Time Series Analysis of Household Debt to GDP Ratio in the United States (2005-2024)

Objective:

This analysis investigates the Household Debt to GDP ratio for the United States over the period 2005 to 2024. The data, sourced from the Federal Reserve Economic Data (FRED) website, is provided on a quarterly basis. The main research questions focus on:

1. **Trends over Time:** Understanding how the ratio changed over the years, including periods of significant increases or decreases.
2. **Seasonality and Cycles**: Identifying any seasonal patterns and recurring cycles in the data.
3. **Impact of Economic Events**: Analyzing how the ratio responded during key events, particularly the 2008 Financial Crisis and the COVID-19 pandemic.
4. **Rate of Change**: Calculating the average rate of quarterly change in the ratio and identifying the quarters with the highest and lowest changes.

Methodology:

The data source includes two main variables:

- Date: The date in YYYY-MM-DD format
- Debt-gdp-hh: The Household Debt to GDP ratio in percentage.

The analysis was done on Stata. The data was aggregated into yearly averages for easier trend analysis, and summary statistics was calculated to assess the distribution of the ratio over time.

Analysis and Results:

a. Trends Over Time

To explore the overall trend, the quarterly data was aggregated to annual data by extracting the year from the date variable and calculating the average of the Household Debt to GDP ratio (debt_gdp_hh) for each year. The dataset was reduced to include only yearly averages for easier trend analysis.

Table 1: Summary statistics for Debt to GDP Ratio

Variable	Obs.	Mean	Std. Dev.	Min	Max
Debt_gdp_hh	20	84.01887	9.200772	71.52288	99.28725

On average, households in the United States had debt amounting to **84.02%** of the GDP. The ratio fluctuated by about 9.20 percentage points from the mean value. The lowest observed ratio was **71.52%,** and the highest observed ratio was **99.29%,** which represents that peak level of during this period.

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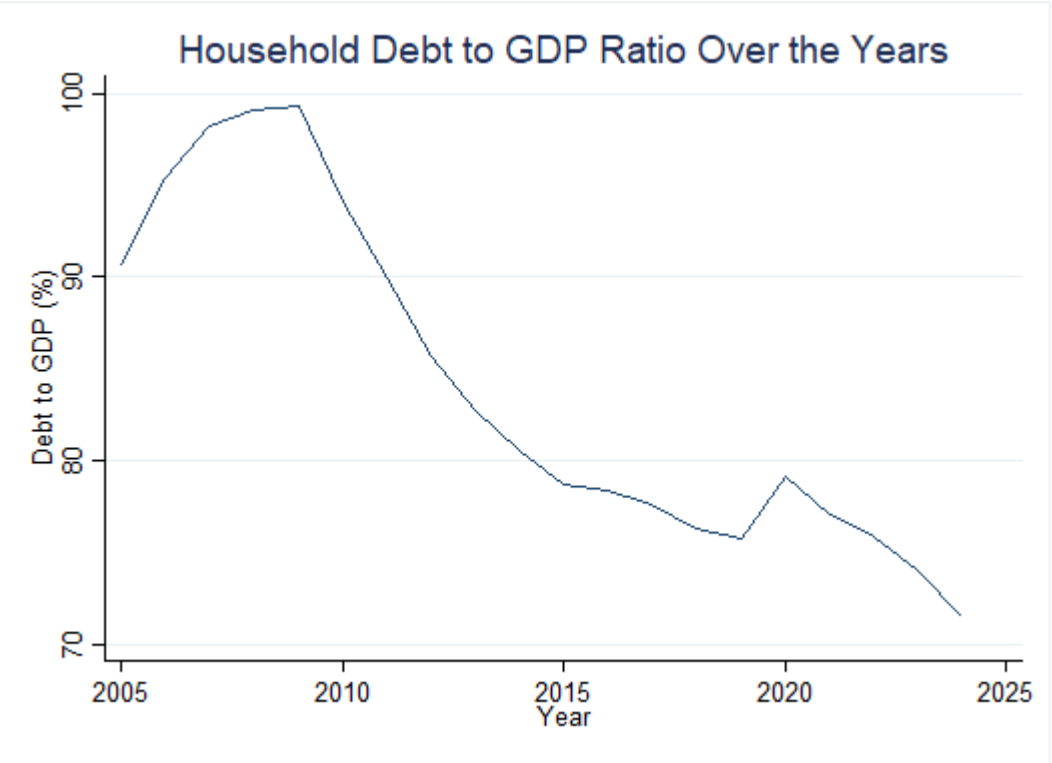
A line graph was created to visualize the trend over time, showing a general decline from 2008 to 2019, followed by an increase in 2020-2021 due to COVID_19 pandemic.

