IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Role of Macroeconomic Factors In Increasing Carbon Emissions In G20 Countries

Shreya Hissaria (2024)

Abstract

This study examines the role of macroeconomic factors in influencing carbon emissions within G20 countries from 2000 to 2020. Given the critical importance of Sustainable Development Goal 13, which aims to combat climate change, understanding the economic dynamics behind carbon emissions is essential. This paper investigates how fiscal and monetary policies, alongside other macroeconomic determinants such as GDP per capita, real interest rates, foreign direct investment (FDI), and domestic credit to the public sector, impact CO2 emissions. Utilizing a comprehensive dataset from the World Bank, the study conducts statistical analyses to identify patterns and correlations. The study shows that economic growth generally leads to increased carbon emissions. However, a significant negative correlation was found between domestic credit to the public sector and carbon emissions. The findings highlight the significant influence of economic activities on environmental outcomes and emphasize the need for targeted policies to achieve carbon neutrality and sustainable development goals.

Introduction

The Sustainable Development Goals, also known as the Global Goals, are a blueprint for a better future adopted by all United Nations member states in 2015. These 17 interconnected goals serve as a universal call to action for countries, businesses, and individuals to work together to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030.One of the most important goal is goal number 13 which is to "*Take urgent action to combat climate change and its impacts*"[1]. Many of the researchers have written papers and talked about climate change and how it is affecting our environment.

Global carbon dioxide (CO_2) emissions from energy combustion and industrial processes grew 0.9% or 321 Mt in 2022 to a new all-time high of 36.8 Gt (IEA 2022). This shows how much the CO_2 emissions are increasing day by day. This increasing change in the climate due to CO_2 emissions leads to desertification, droughts, and water stress; changing patterns of precipitation and temperature, including making some regions uninhabitable (Pal and Eltahir, 2016); Collapse of forests and biodiversity; extreme weather events, such as more intense storms; storm surges from the ocean; rising global sea levels. Because

[1] SDG Goal 13. Link : https://sdgs.un.org/goals/goal13 (Last accessed on 27th March 2024)

of global warming and climate change, an increasing number of studies contend that the frequency and intensity of extreme weather events are rising (Diffenbaugh et al., 2017; Francis & Vavrus, 2012; Rahmstorf & Coumou, 2011). The increasing CO_2 leads to major changes in the environment such as rise in the sea level which leads to flooding of the coastal areas which impacts the livelihood of people residing in the area (Cherian, 2024).

G20 countries contribute to 80 percent of the Greenhouse gas emissions globally[2], In 2023, a meeting was held for G20 countries in India, where they finally committed to achieve net zero and tripling renewable energy capacity globally by 2030. However, in order to achieve these objective, role of both fiscal and monetary policy in all the G20 countries becomes crucial.

Literature review

Chan (2020) compares the effectiveness of environmental policies in reducing carbon emissions to macroeconomic policies. It introduces an environmental dynamic general equilibrium model to analyze the impacts of carbon taxation, fiscal, and monetary policies. It also explores the relationship between government expenditure and CO_2 emissions, suggesting a negative correlation in the long run. It discusses the implications of carbon-dependent fiscal and monetary policies on social welfare and environmental outcomes.

Diluiso (2021) writes about the impact of climate policy on macro-financial stability and central bank mandates. It shows two climate policy scenarios which are compared. Results show that a gradual carbon price increase is not disruptive, while sudden implementation can have negative effects. A gradual climate policy was recommended to minimize disruptions and maintain price stability.

Gregory (2021) pointed out the relationship between carbon dioxide levels, economic damages, and asset prices. Conditions which determine nominal gross returns on bonds, negative long-run relationship between CO2 levels and the price-dividend ratio. Climatic disasters impact risk-free rates, risk premiums, and asset prices.

Mongelli (2022) states that Central banks are being called upon to support a transition to a low-carbon economy saying that they should consider protective actions, awareness raising, and designing monetary operations with green features as Climate change poses risks to price and financial stability, affecting monetary policy transmission. Incorporating climate change into economic modeling and policy assessment frameworks is crucial. Proactive measures can be controversial but effective in reallocating financial flows towards sustainable investments.

Bonevea (2021) mentions that Central banks face challenges in addressing climate risks, affecting monetary policy and financial stability as Uncertainty exists regarding the effects of climate change on inflation and monetary policy conduct. They need to adapt their analytical tools and frameworks to address

[2] Charting a Climate-Resilient Future: The New Delhi Summit's Commitments and Global Unity (2023).Link : http://www.g20.utoronto.ca/analysis/231024-bie.html (Last accessed on 27th March 2024)

climate-related risks. Greening financial markets and promoting climate risk disclosure are key actions for central banks.

