

## Deep Learning Forecasting and the Global US Dollar Money Supply:



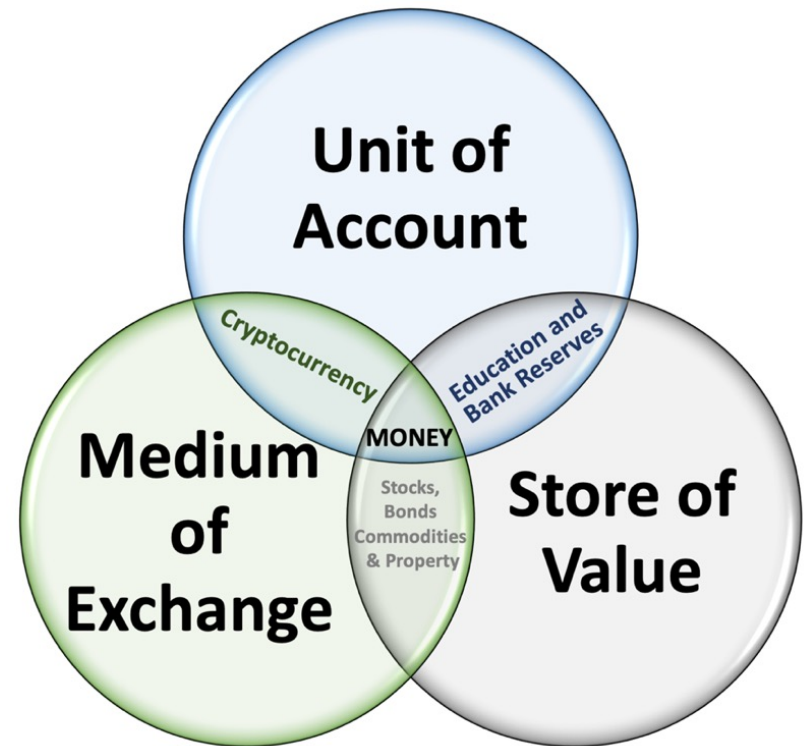
How a Long-Dated US Government Bond Can Explain  
US Economic Activity and Global Reserve Currency

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MSDS 498 Northwestern University Summer 2022

# Introduction

1. Entity Resolution
  - What is Money?
2. Identity Resolution
  - Where is Money Located?
  - How does Money flow?
3. Data Governance
  - Is there Data Management?



# Introduction

## 1. Incomplete Entity Resolution

### ➤ Over – Classification.

The problem is that we cannot extract from our statistical database what is true money conceptually, either in the transactions mode or the store-of-value mode. One of the reasons, obviously, is that the proliferation of products has been so extraordinary that the true underlying mix of money in our money and near money data is continuously changing. As a consequence, while of necessity it must be the case at the end of the day that inflation has to be a monetary phenomenon, a decision to base policy on measures of money presupposes that we can locate money. And that has become an increasingly dubious proposition.     - Alan Greenspan

# Introduction

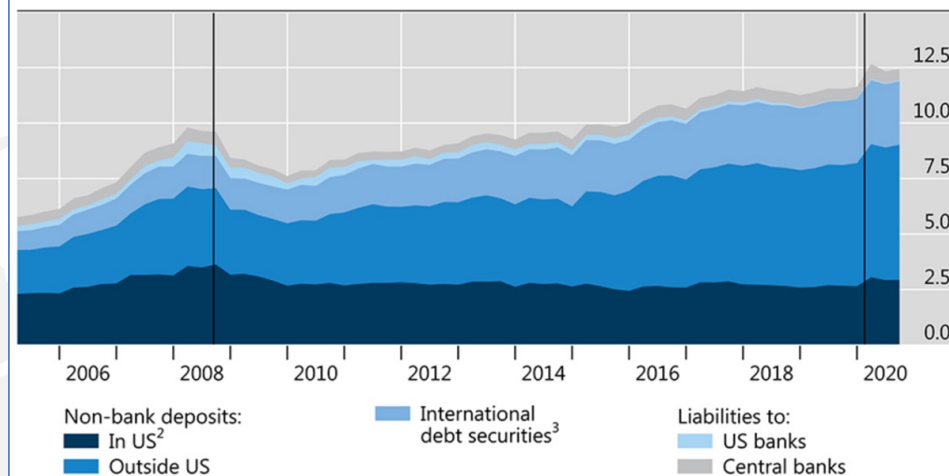
## 2. Incomplete Identity Resolution

### ➤ Under - Classification

On-balance sheet dollar funding of non-US banks<sup>1</sup>

Amounts outstanding; in trillions of US dollars

Graph 1



The vertical lines indicate 15 September 2008 (the collapse of Lehman Brothers) and 19 February 2020 (the start of market turmoil due to Covid-19).

