Gross debt as a % of GDP of European Union

- TIME-SERIES
- HOLT METHOD MODELS AND FORECAST

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1. Introduction

- Public debts are getting significantly more attention since the financial crisis of 2008 and sovereign debt crisis;
- The rise of government debts in the EU (as a % of GDP) has been clearly one of the main concerns of the European Institutions and Policymarkers, as the EU country leaders significantly increased public spending (particularly during the pandemic);
- Inflation, lockdowns and war is causing an even more precarious to the eurozone, as GDP growth is directly affected in Europe;
- It is imperative to prioritize public debt control, as some countries and even european common currency have been steadily at risk;

1. Introduction

- What is the Debt-to-GDP Ratio?

- The debt-to-GDP ratio, commonly used in economics, is the ratio of a country's debt to its gross domestic product (GDP). Expressed as a percentage, the ratio is used to gauge a country's ability to repay its debt. In other words, the debt-to-GDP ratio compares a country's public debt to its annual economic output.

1. Introduction

- The aim of this study is to predict the evolution of Public Debt in EU in a 10 years horizon, as a basis for the measures which shall be taken to control public debt in the future;
- For this analysis, a time-series method will be used, namely the Holt-method, by using STATA software;
- Holt's two-parameter model, also known as linear exponential smoothing, is a popular smoothing model for forecasting data with trend. Holt's model has three separate equations that work together to generate a final forecast.

2. Data Extraction and Preparation

- We have extracted a dataset from the statistical data platform pordata.pt with Gross Debt as a % of GDP of European Union from 1995 until 2021.
- The dataset was exported to STATA software and prepared for the statistical analysis.

Variables	Name
Dependent: gross Public Debt (%)	year
Independent: year (1995 to 2021)	debt

year	debt
1995	71.500
1996	73.500
1997	73
1998	72.600
1999	71.600
2000	69.100
2001	68.100
2002	68.100
2003	69.400
2004	69.700
2005	70.400
2006	68.400
2007	66
2008	69.700
2009	80.300
2010	85.700
2011	87.600
2012	91
2013	93
2014	93.100
2015	91.200
2016	90.400
2017	87.900
2018	85.800
2019	83.800
2020	97.300
2021	95.600

3. Descriptive Statistics

- Descriptive statistics of the dependent variable "Debt":

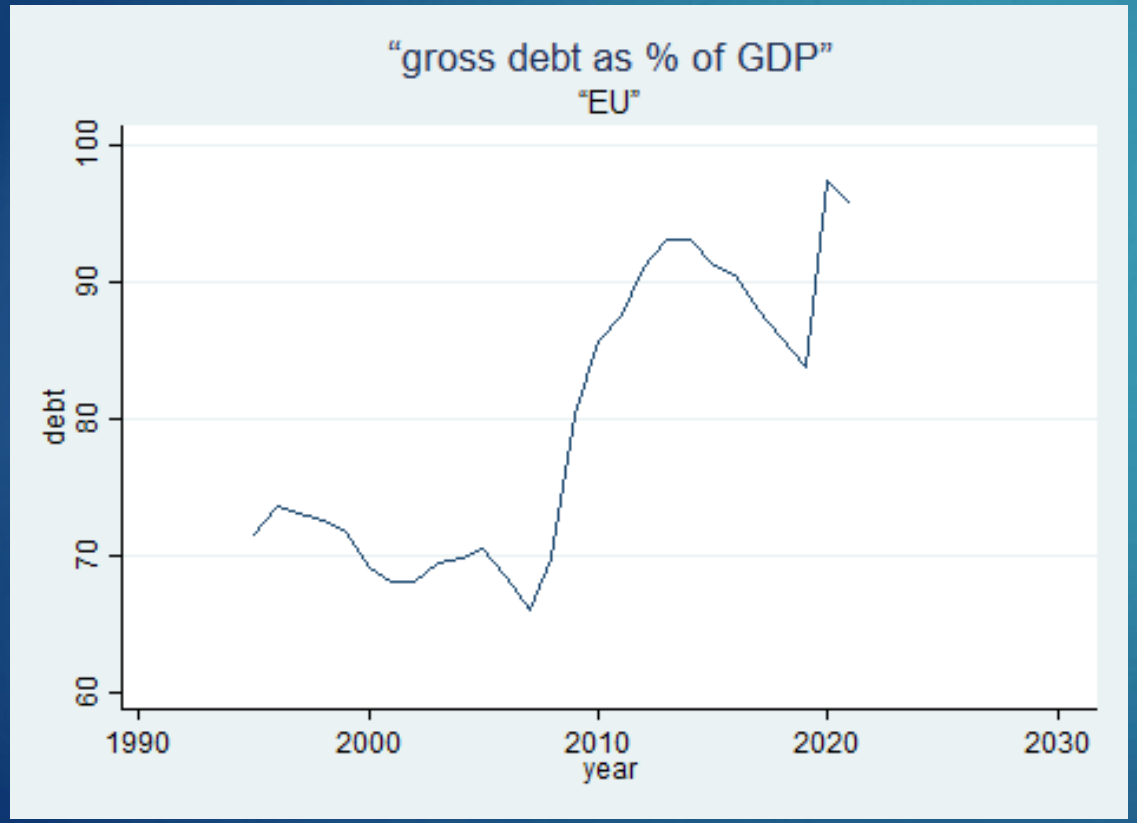
Variable	Obs	Mean	Std. Dev.	Min	Max
debt	27	79.4	10.501	66	97.3

