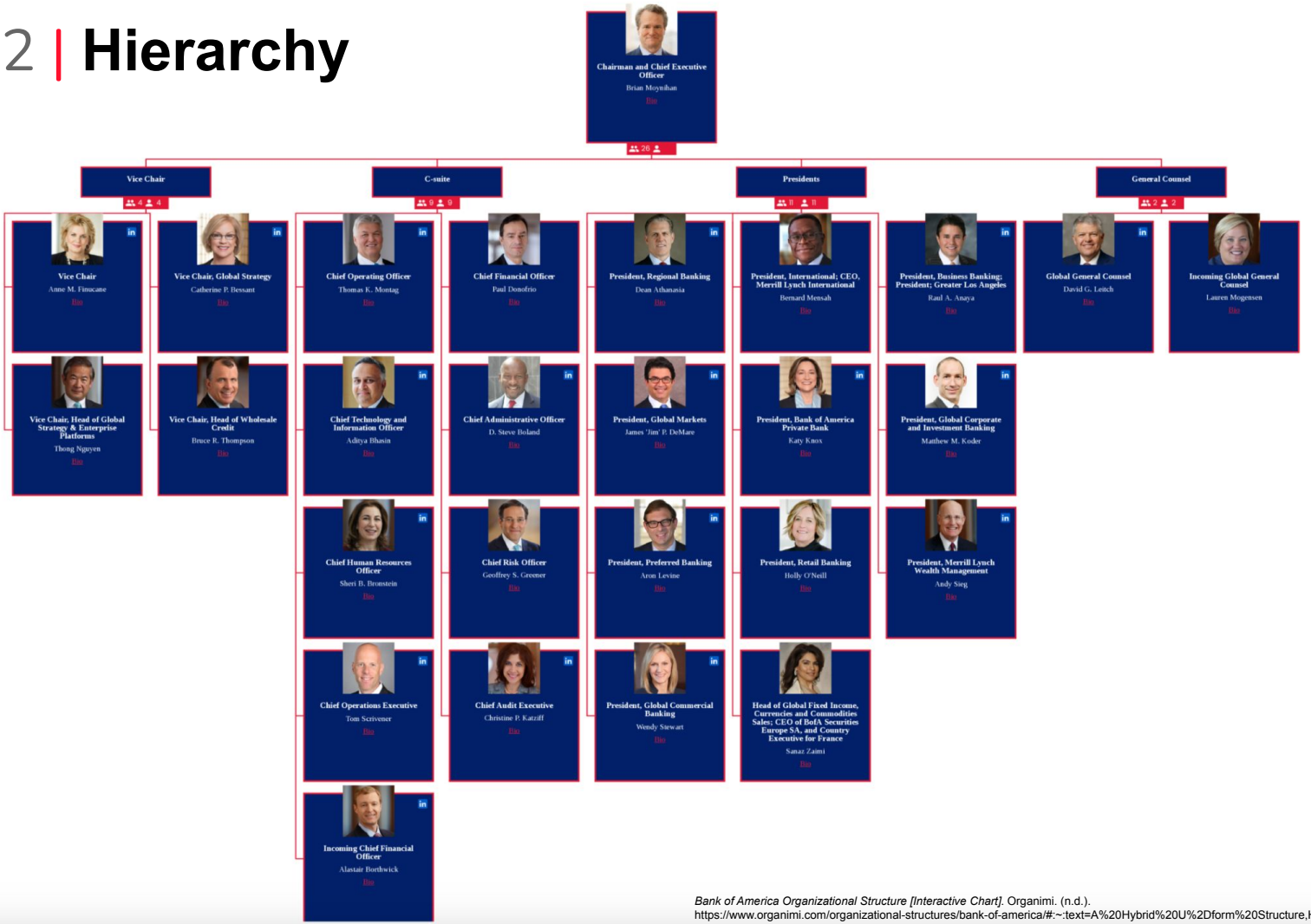
For Businesses:

- **Business Banking**
  - US companies of $5-50M revenues
- **Global Commercial Banking**
  - Middle Market US companies of $50M to $2B annual revenues
  - Treasury, lending, leasing, investment banking, risk management and international subsidiary banking services
- **Global Corporate & Investment Banking**
  - Global Companies $2B+ in revenues
  - treasury services, lending, leasing, advisory, and debt and equity underwriting solutions

For Institutions:

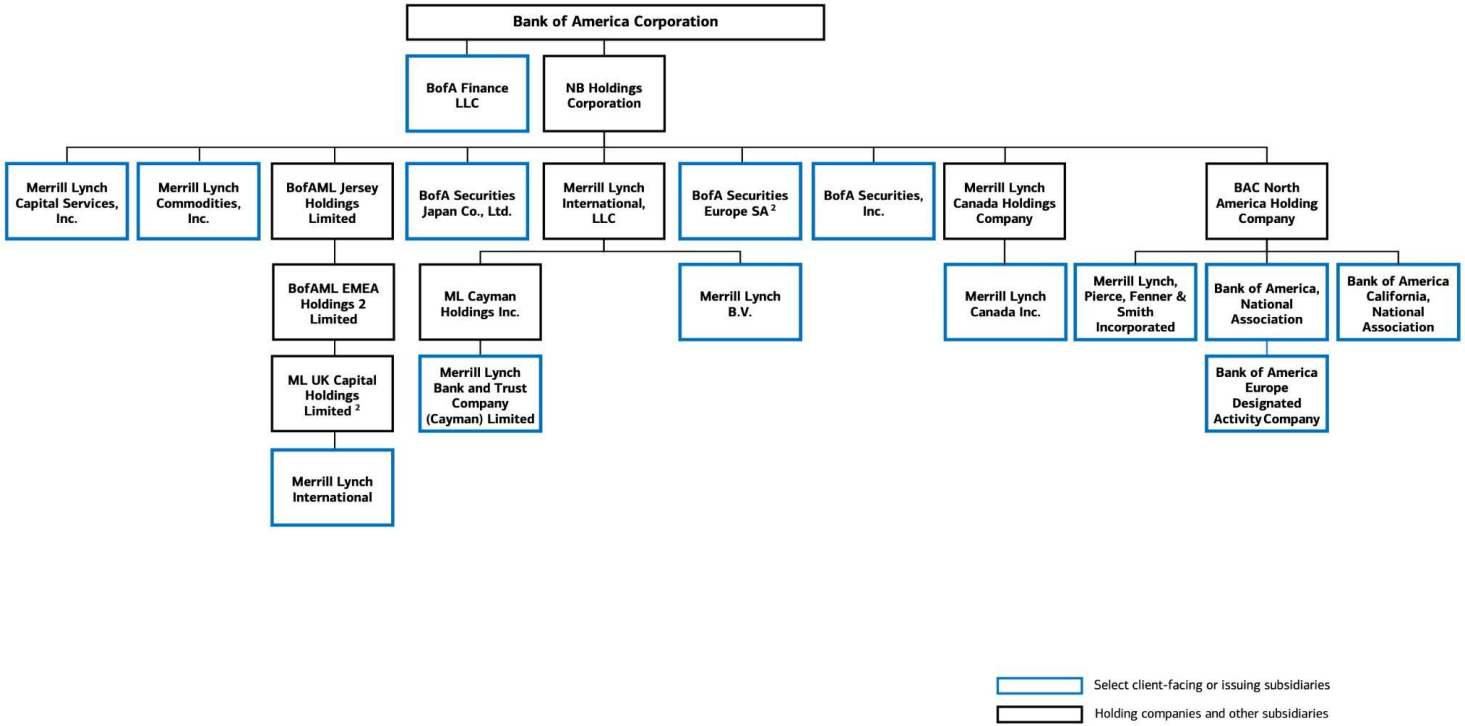
- **Global Markets**
  - liquidity, hedging strategies, industry-leading insights, analytics for Hedge Funds and Asset Managers, pensions etc

Team 2 | **Hierarchy**



Bank of America Organizational Structure [Interactive Chart]. Organimi. (n.d.). https://www.organimi.com/organizational-structures/bank-of-america/#:~:text=A%20Hybrid%20U%2Dform%20Structure,H%2D%20and%20M%2Dform.

