GDP, Debt, and the Health of the Stock Market

PY 538 Econophysics

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ABSTRACT:

The motivation of this paper is to investigate how the values of Gross Domestic Product (GDP) and central government debt affect the major indices traded on the respective nation's stock market. Can the sustainability of an index be determined based on the ratio of debt to GDP of that index's country? Data was gathered for the countries with the highest GDP in US dollars. Comparison of that country's GDP, debt, and major stock market index was made. Ultimately, a pattern was discovered that previewed a bust scenario, by looking at the debt to GDP ratio.

INTRODUCTION:

What defines the health of a nation's economy? Three major attributes that come to mind are Gross Domestic Product (GDP) and central government debt, and a country's major stock index. Gross Domestic Product (GDP) is the monetary value of all finished goods and services produced within a country's borders in a specific time period. [1] Every country's GDP is usually calculated on an annual basis. GDP is generally used as a measurement of a nation's overall economic health. The calculation of GDP includes consumer spending, government spending, country's investments, and the country's total net exports. Central government debt is the total amount owed by a government to its creditors. [2] Internal debt is debt owing to a national creditor. External debt is debt owing to foreign creditors. Central government debt also plays a crucial role in determining the health of a nation's economy. An index is an indicator or statistical measure of change in a securities market. [3] Indices consist of a portfolio of securities representing a particular market or portion of it. Each index has its own calculation methodology. For example, in the US, a major index is the Standard and Poor 500 (S&P 500) The S&P 500 is made up of the top 500 countries in the US stock market.

METHODOLOGY:

For this study, the top ten countries with respect to GDP were looked at, with the addition of Australia and Russia [4]. For each country, data was gathered for the country's GDP, central government debt, and major stock market index. Data for the GDP was available from 1960 to current date. Central government debt data was available from 1990. [5] Major stock market index data was found using Yahoo Finance and was available for various dates. [6] All the data was gathered in Microsoft Excel. Excel was used to make calculations as well as plot the data. The goal of this research was to find a possible relationship between the ratio of debt to GDP and the country's major stock market index price.

RESULTS:

The first thing that was done once all the data was gathered, was to plot the raw data versus time. The following figures represent GDP versus time, and central government debt versus time.
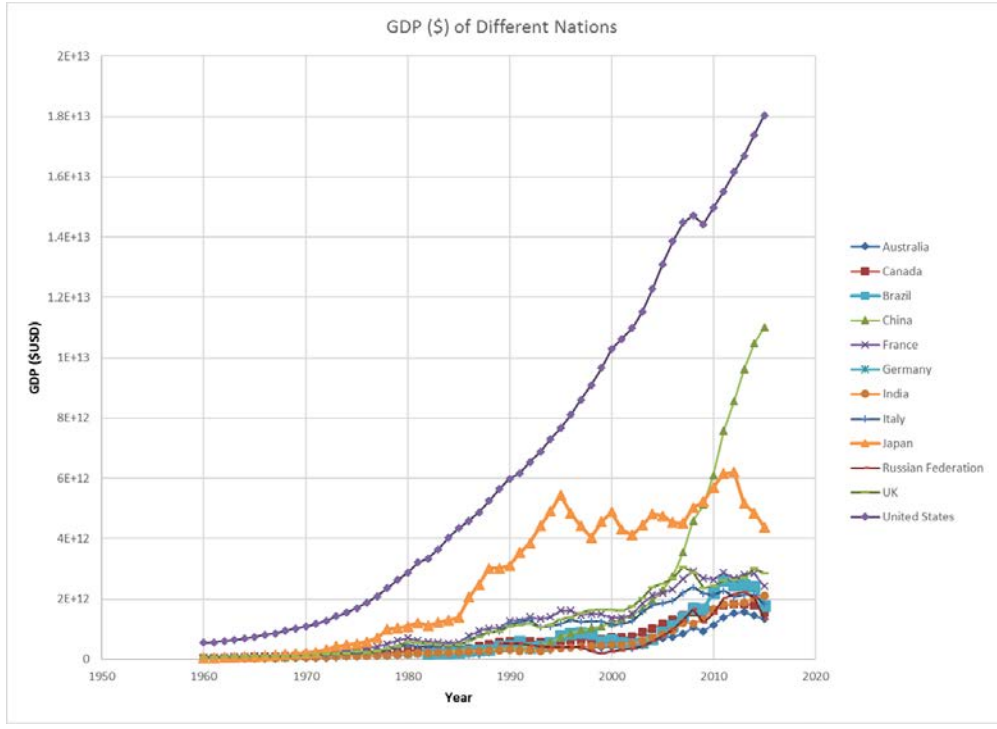
Figure 1: GDP (US Dollars) vs Time

