Determinants of Carbon Emission Cyclical in Three Various Sectors by America GDP Cyclical from 1980 to 2020

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Abstract

The aim of this article is to verify whether the U.S GDP from 1980 to 2020 has a deterrent effect or a causal relationship on the carbon emission in different use as well as income elasticity as an evaluation of factors of their relationships. All the three co-movements of cyclical components and U.S GDP illustrates a close tie of each other, and aviation gasoline and household petroleum carbon emission witness a positive correlation with the U.S GDP. It optimizes the existing articles which study how to reduce the carbon emission in various sectors by advanced technical models. The methodology use in this article is detrending, which use Excel trendline and HP Filter to find out the best-fit line of the trend of U.S GDP and carbon emission in three different sectors and calculate standard deviation and correlation to compare each cyclical component. The remarkable breakthrough is the amount of carbon emission depends on the income elasticity of demand in the U.S

Keywords: *Cyclical of U.S GDP, cyclical of carbon emission, zero emission, income elasticity*

1.Introduction

By reading the book Meteorological Economy and Human Future written by Bill Gates and knowing about the United Nations about the Climate conference in 2009 and the Paris Agreement in 2011, the world topic of achieving zero carbon emission has been watched all over the world. Starting from the five key issues that proposed in the book: the size of proportion the tun people talk about in the 51 billion tons; scheme in the concrete aspect; the size of the electric power in the world; the space and the input costs. Based on these five issues, many scholars have recently studied some of the aspects that relate to them, including mechanism development, population, industrial chain and domestic and foreign input. Some article clearly described how electric vehicles adoption benefits our economy in social influences, humanity and technology. [1] Cuixia G. [2] and his team found that there was a strong correlation between the carbon flows and migration flows and larger trade-related carbon flows, so a clearly results from their study suggested that the migration pattern among all provincials lead the formation of the trade-induced carbon emissions situation. Furthermore, some article about the relationship between energy-relying industry and carbon emissions in China has come out. [3] Certainly, the study on the global carbon emission attracted many people to pay attention on our global warming issue. The article explained the input change from domestic and international nations by comparing the efficiency of reducing carbon emissions in both developing and developed countries. [4] People also used a sustainable design to measure the influences of heavy industry and carbon emission by minimum emission and cost optimization. [5] All these previous articles and the meteorological economy topic facilitates me to investigate whether the country's gross domestic production (GDP) is influenced by the amount of the carbon emission in different sectors in the U.S., since the GDP has a close influential effect on the scheme of carbon emission reduction. This article will analyze the cyclical component of U.S GDP and that on carbon emission in household, commerce and transportation to see how the economy changed through the last 40 years by the carbon emission in the U.S.

Meteorological economy is the economic activities that relate to the weather or other meteorological forecasts services. Its purpose is not only produced social benefits by reducing the damage of natural disasters, but also applies some economic activities for agriculture,

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business or infrastructure development. Zero emission is an activity which persistently reduce the amount of emission of pollutants and energy resources. This aims to recycle and reuse the natural resources in order to leave without any other wastes for the whole ecosystem. The law of conservation of energy and the law of the immortality of matter testified that 100% completely conversion is impossible between resources and energy, raw materials and products, considering that the loss of energy will be conserved into air, water, heat, sound or other states of matter. Therefore, in order to achieve zero emission is an ideal goal, however, standing by the side of infrastructure, agriculture, transportation and electricity power, it is an economic opportunity for the mankind.

To investigate most of the articles that have been published previously, they were dominantly focusing on how the type of natural resources, such as nuclear power, solar, or fossil fuels affects the costs of production and consumption in our economy or its usefulness on a certain of issue. Tuantuan X. Cheng X. Yuhao L.& Yongping Y [6] verified that as the decreasing cost of investment in solar field and the rising coal price, the solar hybrid system can be more efficient in the economy. The results demonstrated that methanol production and net power output can be enhanced by the solar integration, which accounted for 94.2% and 22.9% respectively. In this case, energy required from methane cost as 341.95$/ton, 10.49% higher than other systems. Similarly, the authors Alice G. Jonathan N. B.& John B [7] concluded that material efficiency and the technology of removal capacity is significant. Another article in the position of supply and demand, from Cassarino G. T.& Mark B [8]. verified that heat supply for consumer or district heat pumps cost higher on heat rather than electricity. They also analyzed the investment trade-offs in various infrastructure composition and found the way of lowering the system capacity by making comparison.