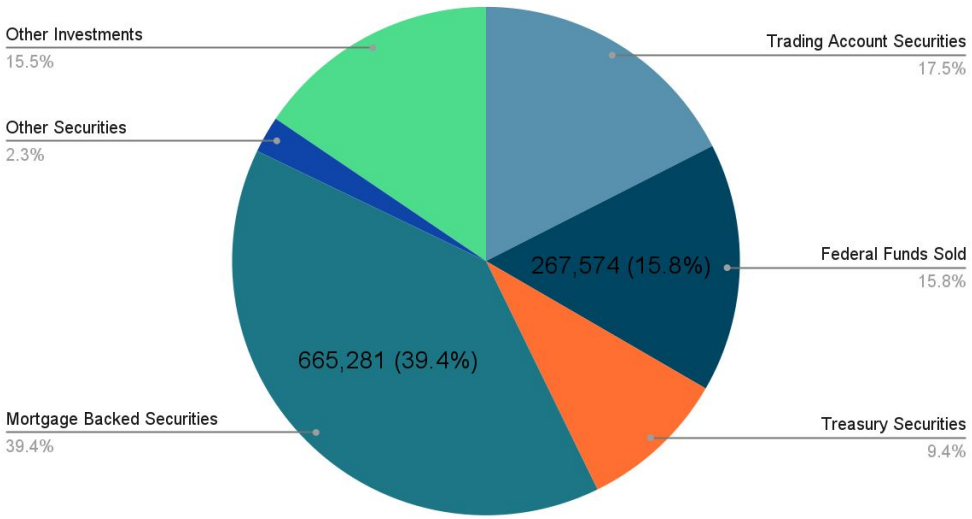
Team 2 | Bank of America Corporate Structure



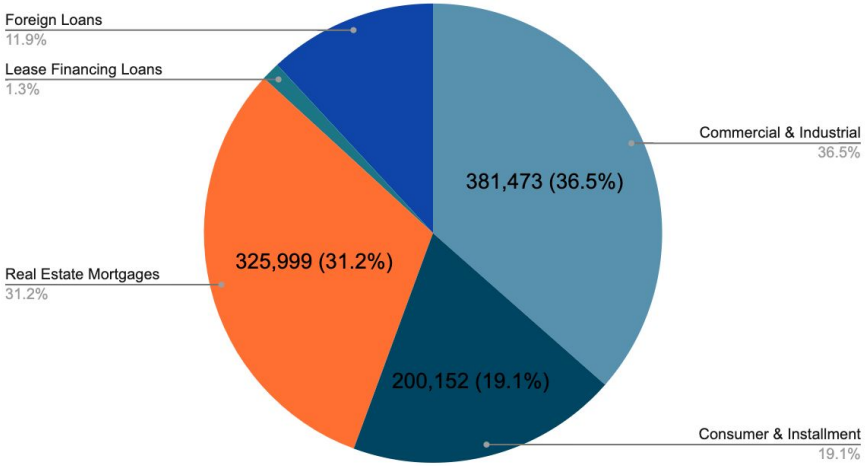
[1] This chart includes only select client-facing or issuing subsidiaries and associated significant holding companies of Bank of America Corporation. Not all subsidiaries of Bank of America are represented.
[2] Reflects a majority-owned subsidiary.

Team 2 | Balance Sheet - Assets ($3 Trillion Total)

55% Investments ($1.7T)



~34% Loans ($1T)

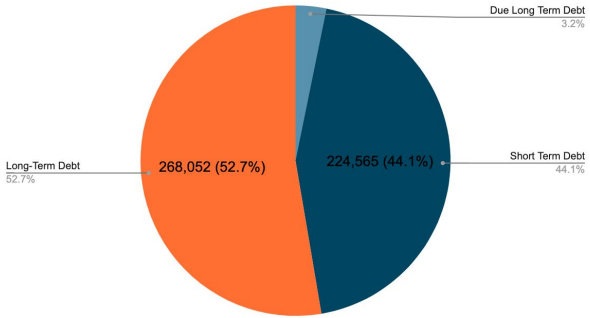


~8.5% Other Assets Including Intangibles ($253B)
~1% Cash ($30B)
<1% Net Property, Plant & Equipment ($21B)
<1% Investment in Unconsolidated Subsidieries ($9.5B)

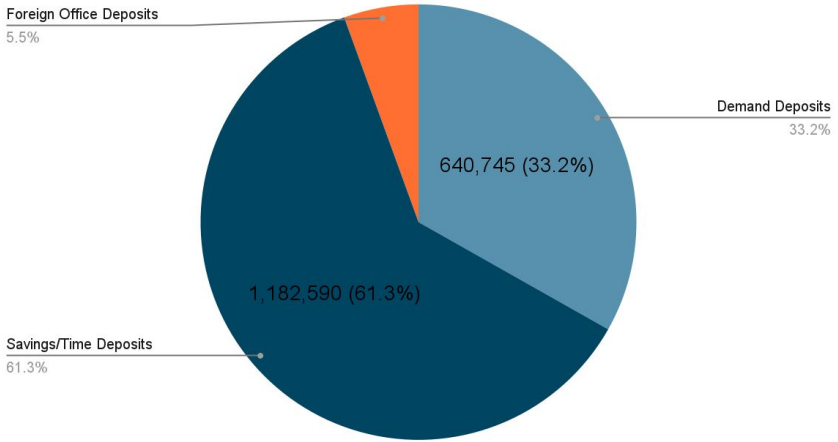
Team 2 | Balance Sheet - Liabilities and Equities

Liabilities

~18% Debts ($509B)



69% Deposits ($1.9T)



~12% Other Liabilities ($337B)

TOTAL LIABILITIES: $2.78T

Total Equity: $287B

Team 2 | **Types of Risk and Mitigation**

Credit Risk

- Default Risk
- A third of their assets are in loans
- Estimating hazard rates
- Diversified loan portfolio

Market Risk

- Stock Market Securities
- Foreign Exchange Market
- Interest Rates
- Securities Market: $132B in unrealized losses

Operational Risk

- Human Error
- Cyber Security Risks
- Systemic and Strategic Risk
- Fraud
- Technical Interruptions

Liquidity Risk

- Cash for Demand Deposits
- Loans for important clients
- LCR: 137%
- NSFR: 116%

Team 2 | **Resources**

Corporate structure. Bank of America Corporation. (n.d.). https://investor.bankofamerica.com/fixed-income/corporate-structure

Top 100 largest financial holding company rankings by total assets. SWFI News. (2023). https://www.swfinstitute.org/fund-rankings/financial-holding-company

Bank of America & Bofa Securities: Our Businesses, Capabilities & Regions. Bank of America Merrill Lynch. (n.d.). https://business.bofa.com/en-us/content/about-us.html#:~:text=Bank%20of%20America%20works%20with%3A&text=Through%20relationships%20with%20thousands%20of,roots%20in%20thousands%20of%20communities.