“The Eurodollar market was for years hidden from economists and other readers of the financial press by a remarkable conspiracy of silence. I stumbled on its existence by sheer accident in October 1959, and when I embarked on an enquiry about it in London banking circles several bankers emphatically asked me not to write about the new practice.”

– Paul Einzig

# Introduction

## 3. Data Misgovernance

- Money Printing is not Money
- No Global Central Bank
- No Global Government

Object	Unit of Account	Store of Value	Medium of Exchange	Explanation
Bank Reserves	✓	✓	✗	Money Printing is an inert form of money
Cryptocurrency	✓	✗	✓	Nothing is priced into it
Stocks, Bonds, Commodities, & Property	✗	✓	✓	Limited functions for the use of money
Education	✓	✓	✗	Not tradeable
U.S. Dollar	✓	✓	✓	Global Reserve Currency

# Summary of False Arguments about Money

Error Type	Implication
Over – Classification	<ul style="list-style-type: none"> <li>• <b>High Bias</b> <ul style="list-style-type: none"> <li>○ Too much data leads to less usefulness</li> <li>○ For example, classifying non–money as money such as bank reserves.</li> </ul> </li> </ul>
Misclassification	<ul style="list-style-type: none"> <li>• <b>Type I Statistics Error</b> <ul style="list-style-type: none"> <li>○ False Positive</li> <li>○ An accurate model, for instance, on non–money about money.</li> </ul> </li> </ul>
Under–Classification or Missing Data	<ul style="list-style-type: none"> <li>• <b>Incomplete and non – representative dataset</b> <ul style="list-style-type: none"> <li>○ You are ignoring the overseas U.S. Dollars that are greater in number than domestic U.S. Dollars, whose prices are driven by different factors.</li> <li>○ For example, whether you use M1 and M2 datasets or both from the U.S. Central Bank that are only domestic U.S. Dollars, regardless of whether it properly fulfills the money classification.</li> </ul> </li> </ul>
Same Model, but Different Results	<ul style="list-style-type: none"> <li>• <b>High Variance</b> <ul style="list-style-type: none"> <li>○ The same model yields different results on different (non) money datasets</li> </ul> </li> </ul>
Always Inaccurate	<ul style="list-style-type: none"> <li>• <b>Reselect features</b></li> <li>• <b>Change the Model</b> <ul style="list-style-type: none"> <li>○ Restrictive assumptions of the classical model ARIMA is one example.</li> </ul> </li> </ul>

# Data

1. 10-year constant maturity of a U.S. Treasury Bond Note
  - Deferred Money
  - Auctions as Primary Markets
  - Foreign Bidders
  - Secondary Markets



Frequency	Dataset Label	Start Date	End Date	Number of Observations
Monthly	GS10	April 1953	July 2022	832
Weekly	WGS10YR	January 1962	July 2022	3,161
Daily	DGS10	January 2, 1963	July 29, 2022	15,130