Kunawotor (2020) suggested that monetary policy and central banks can help mitigate the impacts of climate change. Extreme weather events due to climate change affect inflation and monetary policy in Africa. It was even classified based on criteria like deaths, affected people, and damage. These events have a significant impact on inflation and agricultural production which can lead to price hikes and supply shocks, affecting macroeconomic policy.

Nelson (2023) talk's Sectoral data for CO2 emissions was unavailable, but greenhouse gas emissions were converted to carbon dioxide equivalent, how monetary policy index was constructed using bank discount rate, Treasury bill rate, and reserve requirement ratio. He also mentions Fiscal policy to impact CO2 emissions in the long run, while monetary policy had short and long-term effects. He suggests the need for green policies to balance economic growth and environmental concerns.

Galanis (2016) discusses the effects of climate change on financial stability and global warming implications, how Climate change damages can lead to higher default rates and decline in corporate bond prices, Energy and material scarcity can dampen investment. It affects liquidity preference, leading to a decline in conventional bond prices.

Research Question

In this paper we will focus on two main questions

Q1. What are the macroeconomic factors which can help in reducing the effect of climate change?

Q2. Have the fiscal and monetary policies of the G20 countries helped in reducing carbon emissions significantly?

Data and methodology

We will address this research question based on the secondary data provided by the World Bank. This study will utilize a comprehensive dataset of various macroeconomic indicators of G20 countries. The time used for this study will be from 2000 to 2020.

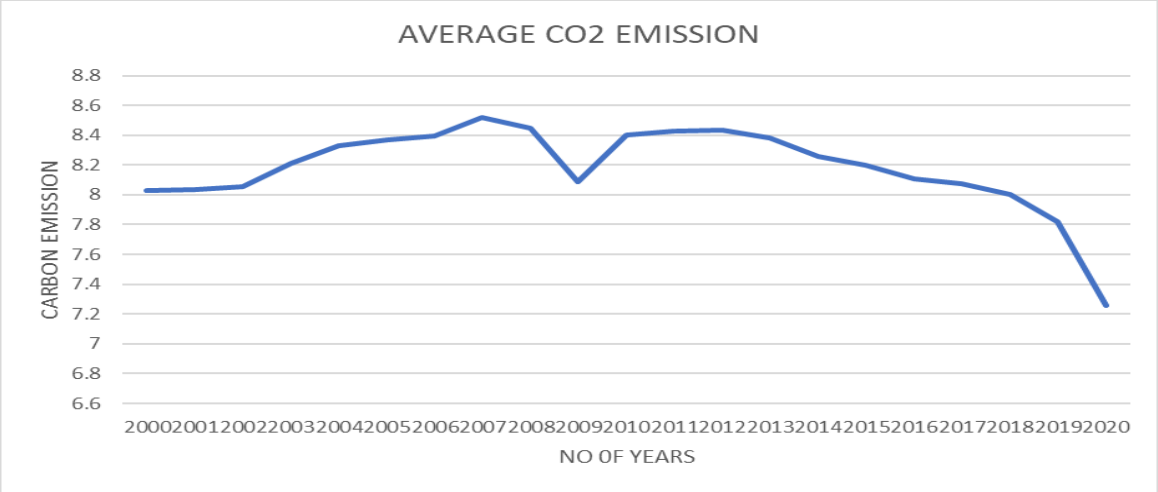
The World Bank has panel data of this G20 countries for this time period. The variables which will be used for this study are per capita Carbon emissions, interest rate (%); Domestic credit to the private sector; Real GDP Growth rate (%); Real GDP per capita, Foreign direct investment, net inflows (exports -imports); Share of agriculture, value added Energy Consumption energy ; inflation rate ; literacy rate, population, percentage of forest cover area .

This dataset will help us with statistical analyses and draw meaningful conclusions towards roles of fiscal and monetary policies and other macroeconomic factors impacting climate change and whether these factors had helped in reducing carbon emissions.

EMPIRICAL FINDINGS

The analysis of carbon emissions in relation to various macroeconomic factors among G20 countries reveals complex interactions between economic growth and environmental sustainability. Using the World Bank data from 2000-2020 of the G20 countries, this study shows how different macroeconomic factors contribute to carbon emissions both positively and negatively. Figure 1 shows the average carbon emissions consumption of G20 countries.