In the development of zero emission, many articles pointed out the advantages and drawbacks of different natural resources. Valeca M. Valeca S.& Giosanu D. [9] suggested that nuclear energy in Romanian experience was a solution to address the problem of global warming by neuron irradiation. Others came to diverse opinions, although renewable energy has successfully made neutralization on carbon, the CO2 itself bring a negative impact on the renewable energy in most of our countries was certified by Xi Y. Chi-Wei S. Muhammed U. Xuefeng S. Oana-Ramona L.[10] In the future, one of the hypothetical research projects [11] assumed that if customer pressure, regulatory control and managerial environmental awareness were all benignly developed, it was possible to reduce the gas emission by 2030 and achieve net zero emission in 2050.

To summarized, the perspectives on zero emission are in different aspects. Compared with both articles from Tuantuan X. Cheng X. Yuhao L.& Yongping Y and Cassarino G. T.& Mark B [6], for investors, only if we understand how the price of natural resources determined by the interactions between consumers, workers and firms in the market, it can be just better for government to intervene and plan the future goal of achieving zero emission. Natural resources can not only aid with each other in order to accomplish the objective of reducing pollutants, but also may interact negatively problems which weaken the economic growth. Its efficacy notwithstanding, the assumption from Hashim Z. Ying W.& Rashid S. M. [12] can strongly be supported.

By summarizing all these studies presented above, zero carbon emission has altered people's life technically and financially, out investigation will conclude the factors and causal relationships that how U.S GDP affects the amount of carbon emission in the three sectors by analyzing its cyclical component, standard deviation and correlation.

2.Literature Review

In order to find out the causal relationship between U.S GDP and the amount of carbon emission in the three aspects, including residential consumption, commercial use and transportation purpose, the methodology used in this article is the method of detrending. I collect some data about the U.S real gross domestic product in billions of chained dollars per year on the website of Bureau of economic Analysis. Furthermore, I also found some figures of carbon dioxide emission in million metric tons in residential petroleum, commercial coal and transport aviation, searching from the Federal Reserve Economic Data. Speaking of how I make data processing, first and foremost, I use the adding trendline function in Excel to find a best-fit line of demonstrating the trend of U.S GDP annually from 1980 to 2020, as well as the carbon emission in the three sectors I mentioned before annually over the 20-year period. During this process, I find that the trend of annual U.S GDP in the 20-year presents by a straight-line equation, and the annual carbon emission in residential petroleum and transport aviation are followed by an exponential equation. However, it is hard to use the trendline in Excel to fit the trend of commercial coal carbon emission. Thus, I use the HP Filter to seek for the best-fit line of this element trend so that making best-fit figures not only looks smoothly, but also are close to the true value. Secondly, in order to find out the casual relationship between U.S GDP and carbon emission amount, I calculate the difference between the trend value and the true value, and use the difference divide the trend value to find the cyclical component. After calculating the cyclical components, I connect the U.S GDP cyclical component and carbon emission cyclical component respectively. The graphs illustrate different categories of relationship. Figure 1 shows co-movement of U.S. GDP and petrol residential carbon emission cyclical

components from 1980 to 2020 and figure 2 demonstrates co-movement of U.S. GDP and coal commercial carbon cyclical components from 1980 to 2020, whereas figure 3 shows co-movement of U.S. GDP and aviation gasoline carbon cyclical components from 1980 to 2020. In general, it can be clearly seen that the cyclical of the amount of carbon emission in the three sectors fluctuate dramatically through the 40-year period, so it supposes that the amount of carbon emission in the U.S. changes with the economic fluctuations. In 2009, the United Nations Climate Change conference came up, the amount of carbon emission in air transport and commerce were at a lower rate (figure 3), compared with the higher amount of domestic carbon emission at that time (figure 1). Surprisingly, as the Paris Agreement was passed in 2015, it is apparent that the total percentage of carbon emission reached the bottom. However, since the U.S. quit from the Paris Agreement in 2019 and the impact of the following COVID-19 in 2020, the carbon emission in air transportation has dropped consistently (figure 3). Many private airlines companies go bankrupt because of the declining consumption in airline industry, global pandemic forced people work domestically and reduced times of traveling. Then we calculate the standard deviation of each element and the correlation values between the GDP and the carbon emissions.