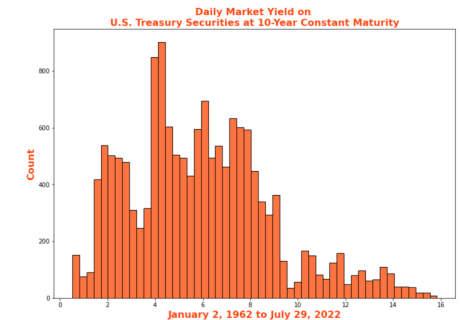


# Methods

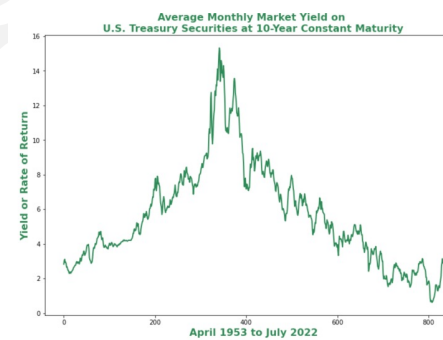
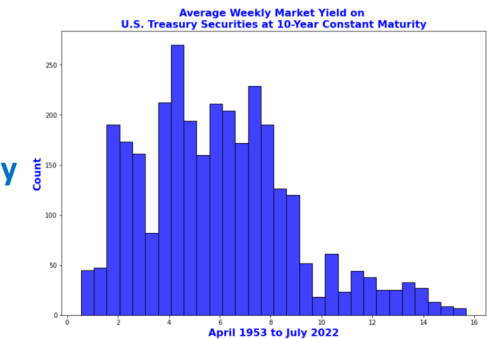
1. Exploratory Data Analysis
  - Line Plot and Histogram
2. Statistical Testing
  - Test for Stationarity
  - Test for Normality
3. Model



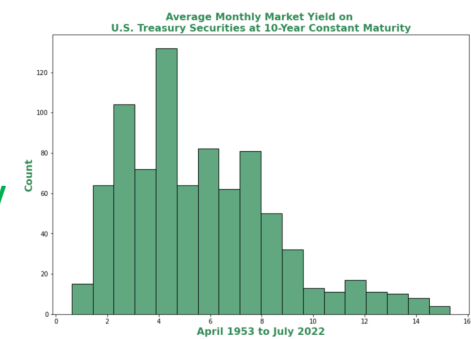
Daily



Weekly



Monthly





# Methods

1. Exploratory Data Analysis
  - Line Plot and Histogram
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## Augmented Dickey Fuller Test

- All Three Frequencies are not Stable
- Mean and Variance vary most of the time

~~A.R.I.M.A.~~

## Jarque – Bera Test

- All Three Frequencies are non – Normal
- Yet, skewness and kurtosis are near zero

# Methods

1. Exploratory Data Analysis
  - Line Plot and Histogram
2. Statistical Testing
  - Test for Stationarity
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**Neural Prophet**

Flexibility

Automation

Interpretability

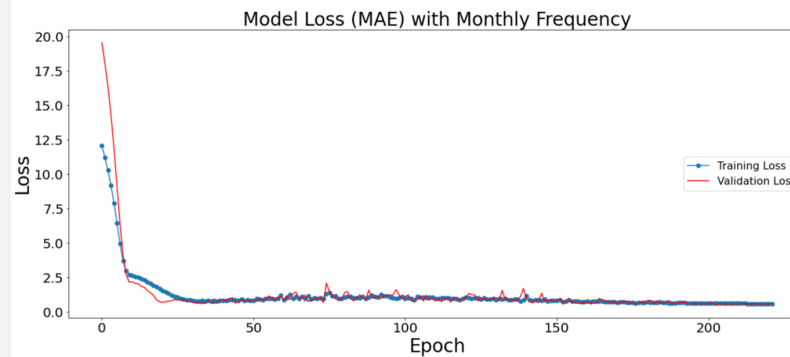
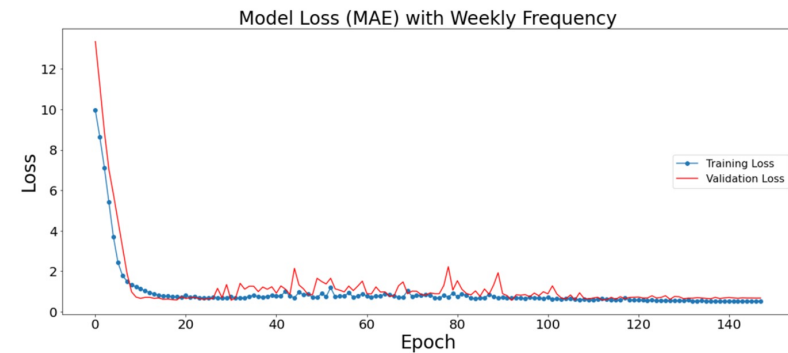
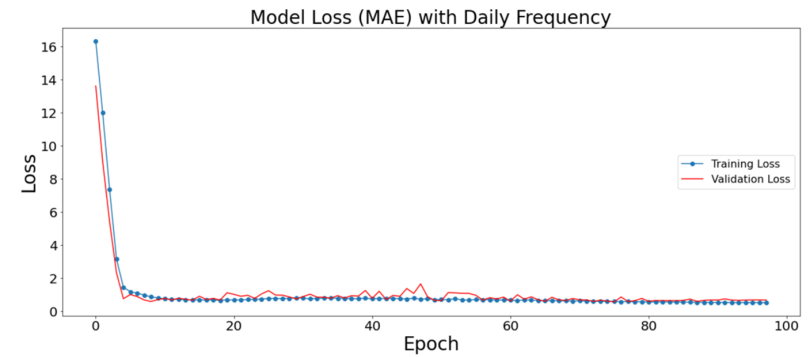
Scalability