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The Wall Street Journal. (2022). *BAC Financials Annual Balance Sheet*. https://www.wsj.com/market-data/quotes/BAC/financials/annual/balance-sheet

Azhar, S., & Anand, N. (2023, October 17). *Bank of America's unrealized losses on securities rose to $131.6 BLN*. Reuters. https://www.reuters.com/business/finance/bank-americas-unrealized-losses-securities-rose-1316-bln-2023-10-17/

Yang, L. (2023). Risk Assessment on Bank of America. *Highlights in Business, Economics and Management*, *15*, 105–110. https://doi.org/10.54097/hbem.v15i.9324

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Regulatory & other filings. Bank of America Corporation. (2022, March 7). https://investor.bankofamerica.com/regulatory-and-other-filings

Bank of America 2023 Dodd-Frank Act Annual Stress Test Results. Bank of America Corporation. (2023, July 3). https://d1io3yog0oux5.cloudfront.net/_7bc41b6d625fd277eec2f153fdf9e5c4/bankofamerica/db/780/9893/pdf/Bank+of+America+2023+Dodd-Frank+Act+Annual+Stress+Test+Results.pdf

Team 2 | Skills and Competencies

Quantitative Finance Analyst

- Ability to **develop, implement, and maintain** quantitative models
- Knowledge of advanced quantitative techniques, including **predictive modeling**, **statistical sampling**, **optimization**, and **machine learning**

- Graduate degree in Mathematics, Statistics, Data Science or related field
- Strong programming skills (R, Python, SAS, SQL)
- Effective communication and presentation skills

Data Engineer

- Proficiency in data engineering practices and **design and architectural patterns** (Extract, Transform, Load)
- Ability to **leverage diverse programming languages** for data engineering and analysis.
- Proficiency in **Git**
- Data engineering certification, familiarity with financial data vendors

Technical Project: **Predictive Modeling of Interest Rates**

Team 2 | **Research Motivation**

- Interest rate yield curves are a critical component of the overall economic picture of an economy
- Accurately predicting these rates is essential for banks to manage investment decisions and risk
- Major, unforeseen rate swings could have severe consequences for small banks, and potentially catastrophic effects if mismanaged by larger banks
- We attempt to build a 20-year forecast from a variety of models trained on historical interest rate data

Team 2 | **Research Question**

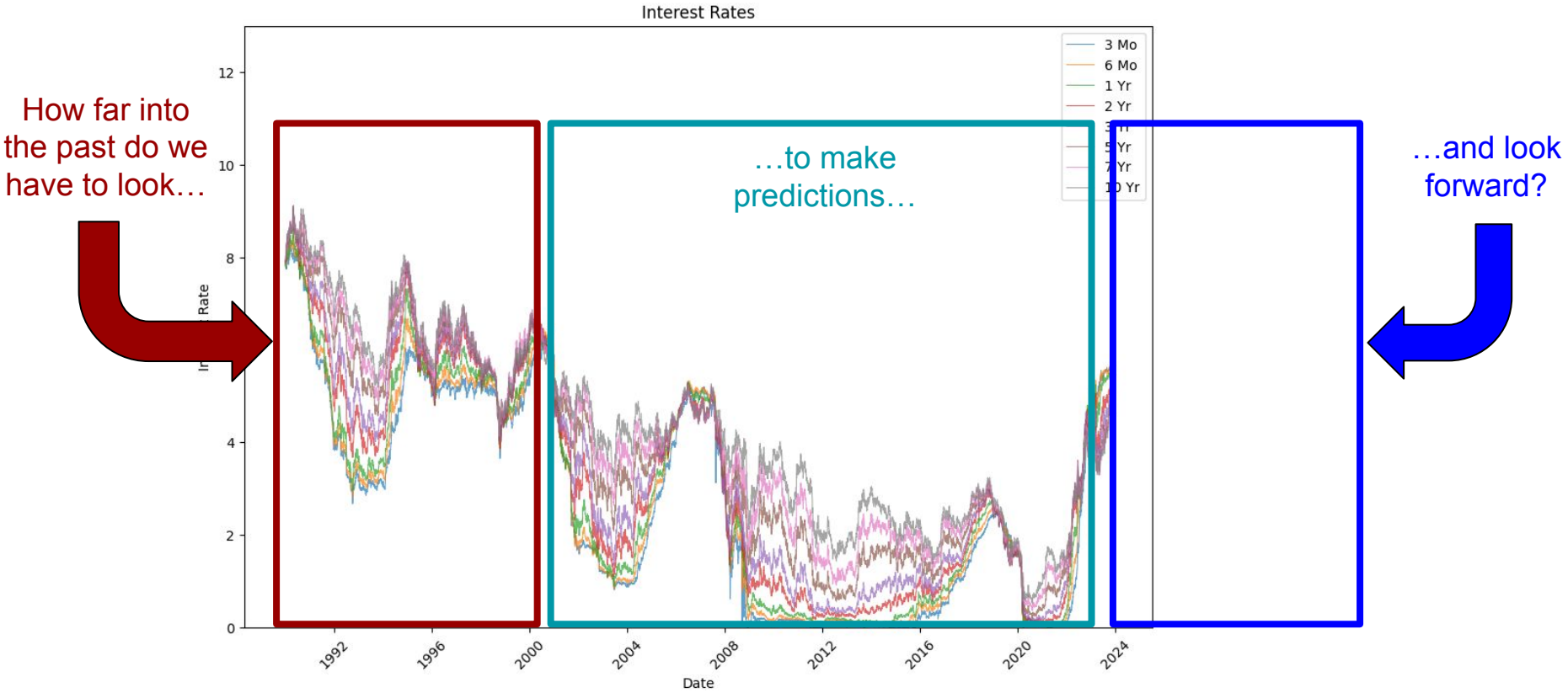
For specified forward prediction ranges:

1. Is it possible to produce a realistic prediction for the interest rate yield curve into the future based on historical data?
2. Does the addition of other economic data positively influence the predictions?

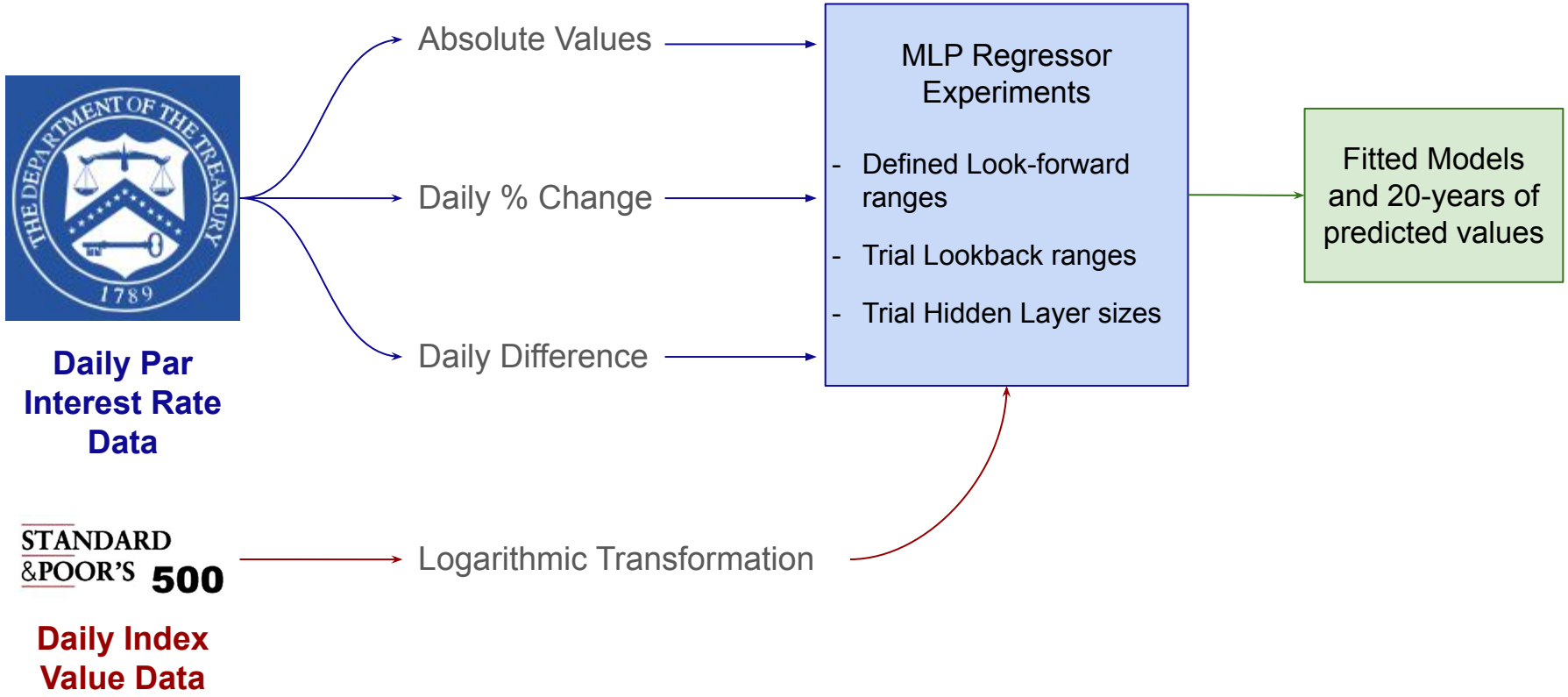
“Look-forward” Ranges:

- 1 Day
- 1 Month
- 1 Year
- 1 Decade

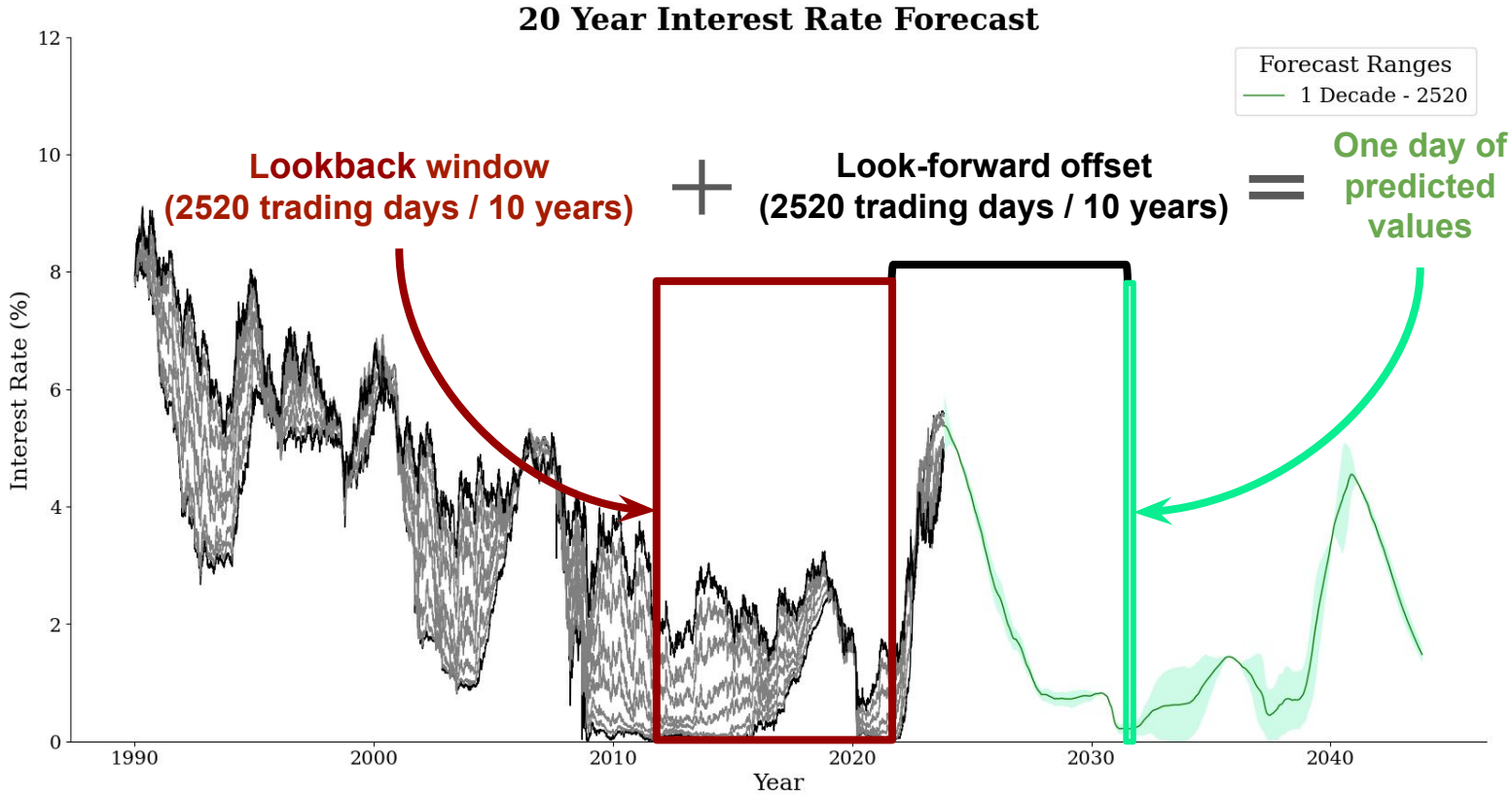
Team 2 | **Research Questions Visualized**



Team 2 | **Experiment Structure**



Team 2 | **Example “Lookback” and “Look-forward”**



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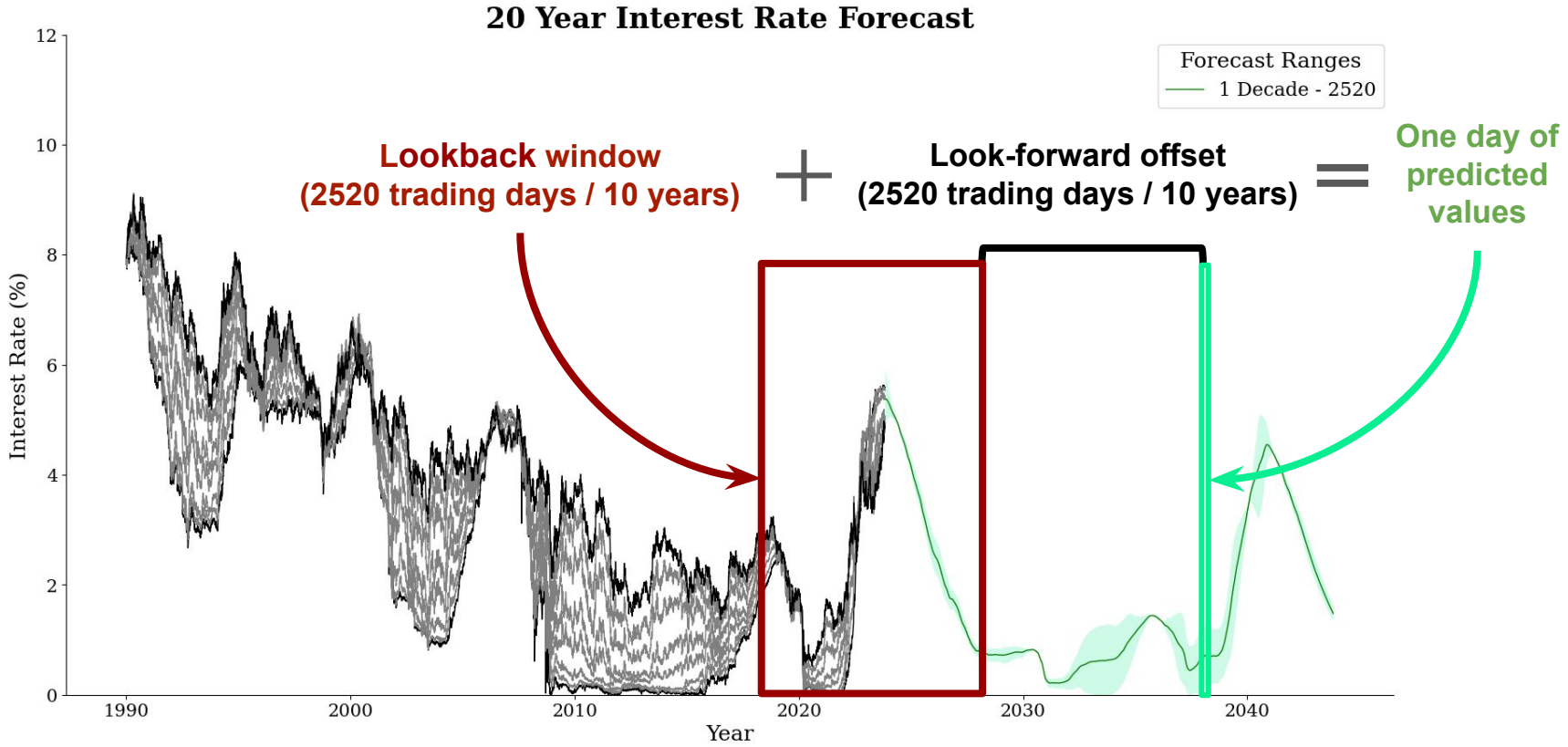