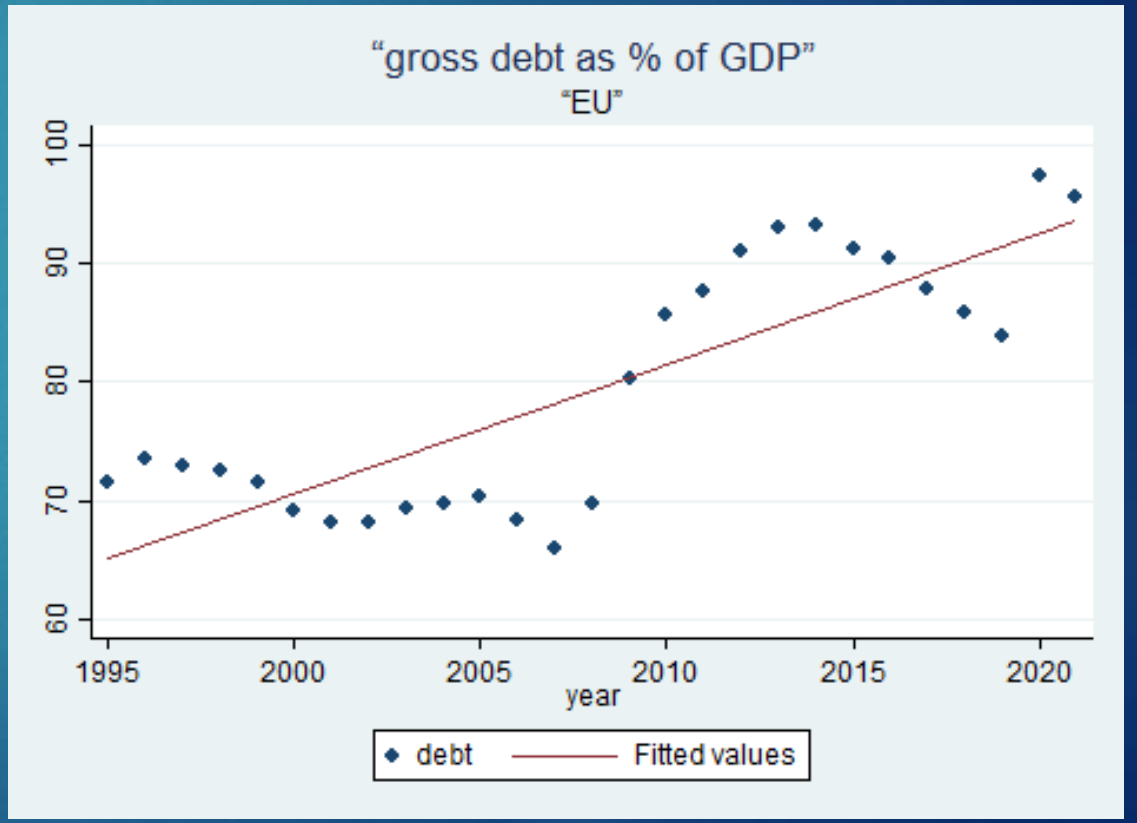
- There's a strong positive correlation (82%) between the 2 variables of the dataset:

Variables	(1)	(2)
(1) year	1.000	
(2) debt	0.822	1.000

3. Descriptive Statistics

- The scatter plot and the fitted regression line to the scatter clearly shows a growing positive trend, very steep after the 2008 financial crisis, and after a correction which started in 2014, clearly the debt aggravated in 2020 due to the covid-19 pandemic.





4. Time-series estimation

The implementation of Holt Method was carried out with 2 analysis for comparison:

- 1) values attributed for the smoothing parameters:

$\alpha = 0.5$ and $\beta = 0.2$

hwinters hwp=debt, parms (.5 .2)

- 2) optimal values for the smoothing parameters

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5. Time-series model prediction

- A forecast for both models with the Holt-Method was carried out for the following decade (2022-2031);

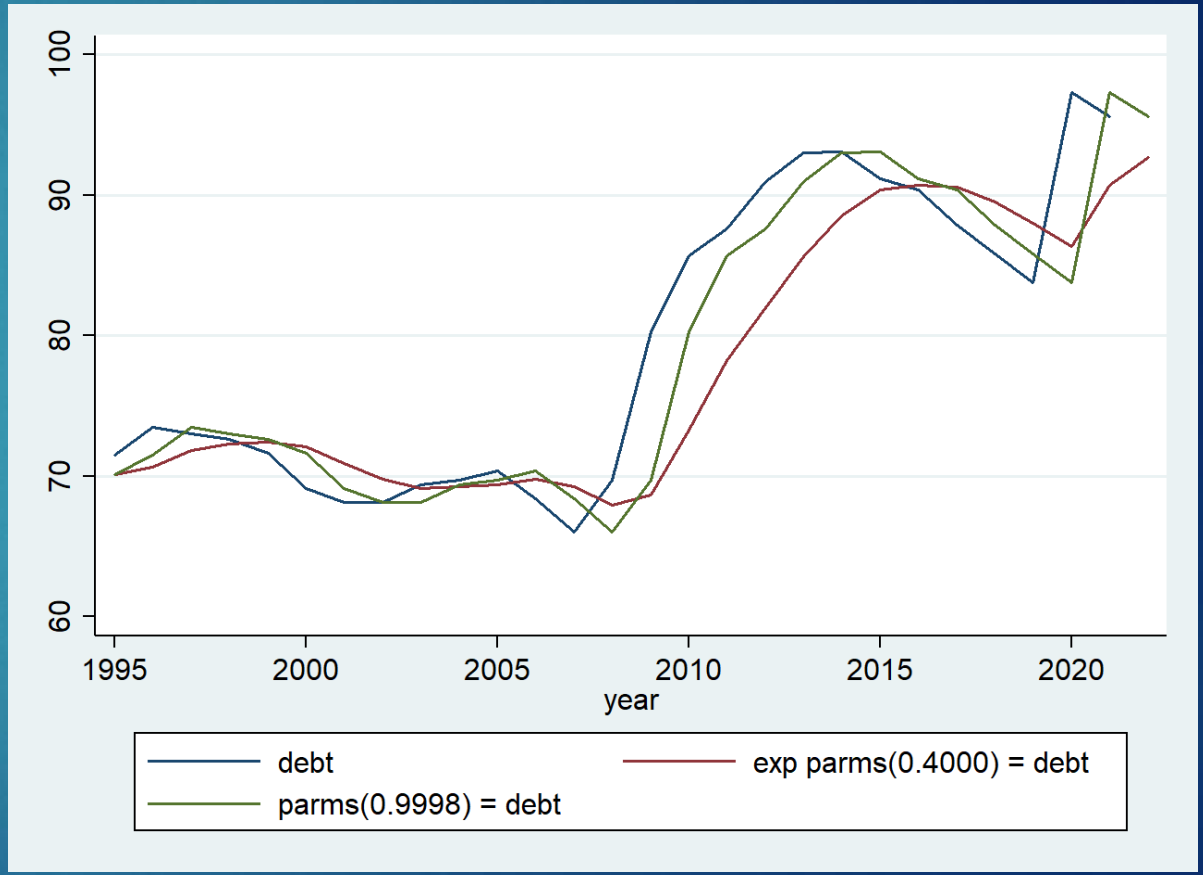
- The table at the right shows the obtained variables with the Hold method for both cases (attributed values for the smoothing parameters and optimal solution).