	Parameter	Default Value	Daily	Weekly	Monthly
1	growth	linear			
2	Changepoints	None			
3	n_changepoints	10		24	12
4	changepoints_range	0.9			
5	trend_reg	0			
6	trend_reg_threshold	FALSE			
7	yearly_seasonality	auto			
8	weekly_seasonality	auto	disabled	disabled	disabled
9	daily_seasonality	auto	enabled	disabled	disabled
10	seasonality_mode	additive			multiplicative
11	seasonality_reg	0			
12	n_forecasts	1			
13	n_lags	0			
14	num_hidden_layers	0		1	2
15	d_hidden	None			
16	ar_sparsity	None			
17	learning_rate	None	0.1		
18	epochs	None	92	139	206
19	batch_size	None	64	32	16
20	loss_func	Huber			
21	optimizer	AdamW			
22	train_speed	None			
23	normalize	auto			
24	impute_missing	TRUE			
25	collect_metrics	TRUE			

# Results

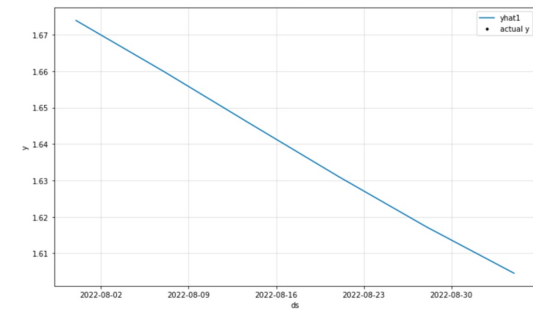
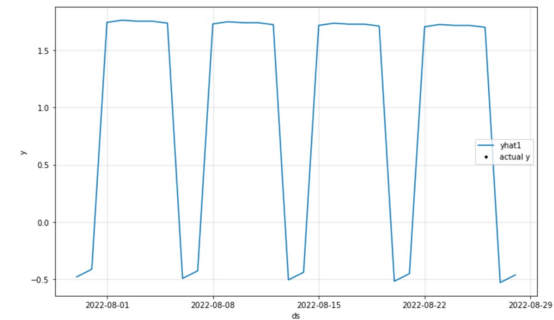
The Neural Prophet Model has all validation metrics near zero, with the training and validation loss in a tight relationship as per below, yielding high accuracy.

Validation Metrics	Daily	Weekly	Monthly
Smooth L1 Loss	0.003	0.003	0.003
Mean Absolute Error (MAE)	0.673	0.660	0.596
Root Mean Squared Error (RMSE)	0.797	0.798	0.747