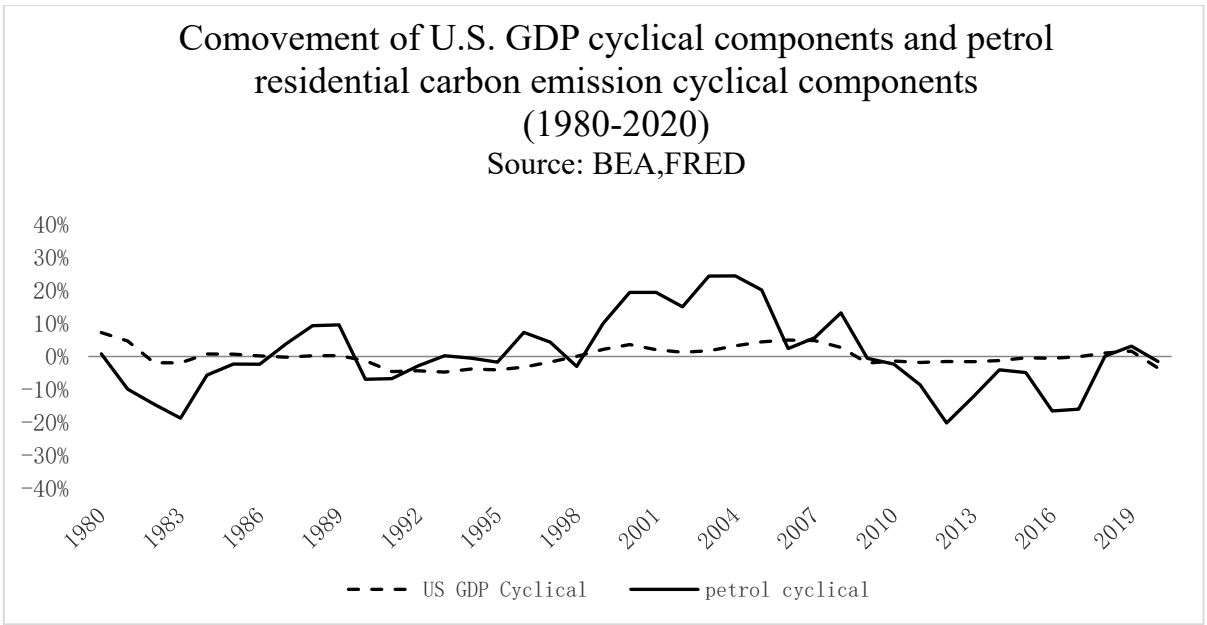

Figure 1 Co-movement of U.S. GDP and petrol residential carbon emission Cyclical Components (1980-2020)