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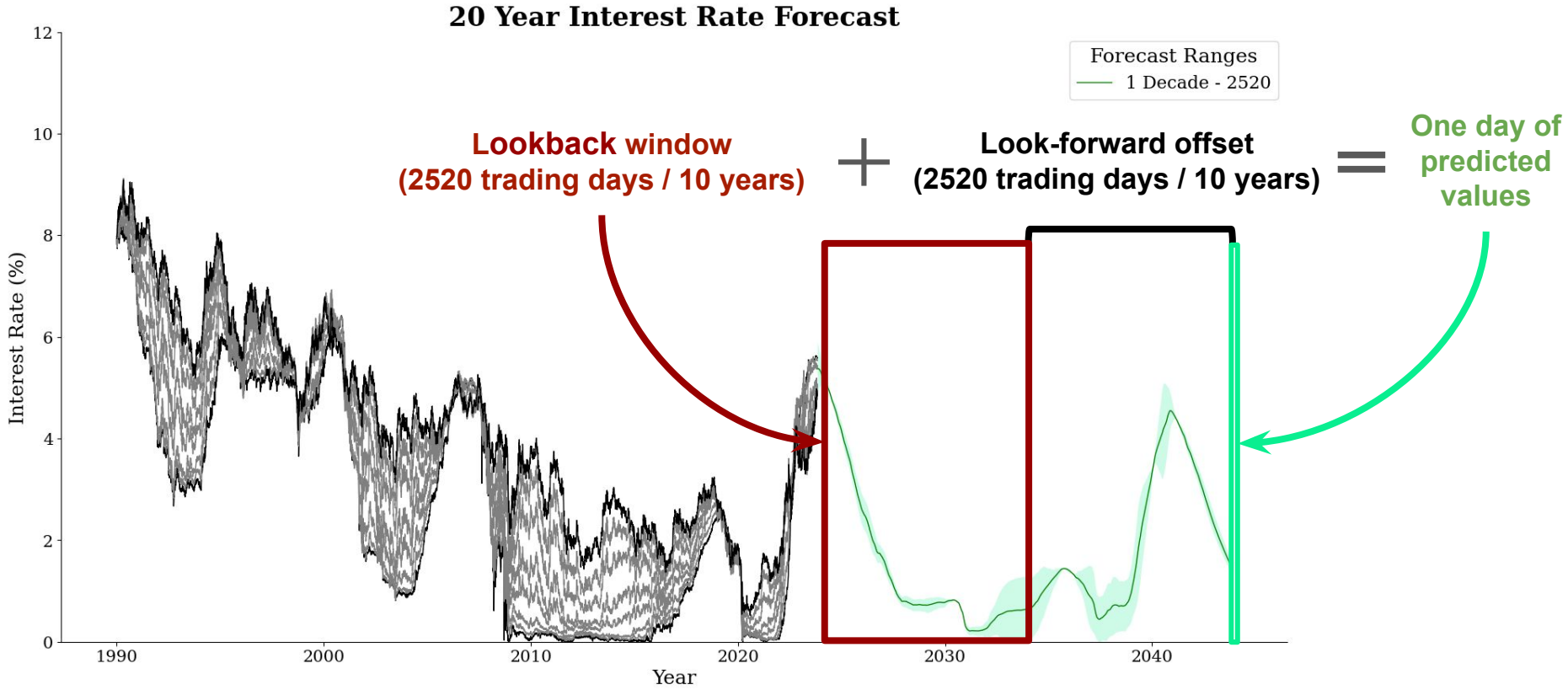
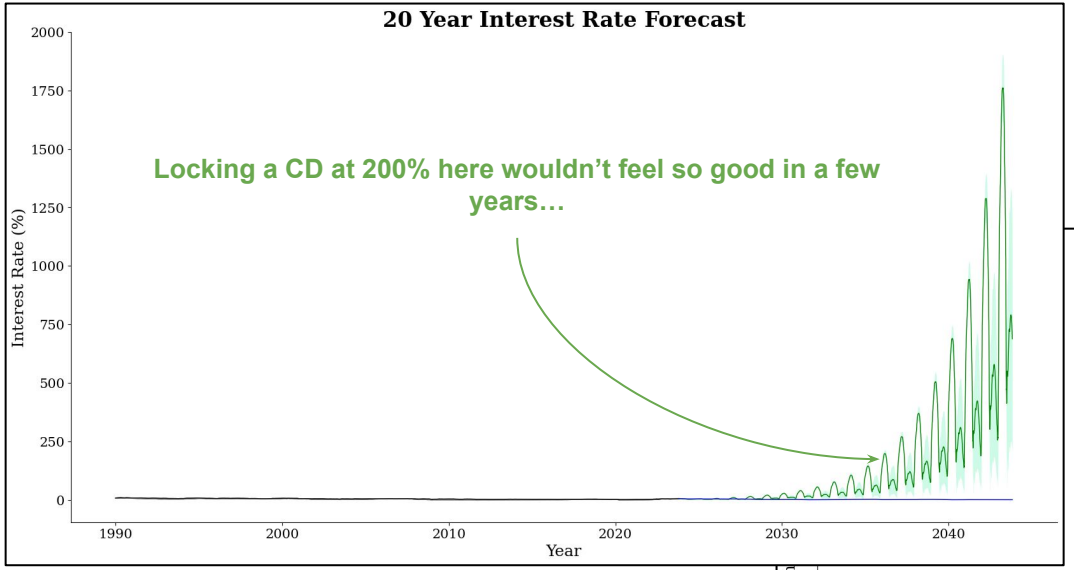
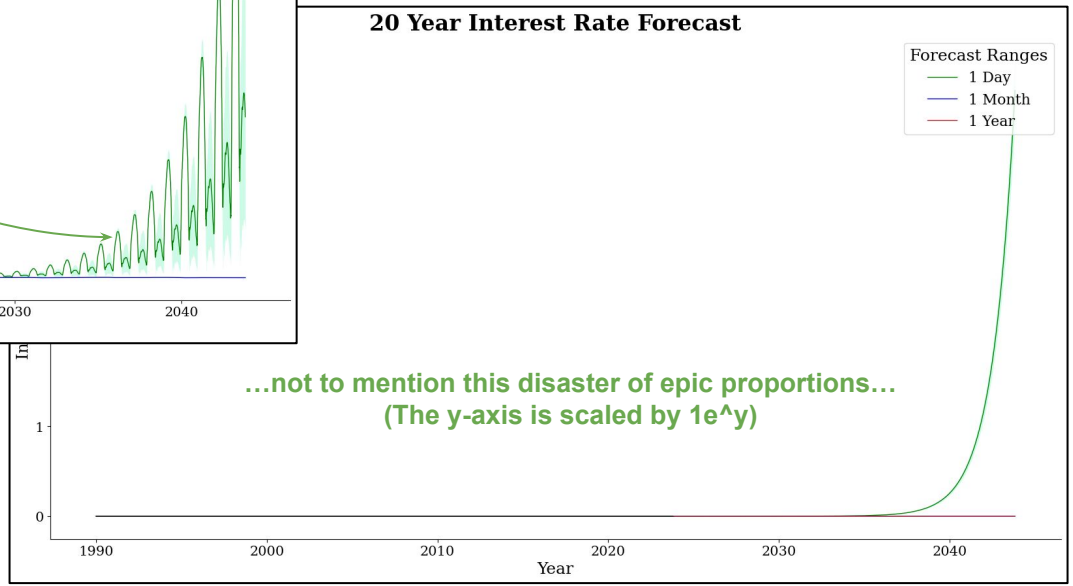