# Analysis and Interpretation

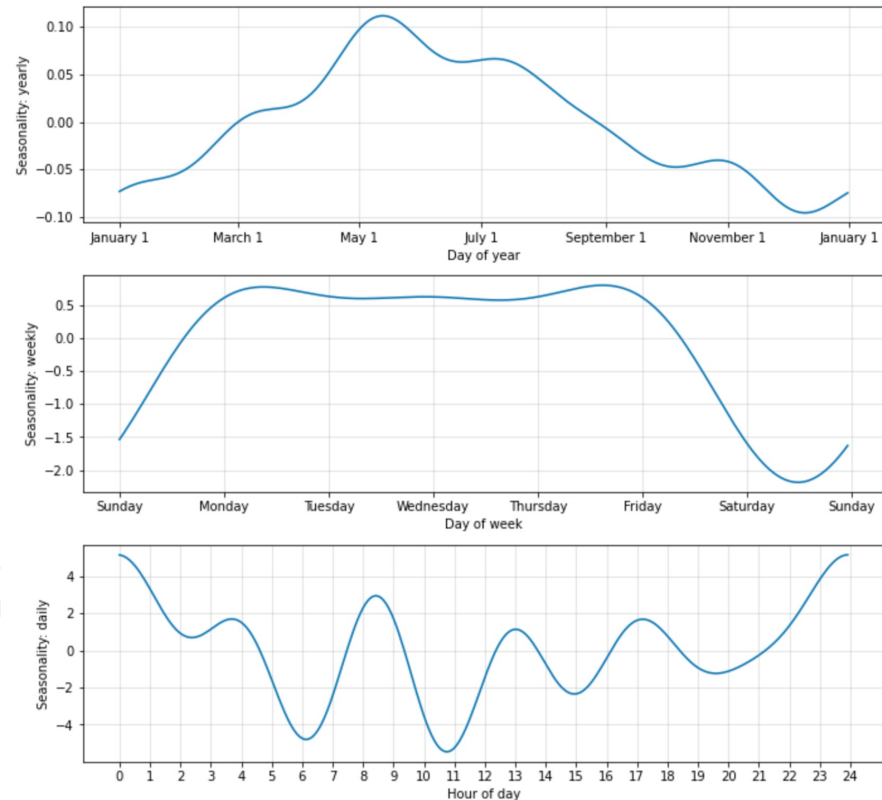
1. Overall Downward Values
2. Daily Volatility Smoothed Out Weekly
  - Speed of real-world operations is weekly and monthly, not daily
3. Monthly Swings But Still Downwards
  - Implied Economic Slowdown



# Analysis and Interpretation

## 4. Daily Forecast Seasonality Component

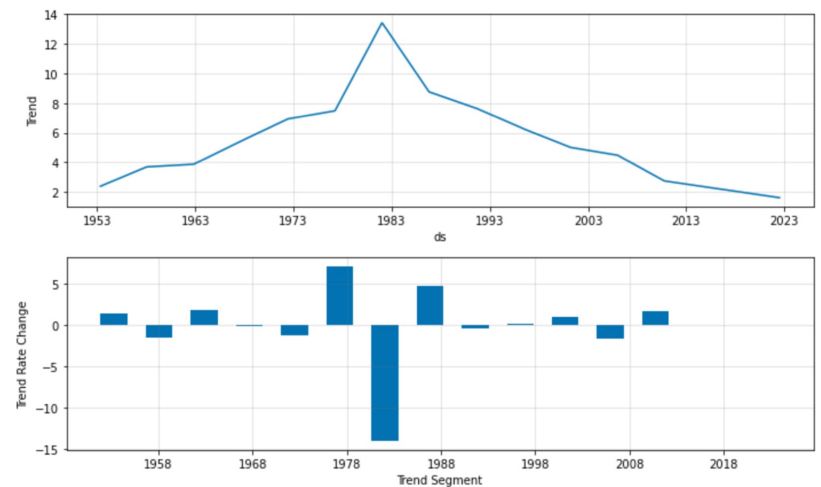
- Sunny Weather Drives Values Up
- Business Days Outpace Weekends
- Before Lunch, Afternoon, and Overseas Demand



# Analysis and Interpretation

## 5. Dataset Regime Switch

- Downward Trend Since 1982
- Long-Term Deflation of Money



# Conclusion and Directions for Future Work

1. Global U.S. Dollar Money Shortage
  - Economic Shortage: Prices keep going up so yields keep falling
2. Global Monetary Policy with International Cooperation
  - Moves towards Entity Resolution, Identity Resolution, and greater Transparency in a Global Data Governance Framework to find and create more U.S. Dollar Money.
3. Other Financial Instruments for Future Work
  - 30 Year US Treasury Bond, US Treasury Yield Curve Shape, and Eurodollar Future Curve