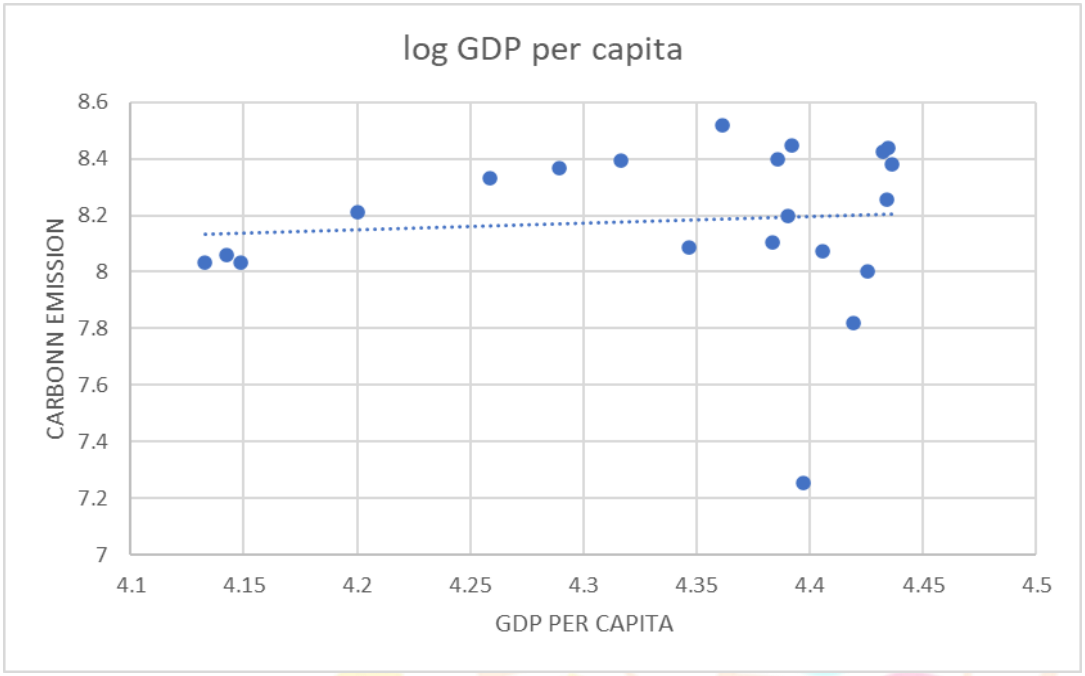
FIGURE 1 AVERAGE CARBON EMISSION FROM 2000 - 2020



These leading economies collectively generate 80% of greenhouse gas emissions. In 2000, the average carbon dioxide (CO2) emissions was at 8.031 metric tons per person. These emissions were consistently rising alongside the economic growth of these nations, as measured by their Gross Domestic Product (GDP). Nevertheless, as depicted in this figure, there was a significant decline in carbon emissions in the year 2009. This can be attributed to the aftermath of the 2008 financial crisis, during which the global economy experienced a decline in industrial operations, resulting in a decrease in energy consumption. Starting from 2009, while the global economy was rebounding from the recession, there was a significant surge in carbon emissions. Since 2013, there has been a growing awareness of the escalating carbon emissions and their impact on both our environment and our daily lives (Galanis 2016).These top 20 economically stable countries have been actively working to reduce their carbon emissions since 2013. In 2020, there was a considerable decrease in CO2 emissions, primarily attributed to the global impact of the COVID-19 pandemic.A multitude of nations witnessed a substantial decline in carbon emissions as a direct result of implementing lockdown measures, imposing travel restrictions, and curtailing economic activity. This could lead to a noticeable reduction in emissions.These countries have a significant role in the regulation of carbon emissions.During the 2023 conference, the G20 nations deliberated on their objective of achieving net zero emissions by 2025. In fact a trend analysis from major six countries shows that there has been not much change in the rate of fall in per capita emissions as shown and explained in details in APPENDIX A1