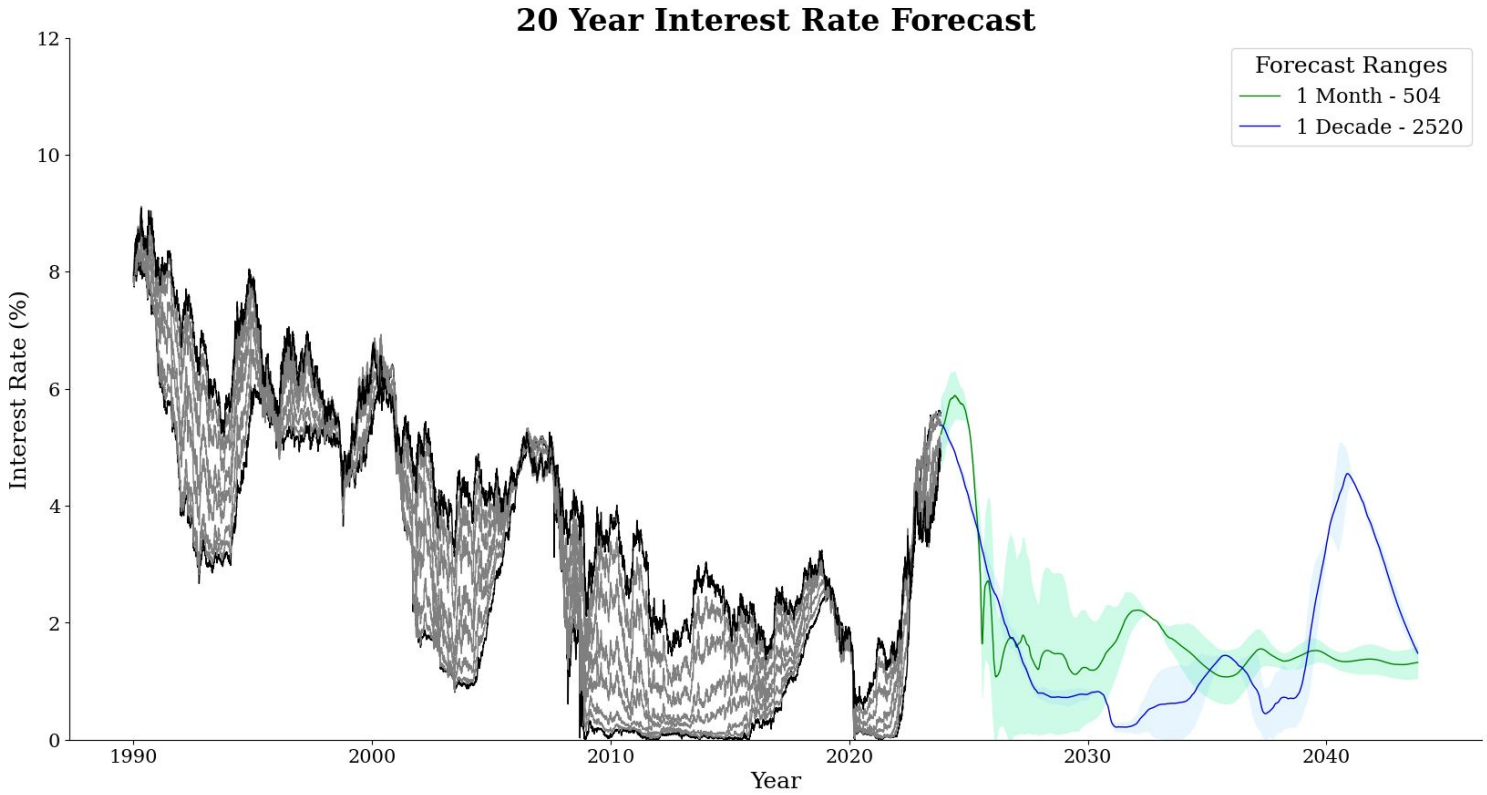
Team 2 | **It didn't always go as planned…**





