PREDICTING GDP OF THE UNITED STATES OF AMERICA

FORECASTING PROJECT

By

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INTRODUCTION

The analysis revolves around forecasting the GDP of USA. In today's economy government debt is considered important in stimulating growth. Hence, we would like to use Federal Debt of USA as a predictor series to check if forecasts can be made using regression methods or normal forecasting models.

OBJECTIVE

- Predict GDP of the USA for the next ten quarters
- Using Debt as a percentage of GDP to forecast GDP
- Analyzing the recession of 2008 as an intervention and adjusting this factor to capture accurate forecasts
- Selecting the best model using appropriate indicators to predict GDP

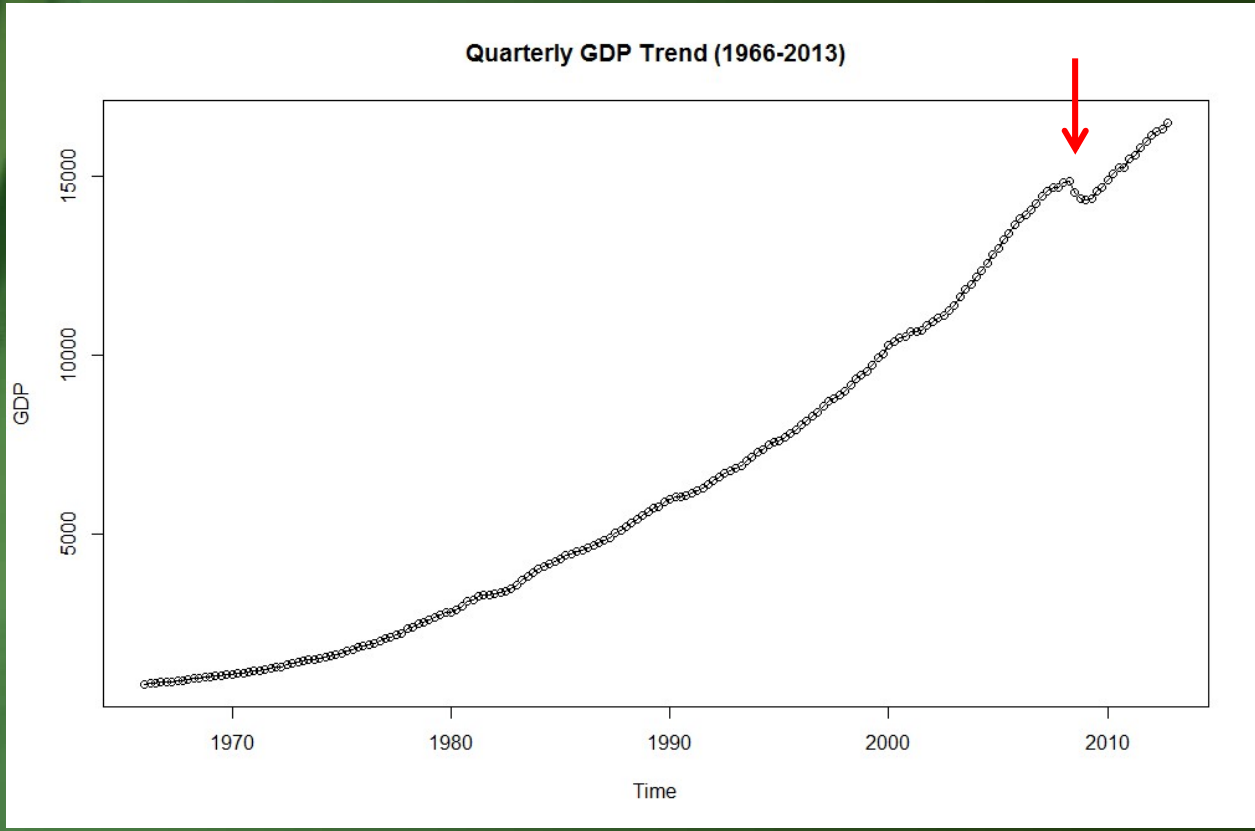
DATA

- We have used two datasets, one containing quarterly GDP and the other containing quarterly federal debt as a percentage of GDP. The data has been sourced from Federal Reserve Economic Data (FRED)
- The GDP dataset and the federal debt dataset contains data from 1996 Q1 to 2012 Q4
- Forecasting models
- Residual analysis
- Significance level of 5% for all analysis