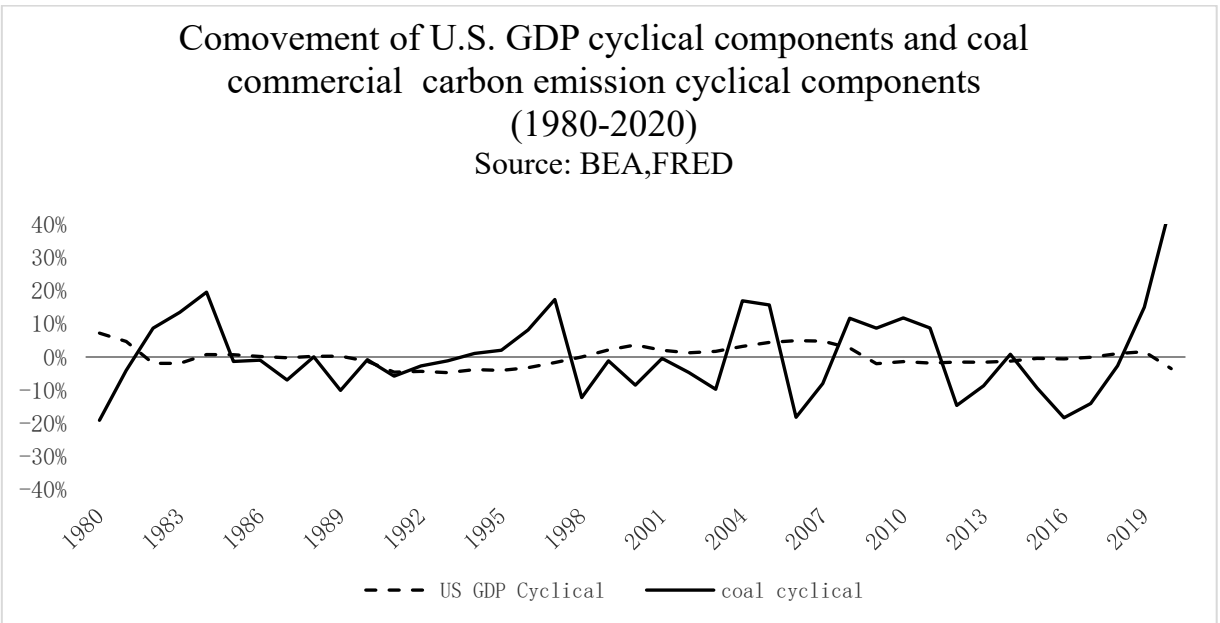

Figure 2 Co-movement of U.S. GDP and coal commercial carbon Cyclical Components (1980-2020)

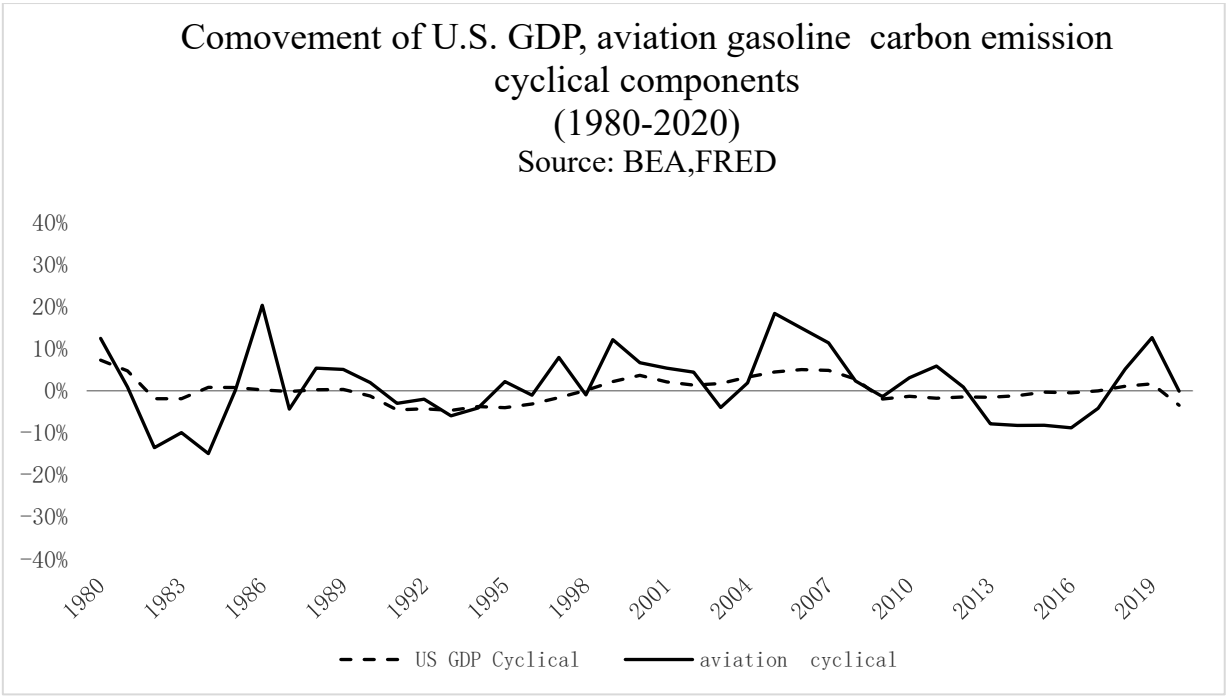

Figure 3 Co-movement of U.S. GDP and aviation gasoline carbon Cyclical Components (1980-2020)