THE EFFECT OF CARBON EMISSION IN RELATION TO GDP PER CAPITA

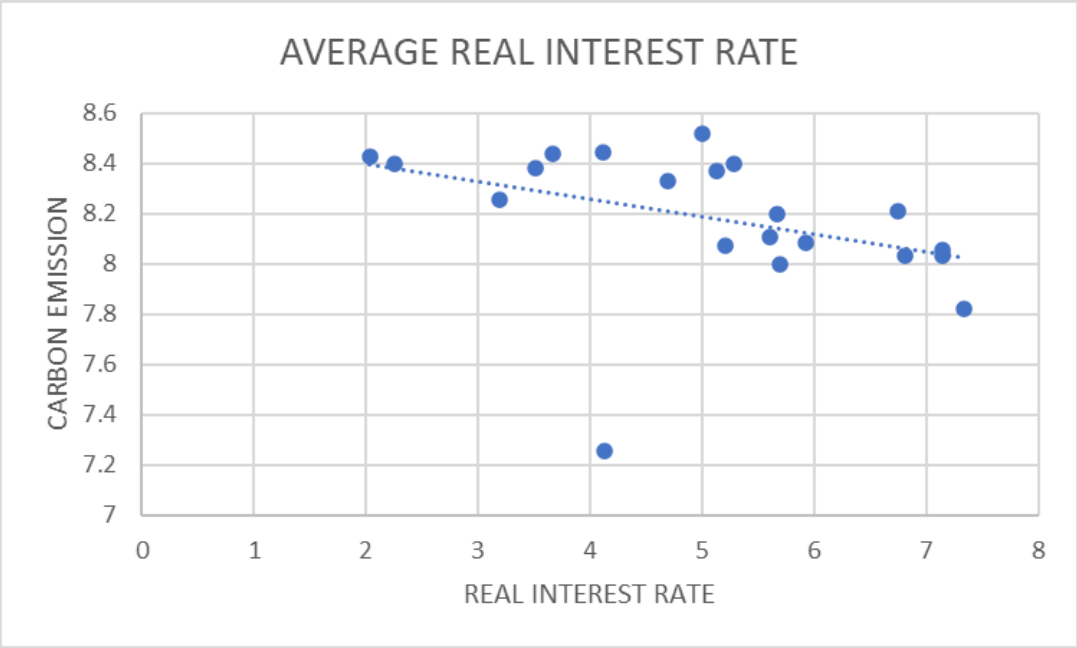
Figure 2 : average co2 emission compared to GDP per capita



In **figure 2** we observe that in the early 21 century there was robust global economic growth . This period was marked by rapid industrialization, urbanization, and increased consumer demand, all of which drove up energy consumption. As the economic activities increased the use of carbon emission also increased . The growth in gross national produce (GDP) leads to an increase in carbon emission . In 2000 the USA contributed maximum to carbon emission with 2.8 tons co2 per capita [3].USA alone is responsible for 25% of the historical emission which is twice more than China (Hannah Ritchie 2019):whereas in 2020 China remained the highest contributor to the carbon emission despite covid 19.The year 2007 was the highest contributor to co2 emission in comparison to GDP per capita as there was rapid industrialization in many parts of the world which led to an increase in both GDP and carbon emission. In 2020 we can see clearly how COVID-19 adversely affected the whole world due to strict lockdown measures. The whole world was shut down which led to significant decline in economic activity including the major G20 countries as shown in figure 2. This can also be attributed to a decline in carbon emissions as well during this period.

[3] CO2 total emissions per capita by region, 2000-2023 link :https://www.iea.org/data-and-statistics/charts/co2-total-emissions-per-capita-by-region-2000-2023(last accessed on 18 july 2024)

Figure 3 : Average carbon emission compared to average real interest rate



In **figure 3** we can observe that the real interest rate has a negative effect on CO2 emission.It can be well inferred that for G20 countries on average an increase in real interest rate is associated with a decline in carbon emissions. In the year 2000, the average rate of interest was 6.80 per cent and the average carbon emission was 8.031 metric ton per capita in these G20 countries. The carbon footprints were very high but the governments in these countries started to understand that carbon emission needs to go down as these carbon emissions were affecting our climate. Countries should adopt the stability of the real interest rates channel to reduce CO2 emissions and '*encourage the renewable energy investment through the production of electricity using renewable sources*'(Isiksal, Samour and Resatoglu 2019). Real interest rate helps in the control of the carbon emissions as when the interest rises the more money is invested in banks as they will receive interest through that. In contrast, when the interest rate decreases the individuals prefer to invest their money in the company which leads to more production in a company and more pollution undoubtedly.