METHODS

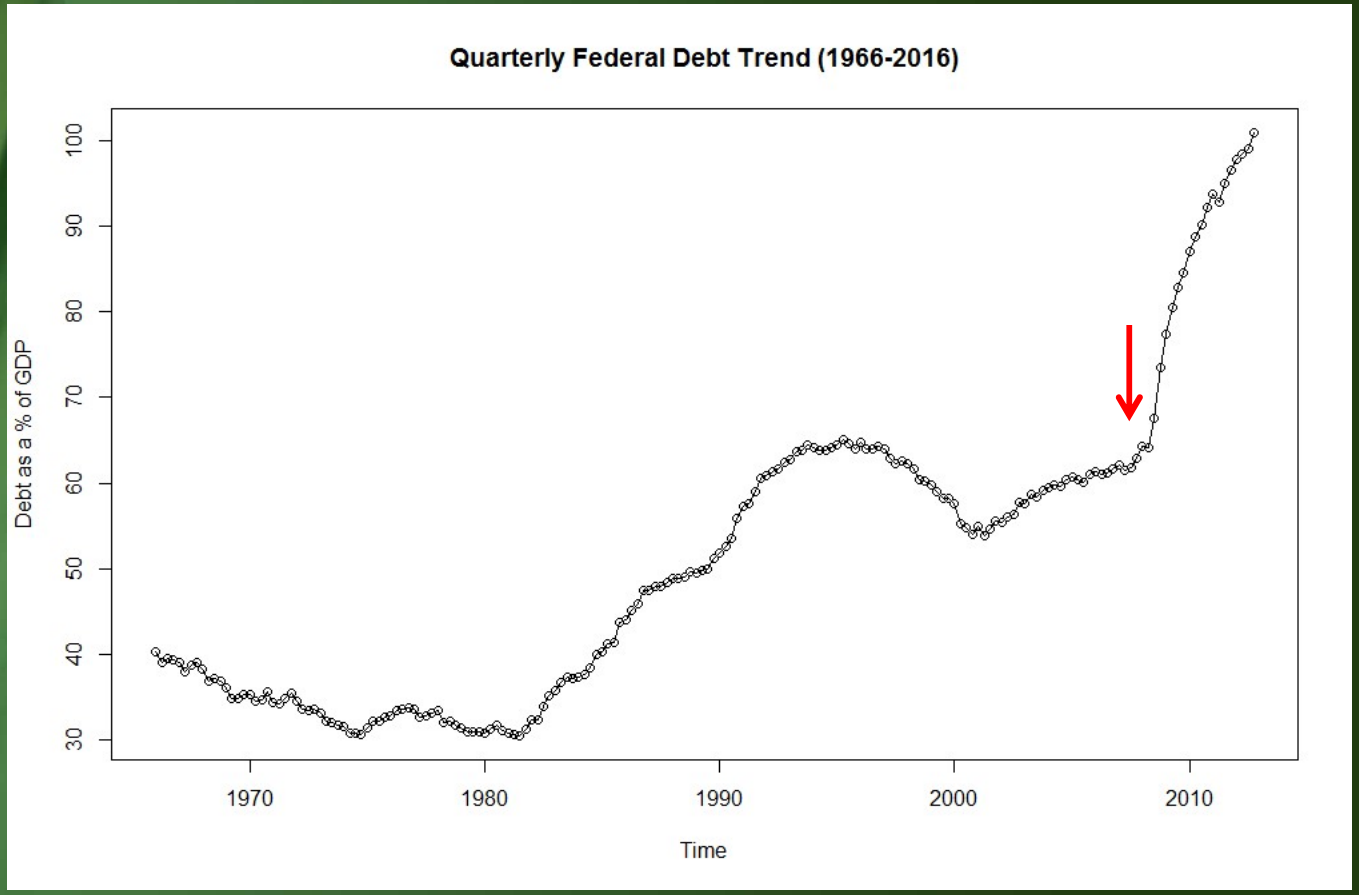
- The type of models to be evaluated
  - Distributed Lag Models (**DLMs**)
  - Dynamic Linear Models (**DYNLMs**)
  - Error, trend, seasonality (**ETS**) models
- Model Selection Criteria
  - Mean absolute scaled error (**MASE**)
  - Ljung–Box test
  - Shapiro–Wilk test