Compared with the three graphs, the standard deviation of U.S GDP is almost 0.03, carbon emission in residential petroleum (0.11), transport aviation (0.08) and commercial coal (0.12). Therefore, we can conclude that the fluctuation of carbon emission in aviation transportation cyclical component from 1980 to 2020 is twice as high as the cyclical component of U.S GDP. Similarly, the cyclical component of carbon emission in residential petroleum and commercial coal consumption witnessed almost the same fluctuation, both with figures of around 0.11 standard deviation. Then I compare the correlation relationship, correlation describes the nature of the linear relationship between the cyclical of the U.S. GDP and the cyclical of the petrol residential carbon emission. By calculation, the correlation between the U.S. GDP cyclical and the cyclical carbon emission in domestic petroleum use is 0.44, which indicates these two variables has a weak degree of positive correlation. Thus, the U.S. GDP does not completely affect the amount of petrol residential carbon emission. The reason behind this is simply because the domestic petrol use has turned into a necessity for large numbers of people in America. So, the percentage change of carbon emission in household may not promote the U.S economic growth. Similarly, the correlation of carbon emission in aviation transport cyclical and U.S. GDP cyclical is 0.53, which gives the same conclusion of that in household carbon emission. The aviation industry was not prospect in the last 40 years, especially after the Tech bubble burst in 2000 and the financial crisis in 2008, the aviation industry was still in the downturn, while the global pandemic in 2020 made many private airline companies doubly affected. As a result, aviation service industry may not contribute to the aggregate demand due to the less consumption and investment. By comparison, the correlation between U.S GDP cyclical and the coal commercial cyclical is -0.26 and it is close to zero, so it means that there is a fewer degree of negative correlation between these two variables. The amount of carbon emission will increase as the U.S GDP decreases. It explains that high efficiency of new energy use and the accomplishment of clean fuel has almost replaced the use of coal. From the design of the air conditioning made by Willis Carrier, most wealthy people in America consumed more of the electricity than coal. Another factor may cause by the high cost of transportation of coal but lower cost of transporting oil and natural gas. The decrease in the price and cost of these substitutes causes the quantity demanded of coal decreases. To shed the light on the standard deviation results, the cyclical of petrol residential carbon emission is 0.11, that on coal commerce is 0.13 and aviation has 0.08 standard deviation, so we can conclude that the aviation industry was in a depression these years, and this has confirmed what has mentioned above.

Based on the results that given before, the results suggest that the carbon consumption has a close connection bond with the U.S GDP, while the gross domestic production in America. Gross domestic product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period. GDP can be calculated using expenditures, production and incomes, and it is an important tool to guide policy makers, investors and strategic businesses decision-making. Thus, the background factors of the why carbon emission changed U.S GDP changed will be probably based on the three factors. This makes me give my argument that income elasticity determines the amount of carbon emission.

Income elasticity of demand (YED) is the sensitivity of the quantity demanded for the coal, petrol and the gasoline to a change in the real income of consumers who buy these goods. We use the ratio of percentage change in both quantities demanded of the good and real income to measure. Focusing on the carbon emission in residential petroleum in developed country, if YED >1 which is elastic, which means the demand of domestic petrol in the U.S increases when disposable income increases in the public. As income rises, the proportion of total consumer expenditure on necessities drop, consumers switch to more type of luxuries. For American people, they tend to increase their consumption on choosing high quality of staffs, which sharply rises the carbon emission. During the economic boom, industry business such as aviation, oil companies start to increase the production and rising the price due to the high national income, maybe firms tend to supply more by encouraging travelling and making preferential policies to boost high-income families, carbon emission grow as the high consumption of cars, aviation. In the opposite, when YED<1, which means income of demand is inelastic, American people switch to inferior goods such as cup noodles and cheap bread. Consequently, the purchasing on domestic oil in cars, travelling abroad and business may drop, the responsiveness of people slows down. In this case, whether the correlation relationship between U.S. GDP and carbon emission is not meaningful, GDP tends to be no impact on the amount of carbon emission.

3.Conclusion

In conclusion, the results demonstrate the positive correlation between the cyclical of the U.S GDP and that on petrol residential and aviation transport carbon emission with a small fluctuation on aviation purpose, but a negative correlation on coal. It is apparent that there is a strong related influence between the U.S GDP and the carbon emission in household, transportation and commerce, but to explain how large extent the GDP affects the carbon emission, it mostly determines on the income elasticity of the public. Therefore, in order to achieve the goal of zero emission in 2030, although policies may sometimes seem meaningless, a sensible and effective policy place an important role. However, if government does not intervene in time, market failure and cutthroat competition may appear, and breakthroughs of meteorological economy does not exist. All federal governments, state governments and local governments should consider how to use fiscal policy and monetary policy to control carbon emission in the following years. In the future, how to help business properly use income elasticity to control carbon emission while increasing revenue, it needs to be studied more.

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