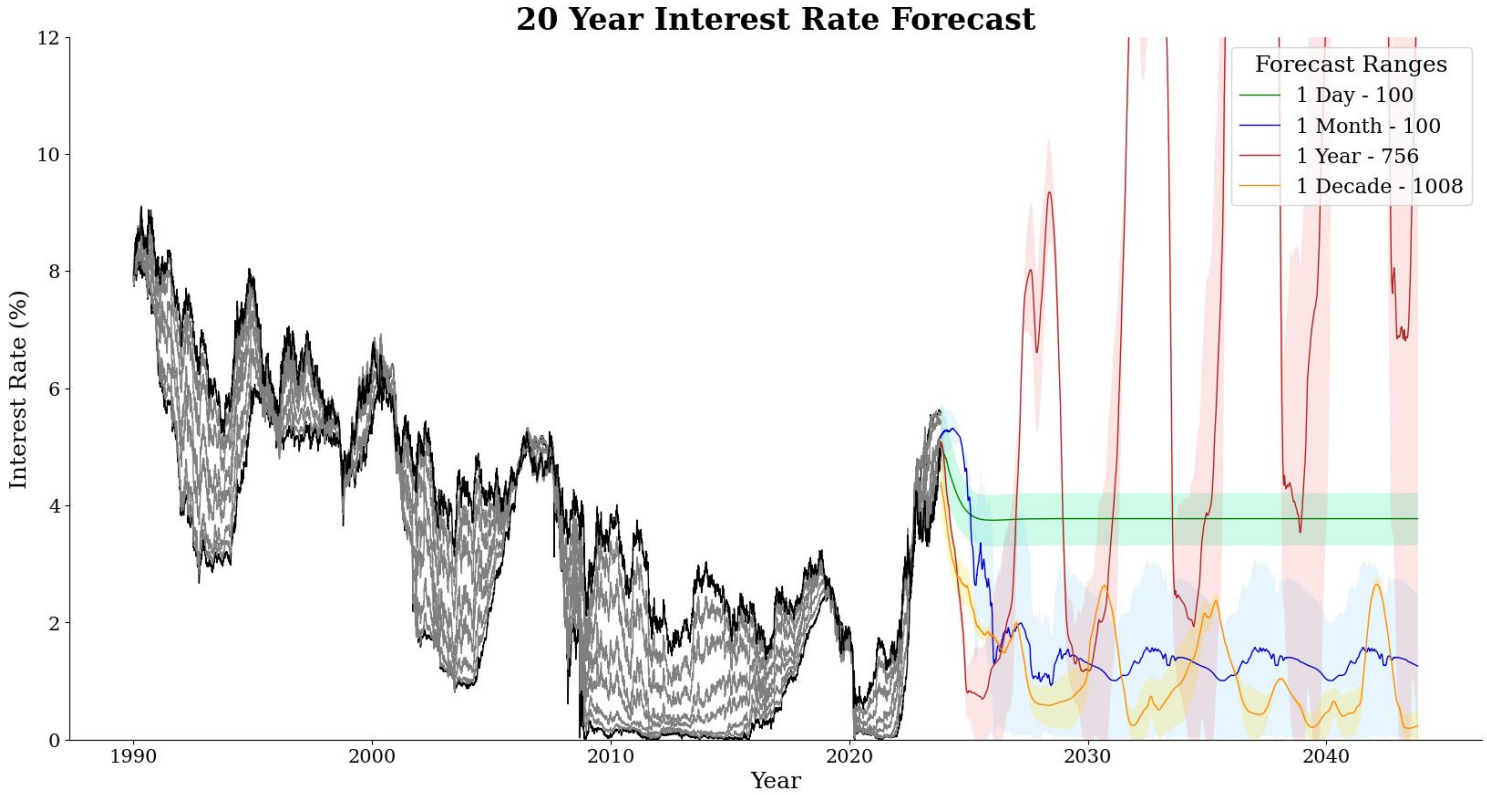
Team 2 | Experiment #1 - Interest Rate Absolute Values

- This is the “best” result from just rate data
- 1-Month is believable for +/- five years
- 1-Decade is somewhat realistic but lacks noise



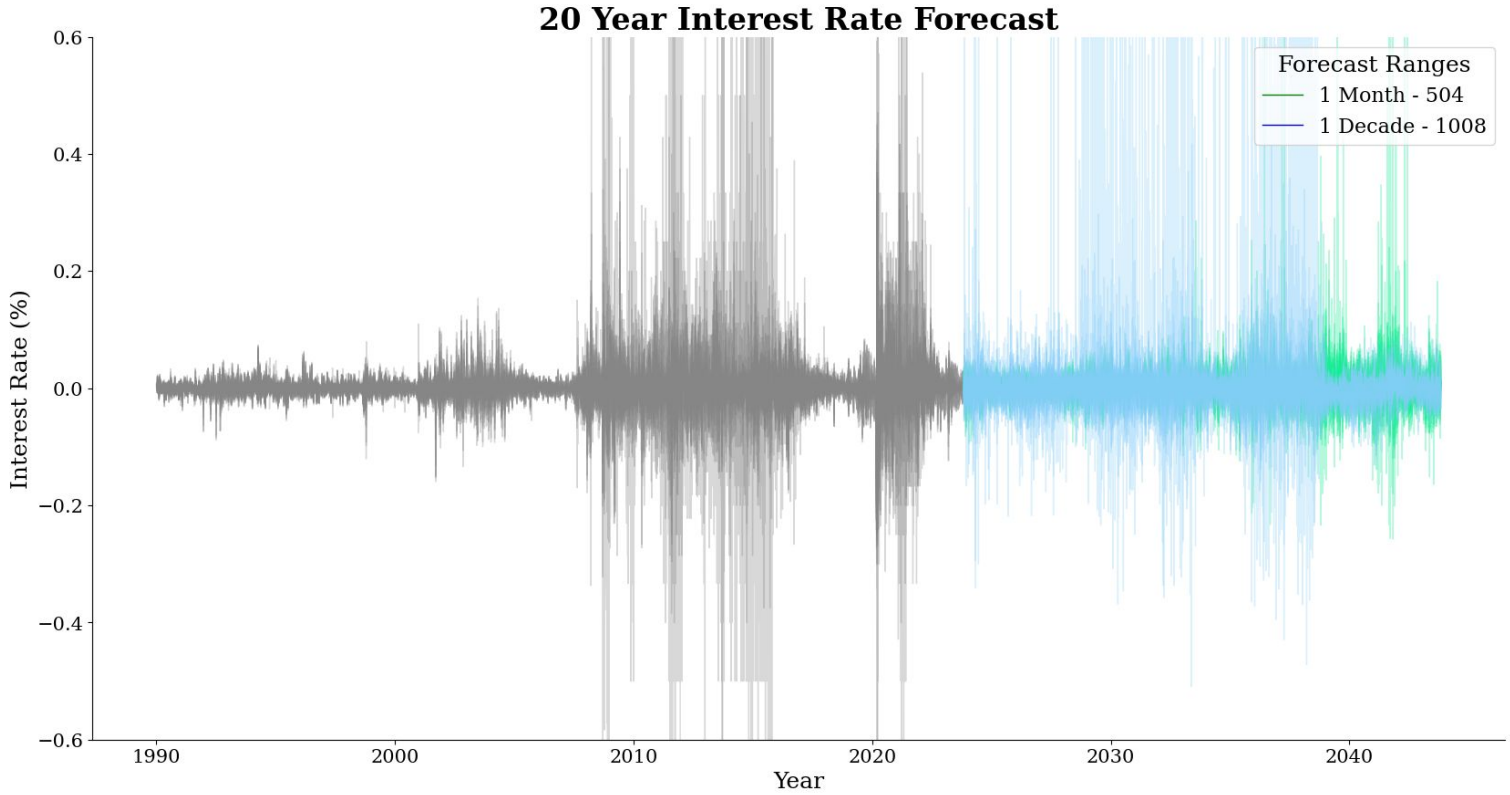
Team 2 | **Experiment #1 - Interest Rate Absolute Values**

- Remaining four models forecasted poorly
- 1-Day model went flat after anchor elapsed
- 1-Year seems to capture a cycle but scale is off