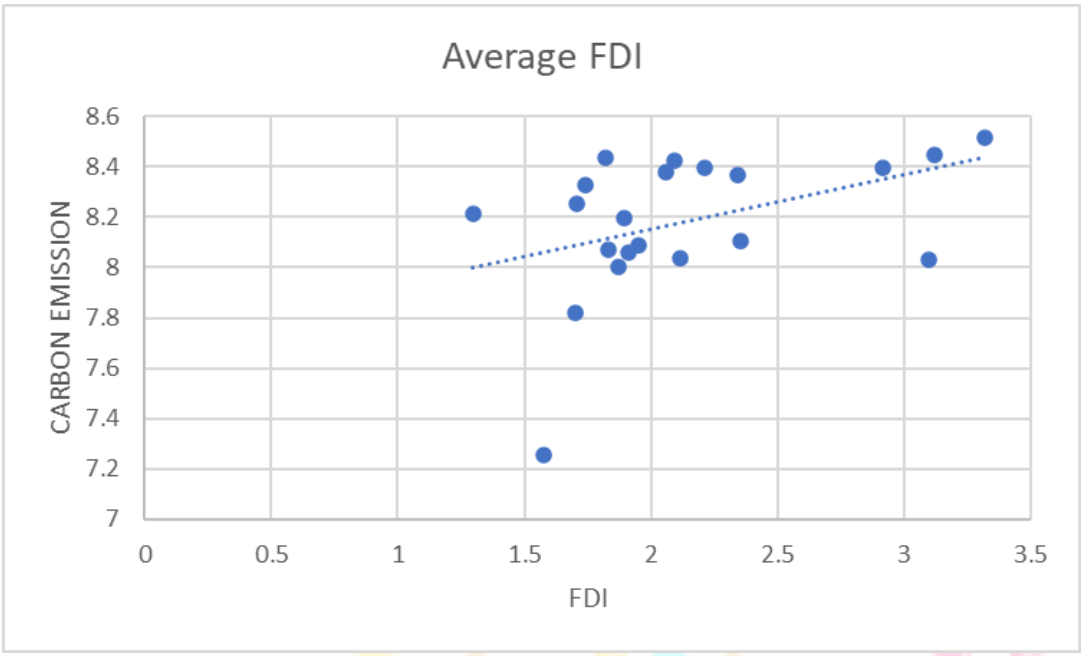


Figure 4: Average carbon emission compared to average FDI

Figure 4 clearly demonstrates that as the foreign direct investments increased the level of carbon emissions also increased.The level of co2 emission in 2000 was 8.03 metric tons per capita in relation to FDI.The figure of foreign direct investment clearly states that these investments are not nature friendly. Even papers suggest that they found out FDI was one of the key terminals in vietnam . They suggest that these countries need to use of cleaner energy (Tang and Tan, 2024). The governments of these states need to take strict hard action against these FDI investments. They need to decrease the rate of carbon emissions and implement environment-friendly FDI investments to reduce carbon dioxide emissions(Muhammad and Khan, 2021). We can only see the growth of co2 emission in relation to FDI. The lowest was recorded in 2020 which was 7.254 metric tons per capita. This demonstrates that FDI investments have been producing a lot of carbon footprint which needs to be cut down.

THE EFFECT OF CARBON EMISSION IN RELATION TO DOMESTIC CREDIT TO PUBLIC SECTOR

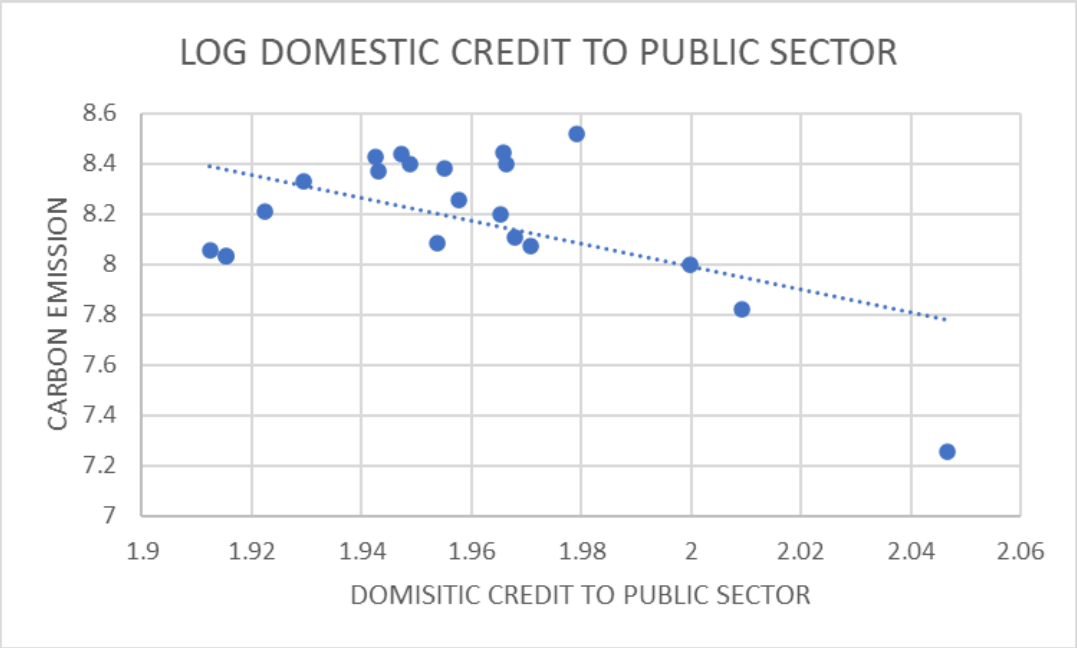


Figure 5: Average carbon emission compared to average domestic credit to public sector

In early 2000 we can see that the domestic credit given to the public sector is associated with a fall in carbon emissions. In the year 2000, the average carbon emission was 8.03 metric tons per capita. As the developments emerged in these economics the governments started to realize how important it is to have co2 emission under control.The government of each country started to take in their notice and started to take action towards it such as green environment investments. Also, the awareness of climate change led to a decrease in the average carbon footprints. The government of each state started promoting and providing funds to their public sector which take an active part in the reduction of carbon dioxide. In fact the average government expenditure of major six countries from the G20 countries is negatively associated with average per capita CO2 emissions as shown in APPENDIX A2