Figure 1



To examine the changes from year to year, the difference in the ratio between consecutive years was calculated. Descriptive statistics for the yearly change are as follows.

Table 2: Summary Statistics for Yearly Change

Variable	Obs.	Mean	Std. Dev.	Min	Max
Yearly_change	19	-1.009867	2.574247	-5.15239	4.67536

On average, the ratio decreased by 1.01 percentage points per year, suggesting that the overall trend in ratio was a gradual decline. The yearly changes varied by about 2.57 percentage points from the mean. The most significant decrease in the ratio was -5.15 percentage points which occurred in 2010. The sharpest increase in the ratio was observed in 2006 and was 4.68 percentage points. The sharp increase in 2006 and decrease in 2010 reflect two distinct periods of economic behavior:

- **2006**: Likely a period of heightened borrowing and economic expansion leading to an increase in household debt.
- **2010**: A post-crisis period, possibly reflecting deleveraging or reduced borrowing behavior due to the lingering effects of the 2008 financial crises.

The specific periods of increase and decrease in debt to GDP ratio is as follow:

Table 3: Specific Period of Increase

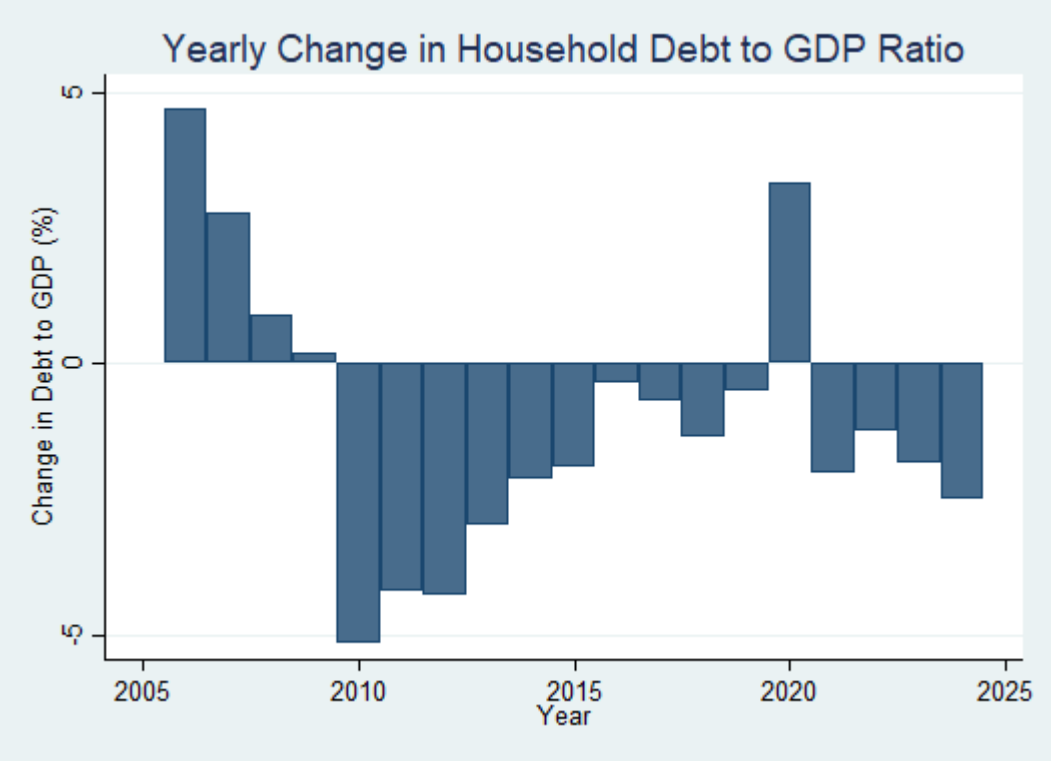
Year	Debt_gdp_hh	Yealy_change
2006	95.385714	4.67536