Team 2 | **Experiment #2 - Interest Rate % Change**

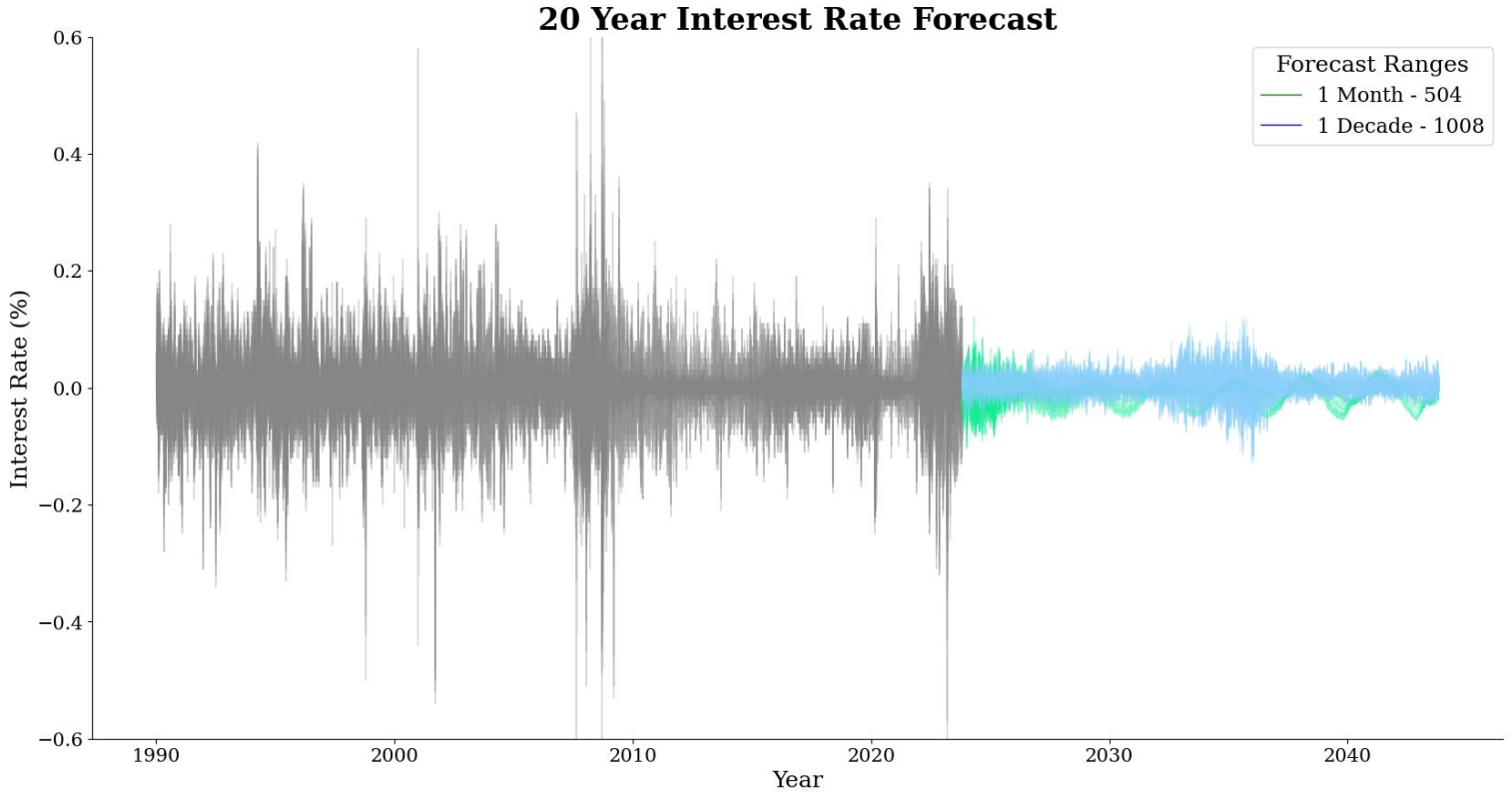
- % Change models are hard to interpret
- 1-Month model has some noise hidden, but is it realistic?
- 1-Decade is a mess, but better than the rest…



Team 2 | Experiment #3 - Interest Rate Daily Difference

- Daily change models performed poorly across the board

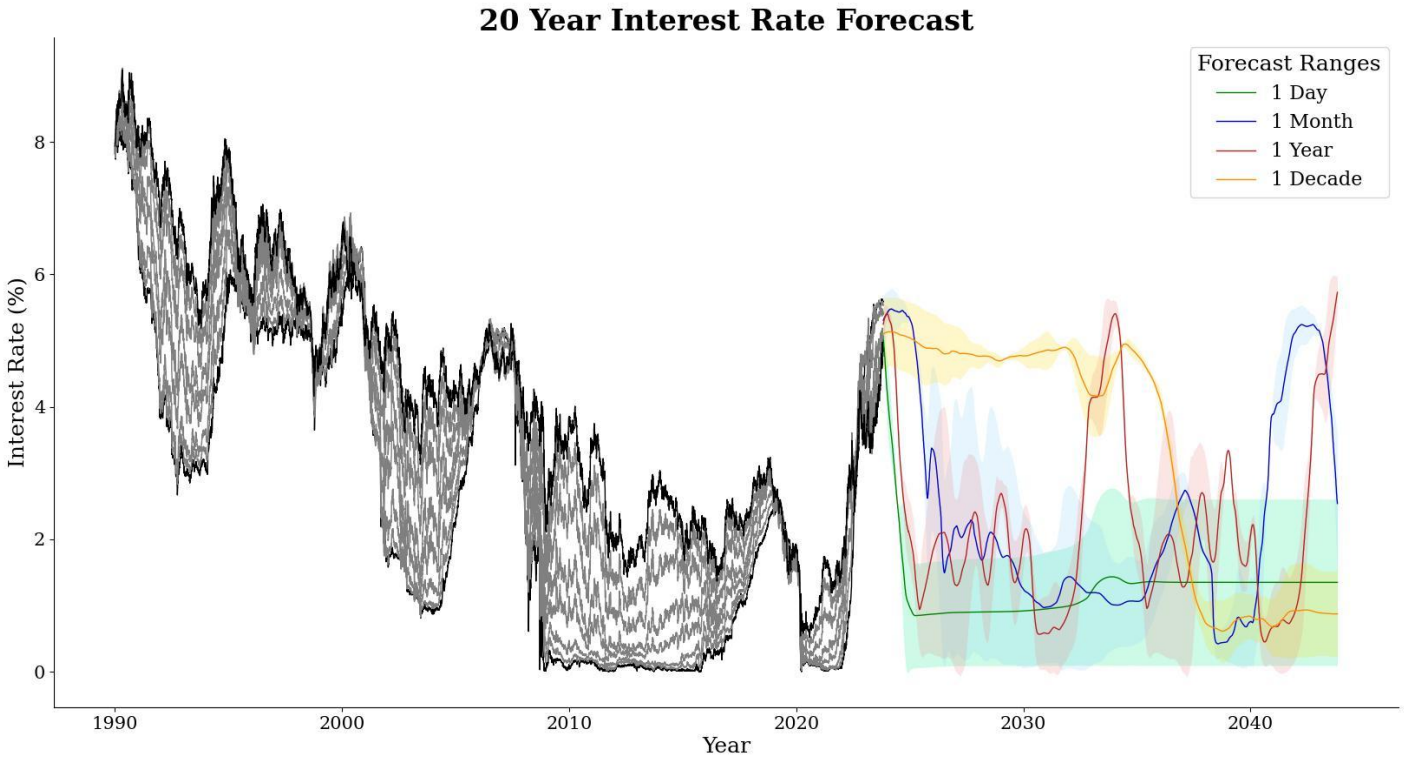
- 1-Month and 1-Decade are visualized to show the least outrageous results



Team 2 | **Experiment #4 - Interest Rates and S&P 500**

- The 1-Day and 1-Decade forecasts showed little behavior that inspired confidence

- 1-Month and 1-Year show a more realistic approximation of the future



Team 2 | **Experimental Shortcomings**

- The analysis is based on historical data only dating back to the early 1990s, suggesting a potential limitation in historical depth
- The time-series nature of the data may surpass the capabilities of the MLP Regressor used. While the model is compelling, it may lack the nuance required to effectively handle time-series data, potentially impacting the accuracy of predictions.
- Introducing additional metrics, data, or index values could increase model complexity.
- To enhance forecast accuracy, exploring alternative methods for generating future values, especially those outside predicted interest rates, is recommended.

Team 2 | **Outcomes**

- The overall function of the models in training was very good, except for Experiment 2. That training performance did not translate to reasonable forecasts in most cases, which indicates overfitting or other issues.
- The addition of the S&P 500 data did not dramatically alter the models, and we believe that more investigation should be done with this type of included data.
- Future work to be considered would explore other methods for time-series modeling, testing different number of indicators, and exploring other ways to transform the input data.

Thank you!

Question & Answer