year	debt	hwp	hwso	hwp_f	hwso_f
1995	71.500	72.844	72.844	72.844	72.844
1996	73.500	71.582	70.961	71.582	70.961
1997	73	72.142	73.118	72.142	73.118
1998	72.600	72.258	72.611	72.258	72.611
1999	71.600	72.150	72.210	72.150	72.210
2000	69.100	71.542	71.172	71.542	71.172
2001	68.100	69.743	68.544	69.743	68.544
2002	68.100	68.179	67.516	68.179	67.516
2003	69.400	67.390	67.553	67.390	67.553
2004	69.700	67.846	68.967	67.846	68.967
2005	70.400	68.409	69.312	68.409	69.312
2006	68.400	69.240	70.080	69.240	70.080
2007	66	68.572	67.976	68.572	67.976
2008	69.700	66.780	65.453	66.780	65.453
2009	80.300	68.026	69.416	68.026	69.416
2010	85.700	75.177	80.690	75.177	80.690
2011	87.600	82.504	86.400	82.504	86.400
2012	91	87.628	88.374	87.628	88.374
2013	93	92.227	91.937	92.227	91.937
2014	93.100	95.603	94.003	95.603	94.003
2015	91.200	97.091	94.047	97.091	94.047
2016	90.400	96.296	91.971	96.296	91.971
2017	87.900	94.909	91.073	94.909	91.073
2018	85.800	92.265	88.377	92.265	88.377
2019	83.800	89.246	86.117	89.246	86.117
2020	97.300	86.192	83.974	86.192	83.974
2021	95.600	92.526	98.299	92.526	98.299
2022	.	.	.	95.150	96.432
2023	.	.	.	96.237	97.264
2024	.	.	.	97.325	98.095
2025	.	.	.	98.412	98.927
2026	.	.	.	99.499	99.759
2027	.	.	.	100.586	100.591
2028	.	.	.	101.674	101.422
2029	.	.	.	102.761	102.254
2030	.	.	.	103.848	103.086
2031	.	.	.	104.935	103.918