PRELIMINARY ANALYSIS – GDP TREND



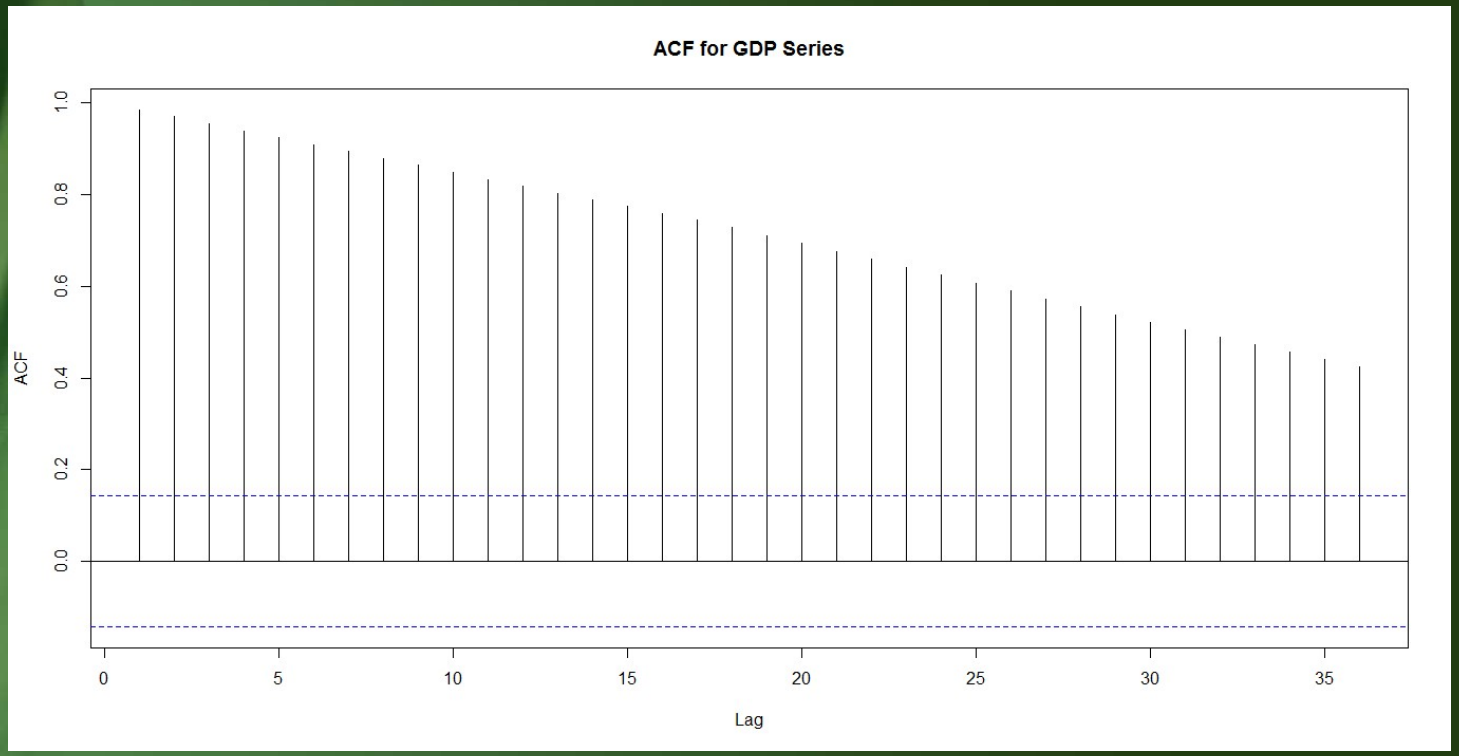
- Upward trend with a dip around 2008
- Intervention