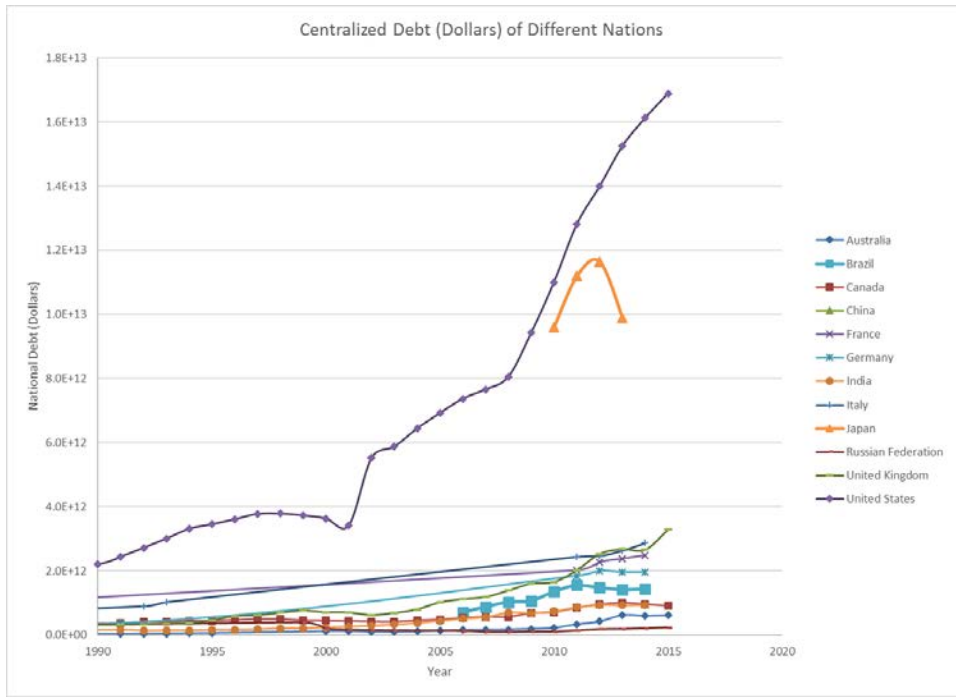The top three countries with respect to GDP are USA, China, and Japan.

Figure 2: Centralized Debt (US Dollars) vs Time

The top country in terms of debt is the US.

Next the volatility of the GDP was compared to the volatility of the major index of each country. The volatility is a measure of the scattering of the returns. The volatility of the each attribute was calculated using the natural log returns.