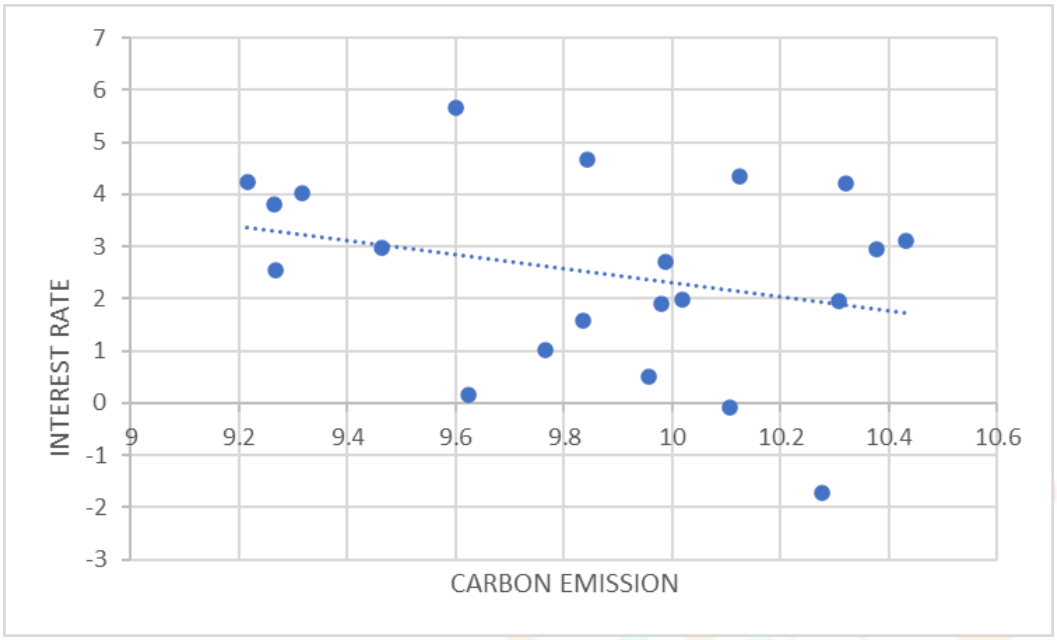


FIGURE 6 : Average carbon emission compared with real interest rate

From the above graph (figure 6) we can see that the rate of real interest has definitely affected G20 countries.In the year 2000 the rate of interest was 2.53 per cent and carbon emissions were 9.26 metric tons per capita. We can see the rate of interest in 2010 as the world was starting to recover from recession. The rate of interest was -0.07 along with carbon emission was 10.10 metric tons per capita which has increased a lot.while in 2020 the interest rate was 4.01and carbon emission were 9.31 which seemed to decrease.

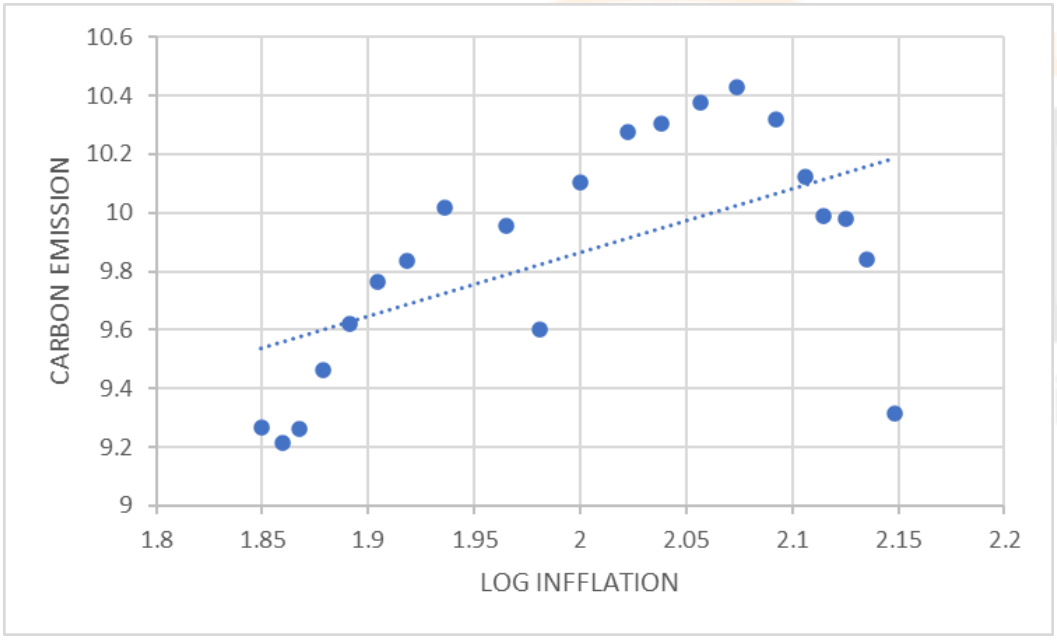


FIGURE 7 : average carbon emission compared with log inflation .