Table 4: Specific Period of Decrease

Year	Debt_gdp_hh	Yealy_change
2010	94.13486	-5.15239

The bar graph below illustrates the yearly changes in the Household Debt to GDP ratio from 2005 to 2024.

Figure 2



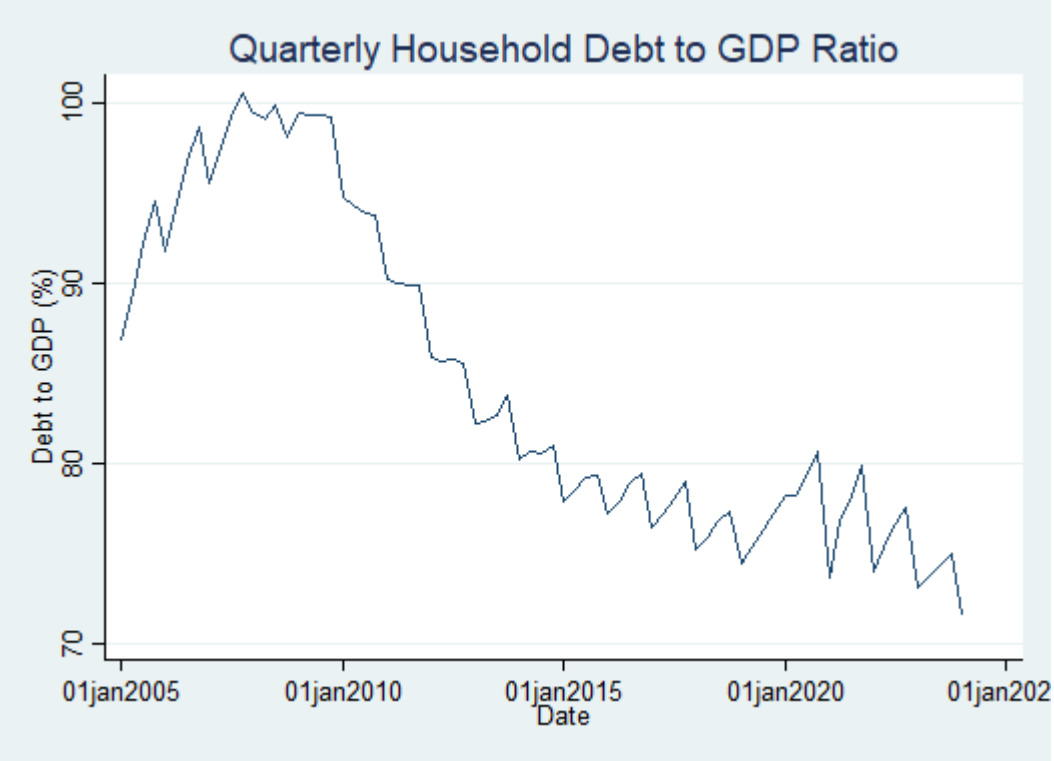
b. Seasonality and Cycles

To investigate potential seasonal patterns in the Household Debt to GDP ratio, the data was examined by quarter. Using the quarterly data, box plot (Figure 3) was created to visualize the distribution of the ratio across each of the four quarters. The plot revealed **no significant seasonal pattern** in the data. The median and interquartile ranges for each quarter overlapped considerably, indicating that the ratio remained relatively stable across all four quarters of each year. Therefore, it can be concluded that the ratio does not exhibit strong seasonality during the period analyzed.