$$Returns = LN(x)/LN(x_i)$$

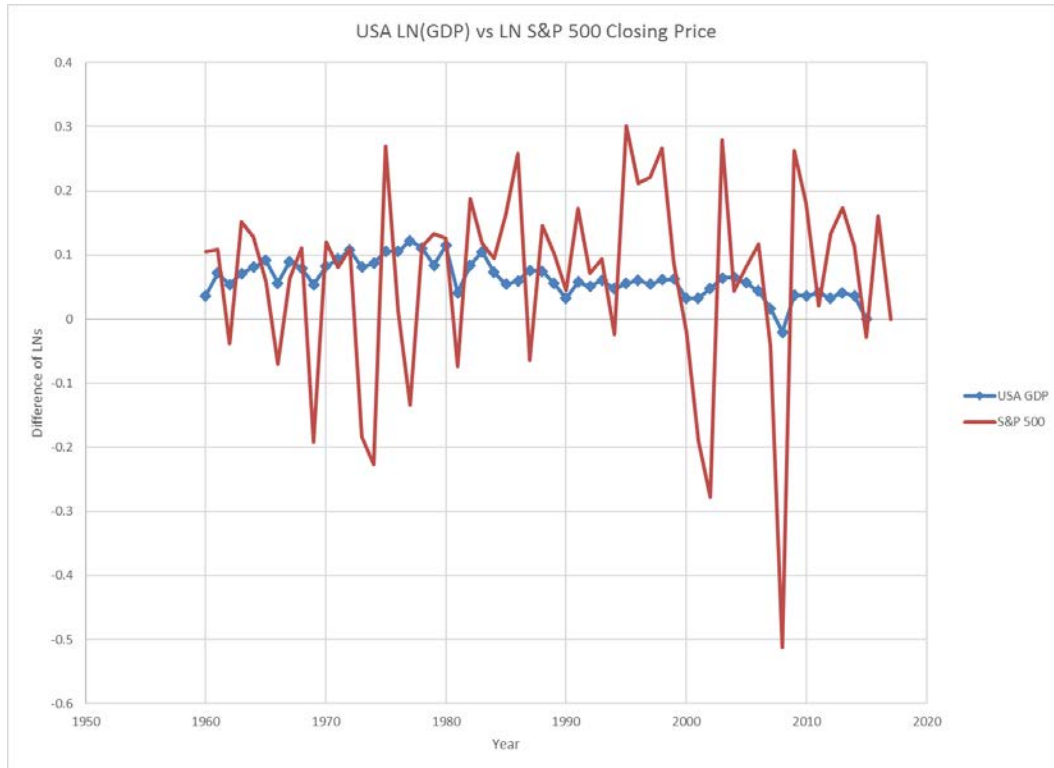Figure 3 shows the volatility of the US GDP and S&P 500.

Figure 3: Volatility of GDP and S&P 500 over time.

The relative volatility of the US GDP and S&P 500 seem to coincide over the same time period.

Debt to GDP Ratio:

The debt to GDP ratio is the ratio of a country's public debt to its gross domestic product. [7] This ratio indicates the country's ability to pay back its debt. High debt to GDP ratio may make it more difficult for the country to pay its external debts. This may lead to creditors seeking higher interest rates when lending to that country. Inherently, higher debt to GDP ratios tends to carry higher risk of default, which is something that should be avoided. The following figure represents the debt to GDP ratio calculated for the countries involved in this study.
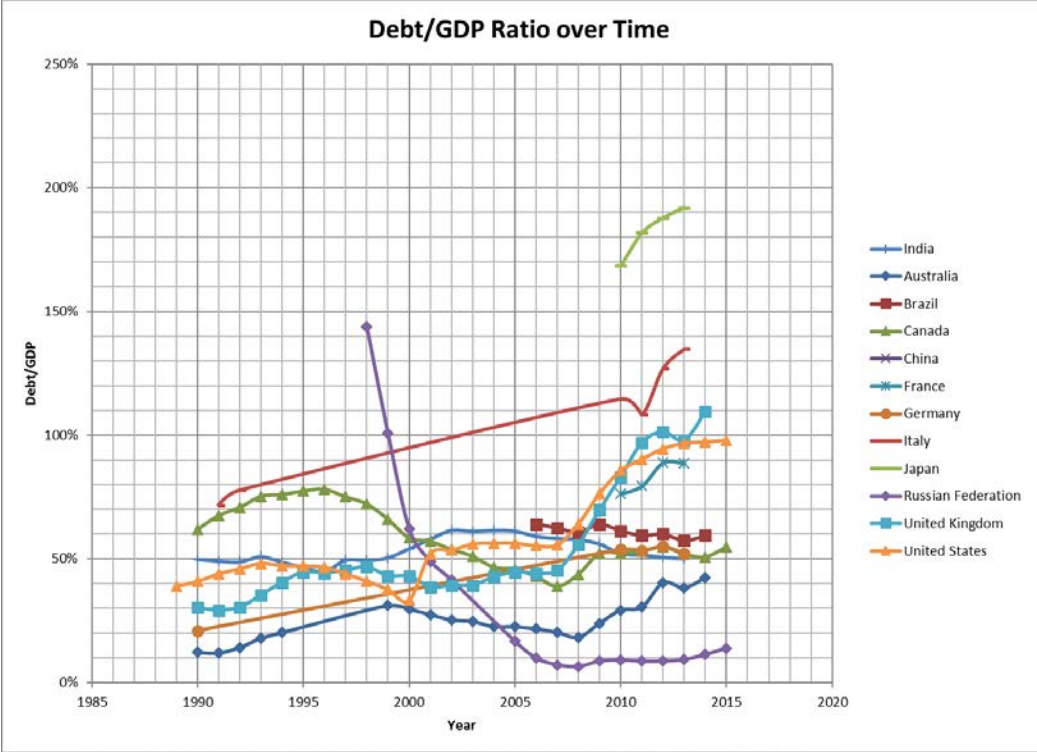
Figure 4: Debt/GDP Ratio vs Time for Different Countries

Having a debt to GDP ratio over 100% means that the country owes more than it produces. The US is close to the range of being over 100% debt to GDP ratio. Debt data was only available up to 2015. The comparison of the stock market price and debt to GDP ratio was made. Figure 5 shows this comparison plotted over time.
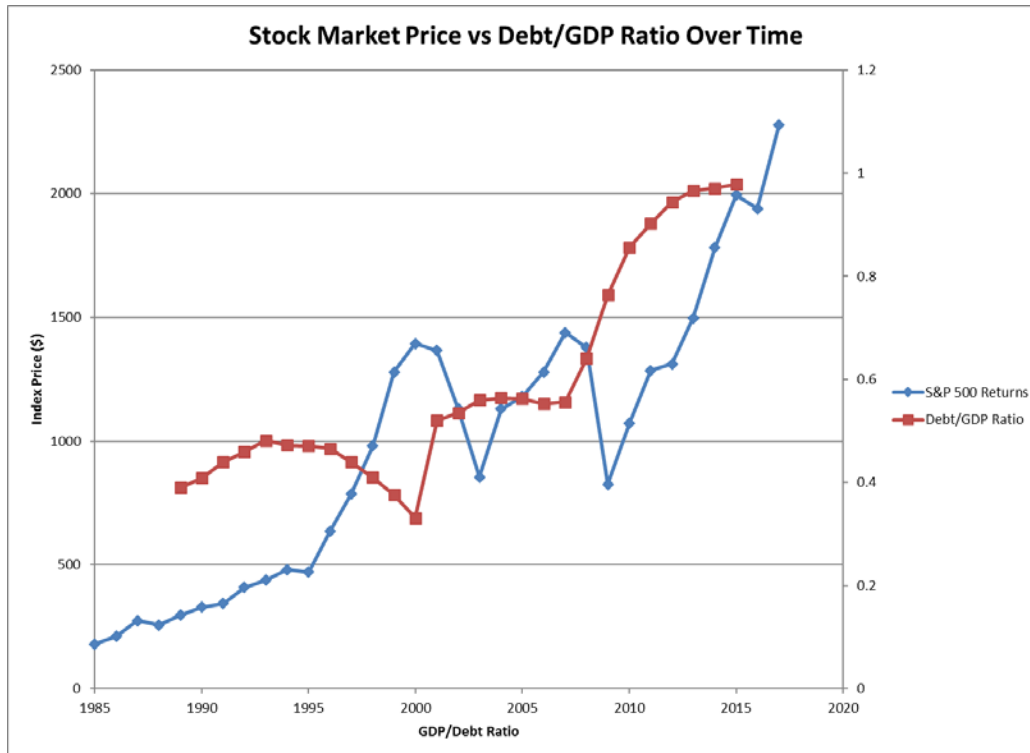
Figure 5: Debt/GDP Ratio Compared to S&P 500 Price over Time