PRELIMINARY ANALYSIS – DEBT TREND



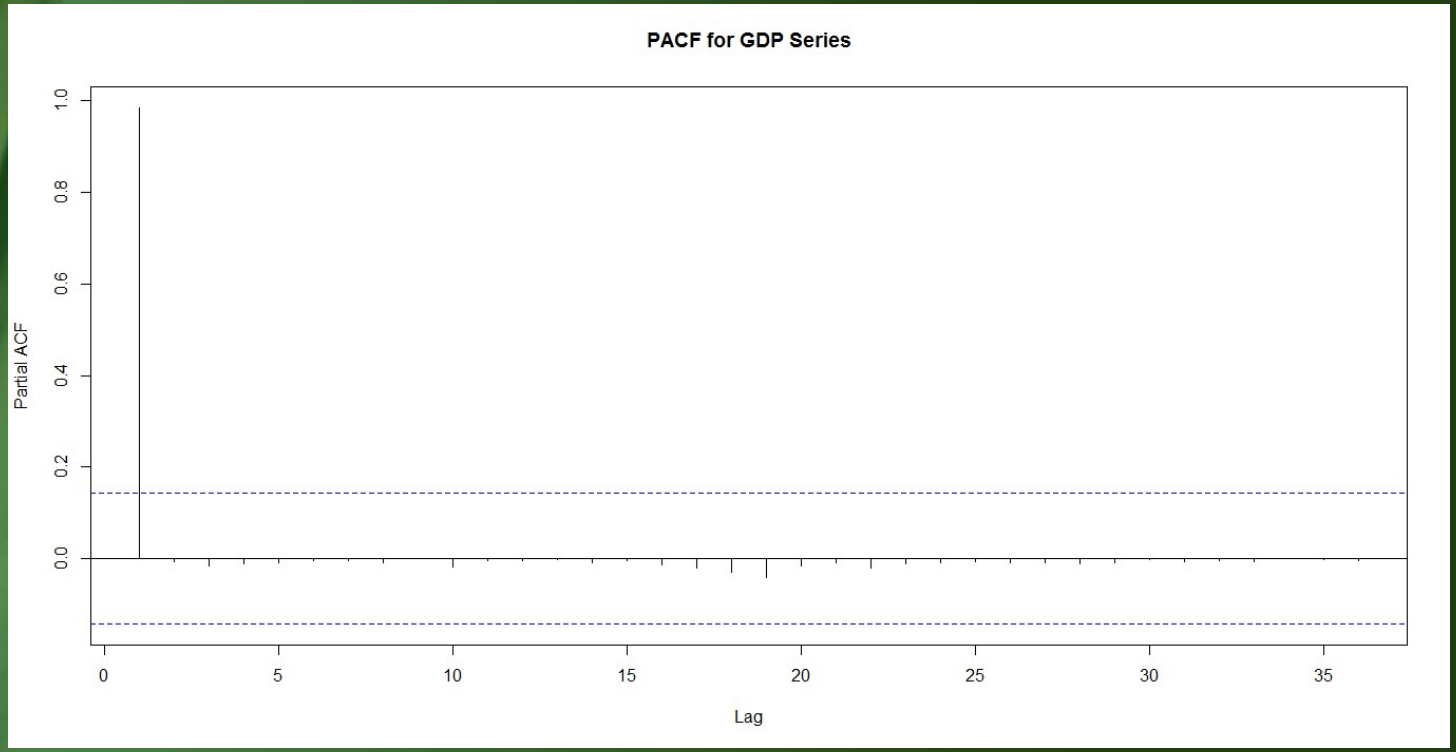
- Trend
- Intervention

ACF PLOT OF GDP



- Decaying lags in ACF shows existence of a trend
- No seasonality

PACF PLOT OF GDP



- High first lag in PACF plot reconfirms existence of a trend

MODEL FITTING – DLM

q	MASE	R Squared	Autocorrelation	Normality	Multicollinearity
1	0.4201391	0.7957	Present	Non-normal	Present
2	0.4202219	0.7952	Present	Non-normal	Present
3	0.4187522	0.796	Present	Non-normal	Present
4	0.4163028	0.7982	Present	Non-normal	Present
5	0.4083079	0.8035	Present	Non-normal	Present
6	0.4027258	0.8063	Present	Non-normal	Present
7	0.3992742	0.8085	Present	Non-normal	Present
8	0.3927201	0.8126	Present	Non-normal	Present
9	0.3886098	0.8168	Present	Non-normal	Present
10	0.3845233	0.82	Present	Non-normal	Present
11	0.3790782	0.8217	Present	Non-normal	Present
12	**0.3731107**	**0.8244**	**Present**	**Non-normal**	**Present**

Best DLM Model: q = 12

MODEL FITTING – OTHER DLM

Model	Parameters	MASE	R Squared	Autocorrelation	Normality	Comment
PolyDLM	q = 1, k = 2	0.4201	0.7957	Present	Non Normal	-
PolyDLM	q = 5, k = 2	0.41057	0.8055	Present	Non Normal	-