4. Time-series Results

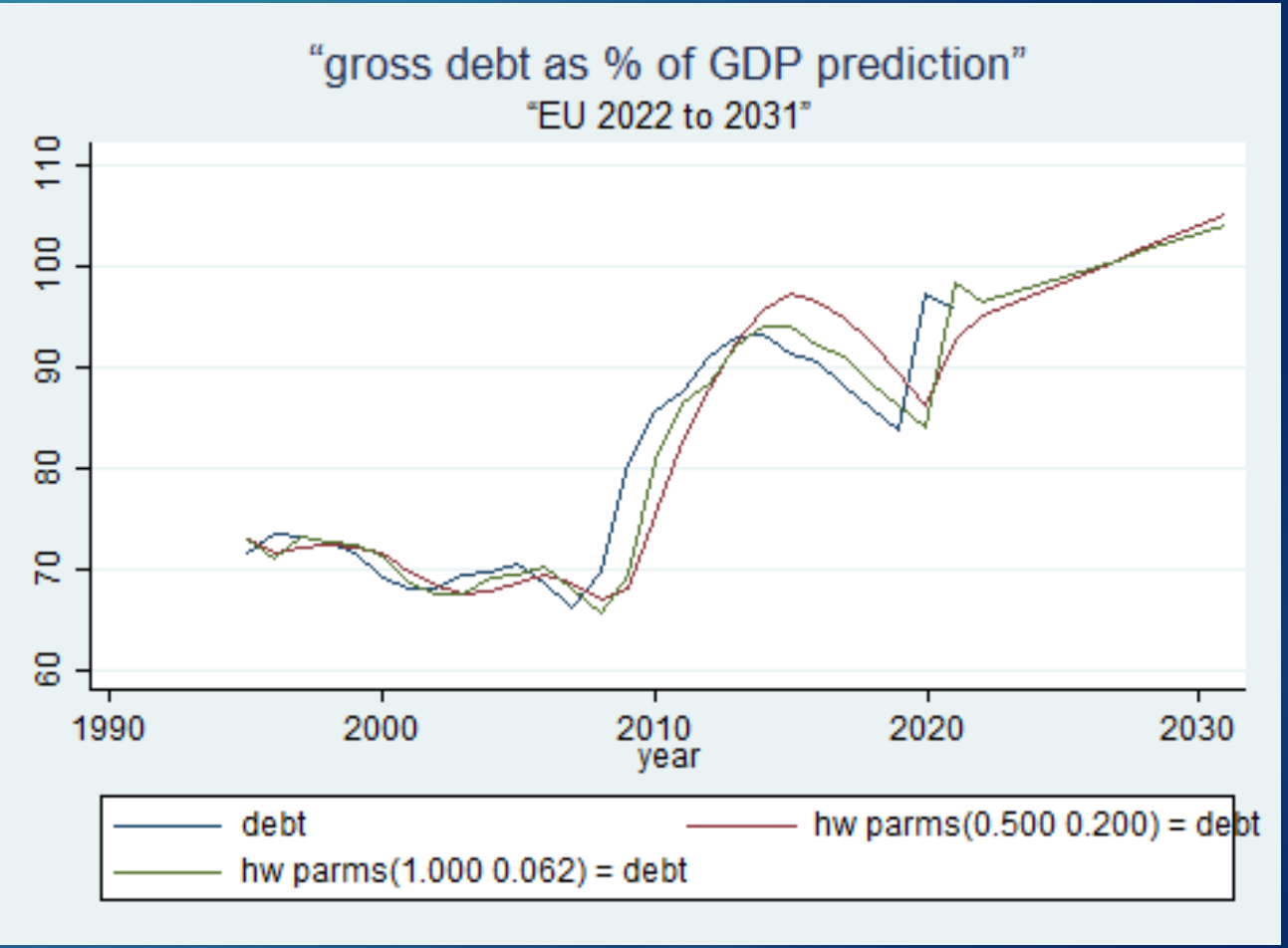
- Following the 2 models for comparison, both were plotted and compared with the real values of debt;

- Visually one can see the optimal solution reaches the real values closely than the other solution with attributed smoothing values.



4. Time-series Results

- Plotting the predicted debt for the upcoming decade, the plot shows after a small decrease in 2022, which is probably related to GDP rise after the lockdowns in 2021, a solid escalation of debt as a % of GDP will occur from 2023 until 2031.



5. Time-series Results

- As a complementary analysis, the prediction errors are analyzed trhough criteria, according to the table below:

- Forecast accuracy statistics for hwso_f, N = 37

RMSE	2.1466784
MAE	1.4927886
MAPE	.01752913
Theil's U	.7666408

- The prediction model shows a MAPE of only 1.7%, which means the adjustment model has an error of around 1.7% in the prediction.

6. Conclusion

- Holt Method provided a very interesting smoothing model for forecasting the Public Debt;
- The Public Debt prediction shows a concerning escalation of the Debt in the following decade as a % of GDP;
- The rise of inflation, precarious situation of some European countries and current devaluation of Euro (€) against the US Dollar ($), means this continuous growth of debt will be one of the major challenges which european policymakers and leaders will face in the upcoming years.

Table: List of Variables

7. Bibliography

- https://www.pordata.pt/
- https://corporatefinanceinstitute.com/resources/knowledge/economics/debt-to-gdp-ratio/

Table: List of Variables

The End

Thank you.

Table: List of Variables