In figure 7 we can observe that the increase in the inflation in these six countries lead to an increase in carbon emission. Which means that these countries need to decrease the inflation rates as the "*high inflation is generally considered harmful for economic growth"(Grolleau and Weber 2024).*when there is high change in rate of inflation the

purchasing power of the consumer decrease which leads to higher production of the stock as the company will be able to produce more which will lead to increase in the carbon emission.we can see that the carbon emission are decreasing but the inflation rates are increasing which is leading to increase in the carbon dioxide.

Table 1. Correlation between CO2 emissions and macroeconomic determinants

	per capita co2 emission
GDP	0.082703
FDI	0.418395
DOMESTIC CREDIT TO PUBLIC SECTOR	-0.52416
INFLATION	-0.37711
REAL INTEREST RATE	-0.38302

The above table shows that Foreign Direct Investment (FDI) is highly positively associated with per capita carbon emissions. This shows that the amount of FDI which is coming in these G20 countries contributes more to carbon emissions. Therefore, governments in these G20 countries should consider the environmental factors while allowing FDI in their respective countries. On the other hand, apart from monetary policy instruments like interest rate, it is the domestic credit given to the public sector is negatively correlated with per capita carbon emissions. This shows that the investments done in the public sector are not associated with increasing carbon emissions. G20 governments should prioritize the public sector to flourish more as it is considering the environmental factor while making its investment decsions.

Conclusion

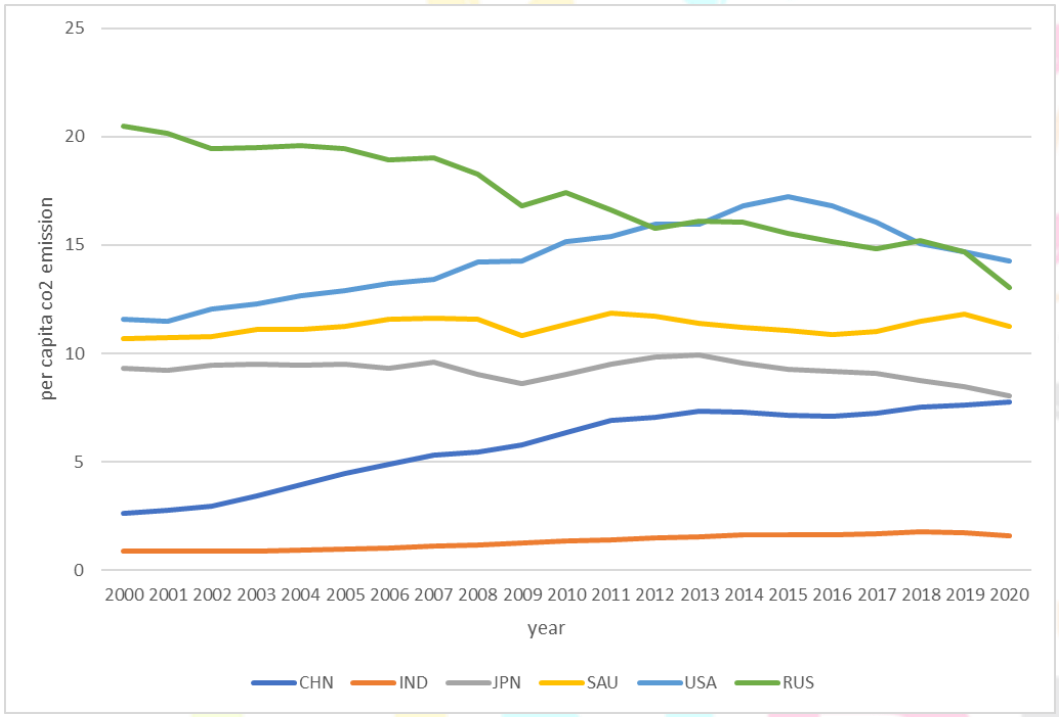
The macroeconomic factors which were increasing carbon emissions in G20 countries were ;when log GDP capita was compared with co2 emission we can see it has shown negative effects as the GDP is increasing there has been increase in the carbon emission for these G20 countries. When carbon emission was compared with the real interest there has been a positive impact in the declaration of the carbon emission which proves to be one of the good measures whereas when foreign direct investment was compared there has been an increase in the global emission which proves that these foreign investment are not good for the countries as it is constantly and rapidly increasing in the terms of average carbon dioxide.When domestic credit to public sector was compared along with government expenditure we can see that there was a swift decrease in the carbon emission which has been help to the countries.it proves that government of these G20 countries are taking major steps to decrease the carbon emission