PolyDLM	q = 12, k = 2	0.3829	0.8304	Present	Non Normal	-
Koyck	-	0.4130	0.9998	Present	Non Normal	Endogeneity
ARDLM	**p = 1, q=1**	**0.4304507**	**0.9999**	**Present**	**Non Normal**	**Coefficient Significant**
ARDLM	p = 2, q=1	0.4290116	0.9999	Present	Non Normal	Coefficient Insignificant
ARDLM	p = 1, q=2	0.3763018	0.9999	Present	Non Normal	Coefficient Insignificant

Best ARDLM Model: p=1, q=1

MODEL FITTING – INTERVENTION AND DYNLM

MODEL	MASE	R Squared	Autocorrelation	Normality
Trend and Pt	9.531071	0.9589	Present	Non-normal
Trend	9.637251	0.9586	Present	Non-normal
Trend + Yt-1	0.3845702	0.9999	Present	Non-normal
Trend + Yt-1, Yt-2	**0.3570696**	**0.9999**	**Not Present**	**Non-normal**
Trend + Yt-1, Yt-2, Yt-3	0.3483	0.9999	Not Present	Non-normal

Best DYNLM Model: Trend + Yt-1, Yt-2

MODEL FITTING – HOLTS TREND & ETS

Model	Parameters	Mase	Autocorrelation	Normality
ETS	**Beta = 0** **Model = "MAN"** **Lambda = 0.3214375**	**0.09058866**	**Present**	**Non Normal**
ETS	Model = "MAN" Lambda = 0.3214375	0.09062391	Present	Non Normal
ETS	Model = "MAN" Lambda = 0.3214375 Damped = True	0.09151425	Present	Non Normal