One major pattern that appeared is that local minimums in the debt to GDP ratio seem to prelude local minimums of the S&P 500 index price. To verify this pattern, the data was normalized two ways. The first way that the data was normalized was to the start date of the data set. This show how much the ratio and index price changed from the start date.

$$Normalized_1 = (x - x_1)/x_1$$

The second way the data was normalized was to take a percent difference from the previous date. This shows how the ratio and the index price are changing year by year.

$$Normalized_2 = (x_i - x_{i-1})/x_i$$

The following two plots, Figure 6 and Figure 7, show the normalized debt to GDP ratio compared with the normalized S&P 500 index price.
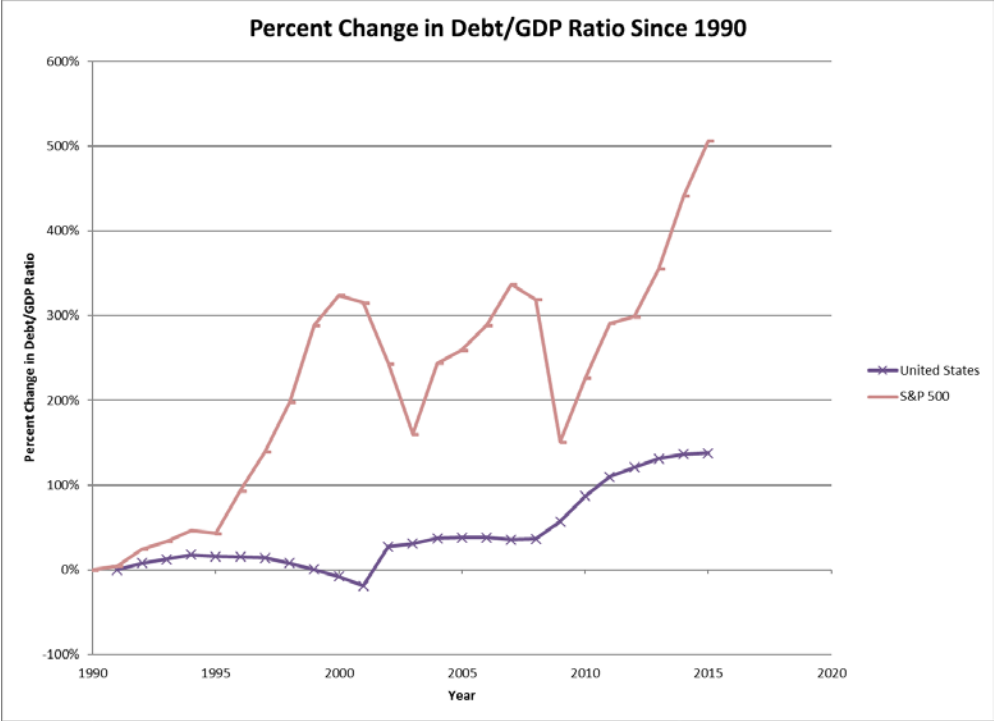
Figure 6: Debt/ GDP ratio compared to S&P 500 index price normalized to the start date of the data.
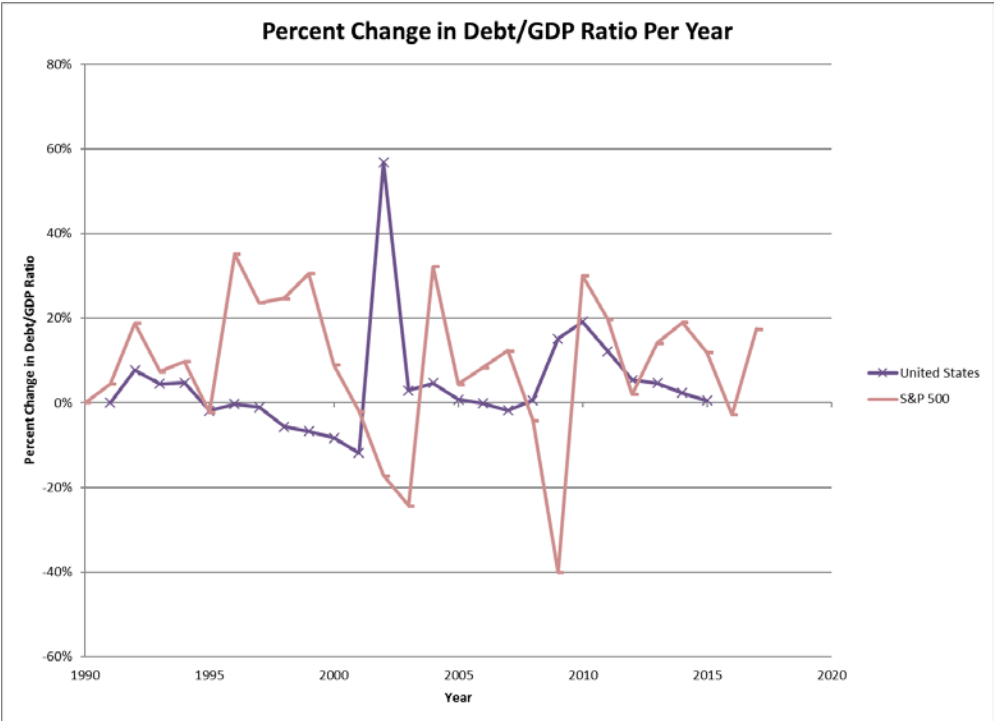