When the six countries form the G20 countries are taken out for the detailed information we can witness that all the countries other than china are taking measures in decreasing co2 emission.When the average carbon emission was compared with the real interest rate we can observe that it has swiftly brought down the carbon emission

And when compared with inflation there has been a rapid rise in the carbon emission for these six countries which are China , India , Japan ,USA and Russia. From this we can come to the conclusion that yes some macroeconomics factors have helped in the reduction of theco2 emission such as real interest rate and domestic credit to the public sector.they have helped in the reduction of co2 emission which will help with climate change.

Appendix

A1. Per capita Carbon emission by six major G20 countries

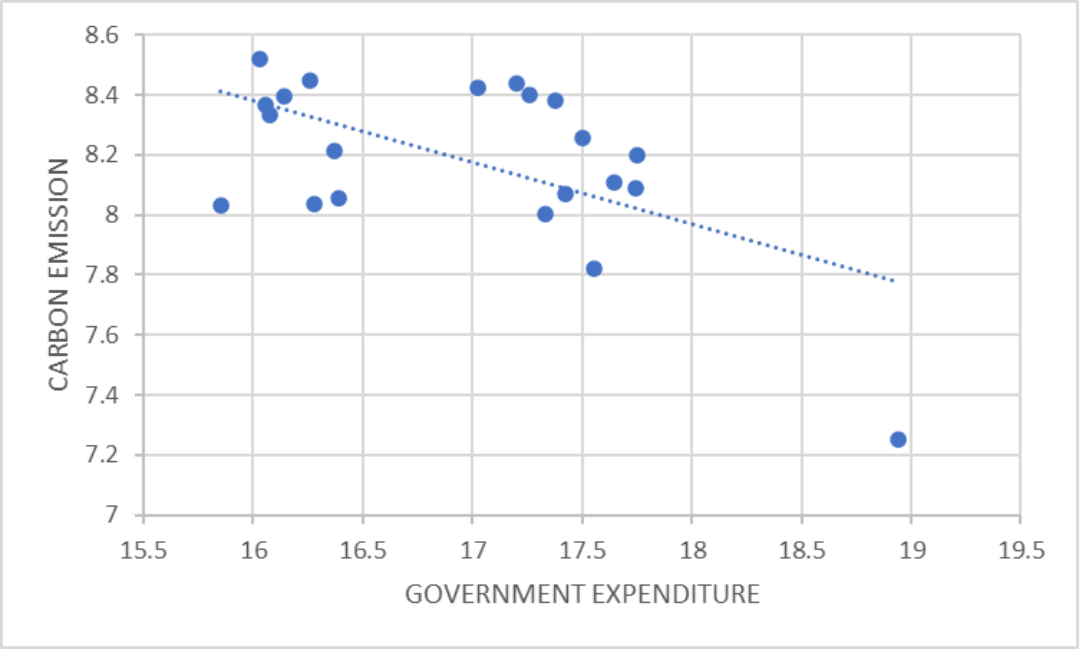


Per capita Carbon emission from 2000 to 2020 by major six countries

In the early twentieth century we can see the economies are emerging economies . We can witness that russia had produces that maximum co2 emission per capita in 2000.Russia has made up 10% of the world's population, industrialized nations which has contributed 39% in overall carbon emissions since 1850[4] . But we can see Russia has taken effective measures to bring down these carbon emissions and is still decreasing whereas the USA which has contributed to 26% of the world's global emission. we can notice that the carbon emission produced by the US is increasing again which means the government has not taken any effective measures to decrease these ring the early twentieth century we can observe that all the six are developing carbon footprint. Saudi Arabia, which is an oil producing country, has carbon emission . When comparing China with India we can denote that India benging the largest country with population has the least carbon production in the past two decades which has been relatively low. It seems like China is not taking an effective method to reduce these carbon emissions. Both India and China are developing economies where huge companies invest for producing purposes. Still India is very less in the production.whereas Japan has been trying to cut down their carbon emission which has been constant and has bening decreasing .

[4] Russia Named World's 3rd-Highest Carbon Emitter in History Linkhttps://www.themoscowtimes.com/2021/10/05/russia-named-worlds-3rd-highest-carbon-emitter-in-history-a75213 (last accessed on 26 june 2024)

A2. THE EFFECT OF CARBON EMISSION IN RELATION TO GOVERNMENT EXPENDITURE



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