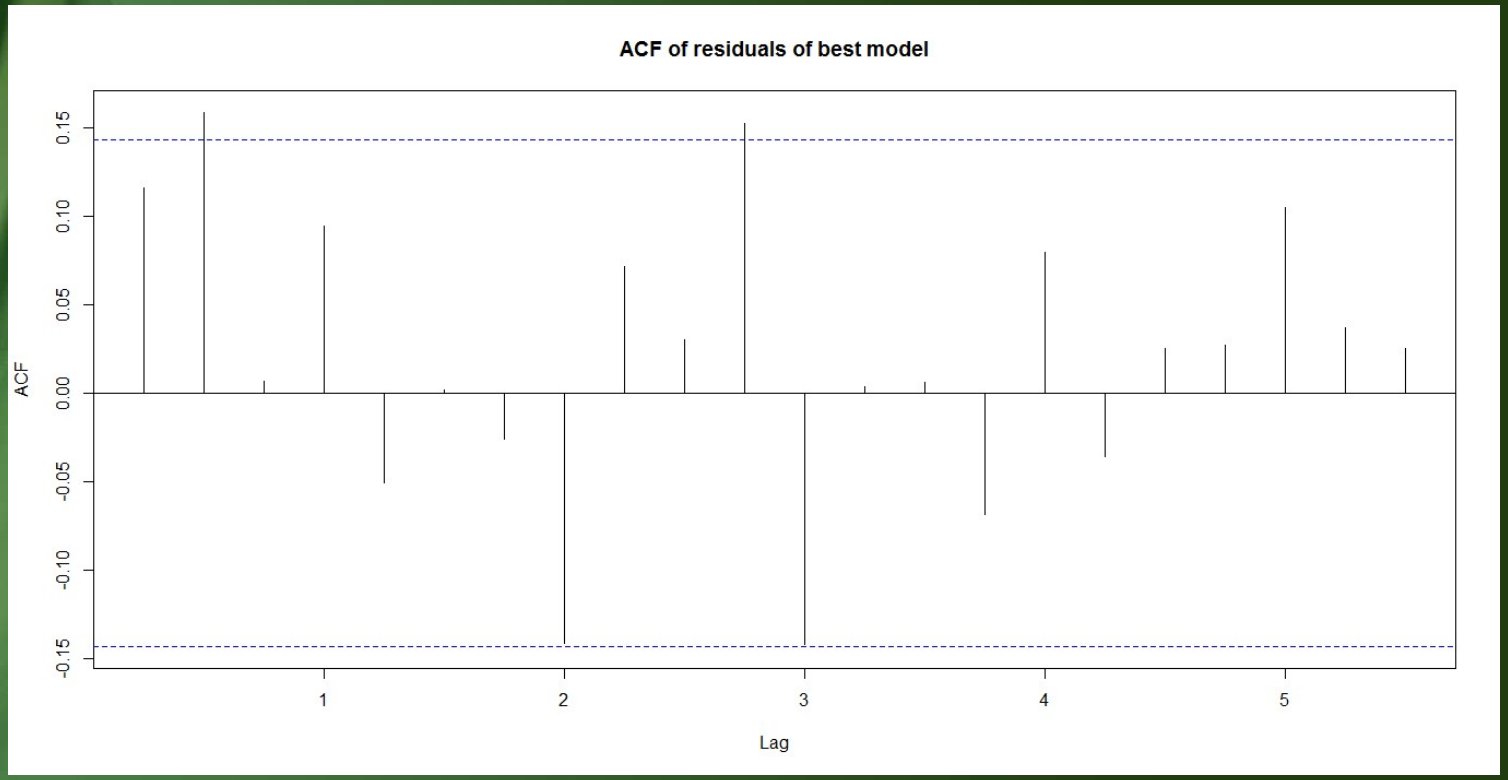
- ETS models show better MASE values than DLM or DYNLM models
- **Best model**: ETS(Beta = 0, Model = "MAN", Lambda = 0.3214375) with drift

MODEL FITTING – MODIFICATION OF ETS MODEL

Model	Parameters	Opt.Criteria	Mase	Autocorrelation
ETS	Model = "MAN" Lambda = 0.3214375	MSE	0.089	Present
ETS	Model = "MAN" Lambda = 0.3214375	MAE	0.089	Present
ETS	Model = "MAN" Lambda = 0.3214375	SIGMA	0.089	Present, But less than previous two models
ETS	**Model = "MAN" Lambda = 0.3214375 Damped = True**	**MAE**	**0.088**	**Present, slightly**
ETS	Model = "MAN" Lambda = 0.3214375 Damped = True	MSE	0.089	Present

- **Best model**: We try to deal with the Normality issue by changing the optimization criterion of Log Likelihood to other criterion. The best model we get is the **ETS – 'MAN'** model with damped trend and lambda = 0.3214 with MAE criterion