Figure 7: Debt/ GDP ratio compared to S&P 500 index price normalized to the previous date.

Both Figure 6 and Figure 7 illustrate the pattern that a local minimum of the debt to GDP ratio precedes a local minimum of the S&P 500 index price. This pattern holds not only for the US, but for other

countries as well, including Canada, and India. The length of time between the local minimum of the ratio of debt to GDP and index price seems to vary by 1-2 years. In terms of using this method to turn a profit, it is not recommended as the study uses attributes that look at the economy on a macro scale. The pattern could be used to predict a correction on the macro scale, but further investigation is needed in order to get a more accurate timing of the minimum of the debt to GDP ratio and index price minimum.

CONCLUSIONS:

Overall GDP, central government debt, and major stock market index price can all be good indicators of the health of a nation's economy. The use of the debt to GDP ratio as an indicator of sustainability for an index is inconclusive. There are several other factors that affect the price of an index that were not taken into account for this study. Further investigation is needed in this area. As stated previously, the pattern of local minimum in debt to GDP ratio preceding local minimum in index price can be used on a macro scale as a warning sign for an impending correction to the country's stock market and economy.

FURTHER INVESTIGATION:

There are several areas of interest for further investigation. One area would be to use the market capitalization to GDP ratio and compare this ratio to the index price. Based off of historic ratios one could forecast possible bust scenarios. There were also several other economic factors that were not taken into account in this study such as employment rate, average wages, cost of living, ect. These factors could be used to help identify the health of an economy. How much each attribute affects the economy could also be looked at. One last area that could be looked at is the global interconnectedness of each nation's economy. Each nation's economy does affect other nations' economies. What could be looked at here is which nations are more closely related, and how major news in one nation could affect the market on a global scale.

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