Figure 3

Next, a line graph of the quarterly data displayed fluctuations in the ratio, highlighting cycles of growth and decline. Notably, there were distinct cycles of growth and contraction, with substantial increases observed around the time **of 2008 financial crisis** and the subsequent recovery period, as well as some cyclical behavior observed in the years following the **COVID-19 pandemic**. This analysis indicates that while the ratio does not follow a clear seasonal pattern, it does exhibit recurring cycles driven by significant economic events.

Figure 4



c. Impact of Economic Events

Furthermore, the impact of economic events on Household Debt to GDP ratio over the given period was examined. The two major economic events of the interest are the following:

- *2008 Financial crisis*: An indicator binary variable, crisis_2008, was created which is coded as 1 for the years 2007 to 2009, corresponding to the financial crisis period, and 0 for other years.
- *The COVID-19 pandemic (2020)*: another binary variable was created, covid_2020, which was coded as 1 for the year 2020, and 0 for other years.

Then, the average ratio during these periods were compared and the data was aggregated by the crisis and pandemic years.

The findings suggest that the average Debt to GDP ratio during the crisis (2007-1009), was **98.85%,** compared to **81.86%** outside the crisis. This shows a significant increase during the financial crisis, reflecting the surge in borrowing and debt accumulation, likely driven by economic policies, the housing market bubble, and increased household borrowing during the pre-crisis years.

Table 5: Average Debt to GDP Ratio During and Outside the Crisis

Crisis_2008	Debt_gdp_hh
0	81.857639
1	98.849557

Moreover, the average Household Debt to GDP ratio during the COVID_19 pandemic year (2020) was **79.14%.** compared to 84.80% outside the pandemic. This slight decrease during pandemic reflects the economic slowdown, reduced consumer spending and borrowing, and government interventions (such as stimulus packages). People may have reduced their debt levels or had limited access to borrowing due to the economic uncertainties.

Table 6: Average Debt to GDP Ratio During and Outside the COVID_19 Pandemic

Covid_2020	Debt_gdp_hh
0	84.799683
1	79.141092

d. Rate of Change

Finally, the differences in the ratio between consecutive quarters was computed, and the summary statistics of quarterly change was calculated to summarize the overall behavior of the ratio's fluctuations.

Table 7: Summary Statistics for Quarterly Change

Variable	Obs.	Mean	Std. Dev.	Min	Max
Quarterly_change	76	-0.2012376	2.111032	-7.034619	3.068969

On average, the ratio declined by **0.20** percentage points per quarter. The quarterly changes varied significantly, with a high standard deviation of **2.11** percentage points. The largest quarterly increase in the ratio was **3.07** percentage point in **April 2021**, likely reflecting the economic recovery. While the largest quarterly decrease was **-7.03** percentage points, observed in **January 2021**. This sharp drop likely reflects a major shift in the economy, possibly due to the ongoing COVID_19 pandemic's impact on economic activity and household debt behavior.

Table 3: Specific Period of Decrease

Date	Debt_gdp_hh	Quarterly_Change
01Jan2021	73.675354	-7,034619

Table 3: Specific Period of Increase

Date	Debt_gdp_hh	Quarterly_Change
01apr2021	76.726323	3.068969

Conclusion:

This analysis highlights significant fluctuations in the Household Debt to GDP ratio over the period 2005-2024, driven by key economic events such as the 2008 Financial Crisis and the COVID-19 pandemic. While no clear seasonal pattern was found, there were notable recurring cycles of growth and decline, reflecting the broader economic conditions during those periods. The rate of change analysis revealed considerable quarterly volatility, with both large increases and decreases observed, particularly during 2021.

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Reference

Dataset: https://fred.stlouisfed.org/series/HDTGPDUSQ163N

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