ACF OF RESIDUALS - ETS MAN MODEL WITH DAMPED TREND AND MAE OPTIMIZATION CRITERIA

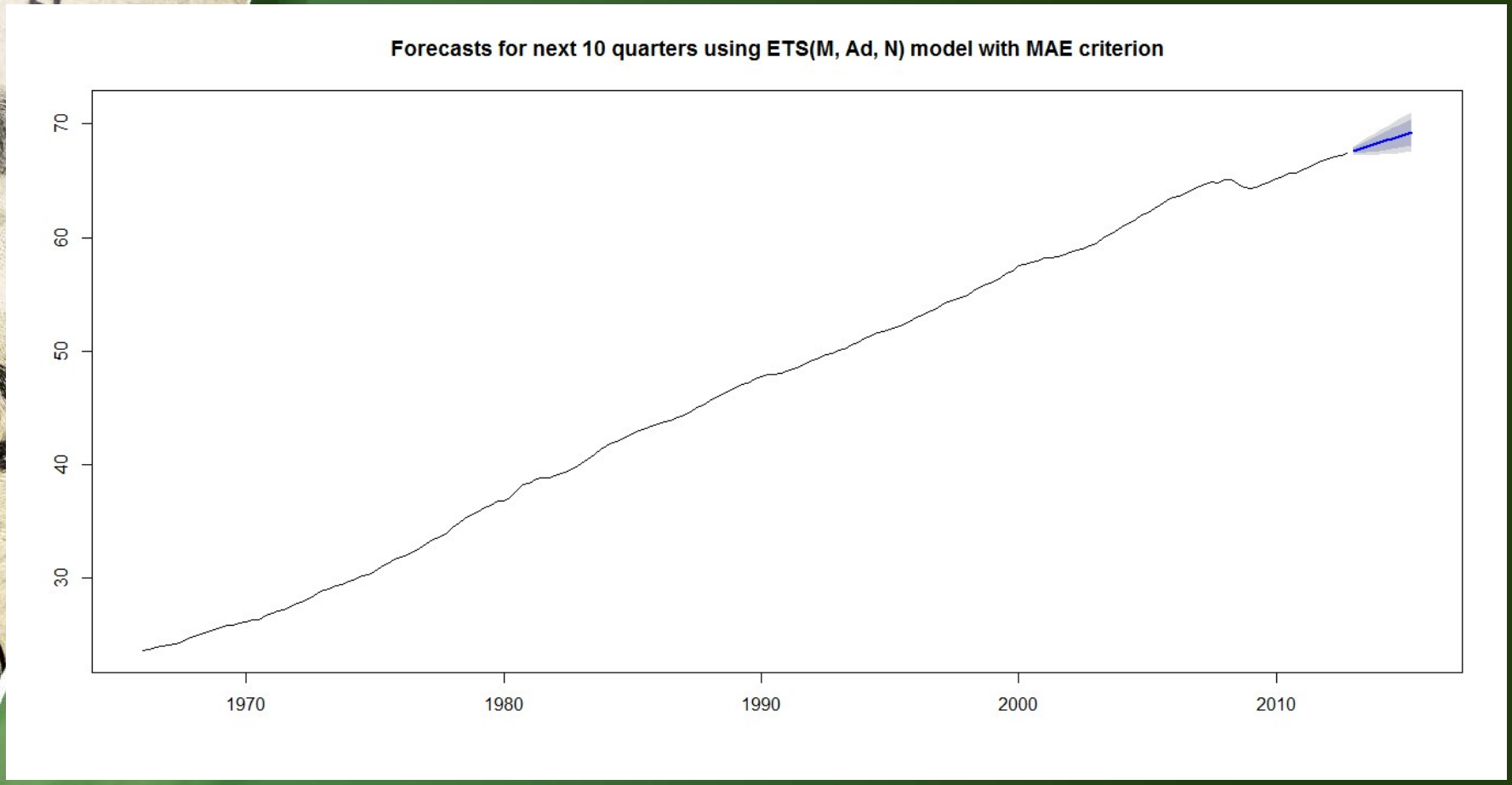


- ACF shows slight correlation in residuals

RESULTS

- ETS MAN model with damped trend and MAE optimization criteria is the most suitable model
- There is slight correlation in residuals
- Since we use MAE criterion, there is no need to check normality of residuals

FORECASTS FOR THE NEXT TEN QUARTERS



Forecasts show increasing trends over the next ten quarters

REFERENCES

- Data source
  - GDP dataset: U.S. Bureau of Economic Analysis, Gross Domestic Product [GDP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GDP, October 4, 2017
  - Federal debt as a % of GDP: Federal Reserve Bank of St. Louis and U.S. Office of Management and Budget, Federal Debt: Total Public Debt as Percent of Gross Domestic Product [GFDEGDQ188S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GFDEGDQ188S, October 4, 2017.
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