Quantifying the Carbon Footprint: An Analysis of CO_2 Emissions across Domestic Demand

1. Introduction

Global warming is mostly caused by carbon dioxide (CO_2) emissions, making climate change one of the most important challenges of our day. It is essential to comprehend the origins and trends of these emissions in order to create efficient mitigation plans. The purpose of this data engineering project is to look into how domestic demand affects CO2 emissions in different nations. Working with this project and by examining historical records, applying data analysis methods, I seek to answer to the question, How do domestic consumption patterns and final demand across different countries contribute to the overall carbon footprint, and which sectors or industries drive the highest levels of embodied CO_2 emissions?

2. Used Data

This project contains two open datasets from the International Monetary Fund (IMF) repository. These datasets provide crucial information for our research and are free to use for study purposes, subject to the IMF terms of use. The following datasets I have chosen for this project,

Structure and Meaning of the Data:

Dataset 1	Dataset 2
CO2 Emissions Embodied in Trade	Explicit Fossil Fuel Subsidies
Country: The name of the country (e.g., Argentina)	Country: The name of the country (e.g., Argentina)
ISO2: The 2-letter ISO country code (e.g., AR for Argentina)	ISO2: The 2-letter ISO country code (e.g., AR for Argentina)
ISO3: The 3-letter ISO country code (e.g., ARG for Argentina)	ISO3: The 3-letter ISO country code (e.g., ARG for Argentina)
Indicator: The specific metric or data being measured (e.g., CO2 Emissions Embodied in Trade)	Indicator: The specific metric or data being measured (e.g., Explicit Fossil Fuel Subsidies)
Unit: The unit of measurement (e.g., metric tons).	CTS Name: A descriptive name for the category (e.g., Explicit; Coal).
Source: The source of the data	Source: The source of the data
CTS Code: A unique code for categorizing the data (e.g., ECBTDB)	CTS Code: A unique code for categorizing the data (e.g., ECGFTEC).
F2015_C: The 2015 data for CO2 emissions or subsidies (e.g., -15.944 for Argentina)	F2015_F: The 2015 fossil fuel data (e.g., 3.47844577773985 for Argentina)

Table 1: Datasets Meaning

Dataset 1: focuses on Amount of CO_2 emissions from fuel combustion embodied in domestic final demand, production, and trade.

Country	ISO2	ISO3	Indicator	Source	CTS Code	CTS Name
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTEC	Explicit; Coal
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTEC	Explicit; Coal
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTET	Explicit; Electricity
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTET	Explicit; Electricity
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTEN	Explicit; Natural Gas
Argentina	AR	ARG	Explicit Fossil Fuel Subsidies ...	Parry, Ian; Black, Simon; Vern...	ECGFTEN	Explicit; Natural Gas

Figure 1: Dataset 1

Country	ISO2	ISO3	Indicator	Unit	Source	CTS Code
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTDB
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTDD
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTTX
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTT
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTT
Argentina	AR	ARG	CO2 Emissions Embodied in ...	Millions of metric tons	OECD (2021), Trade in embo...	ECBTP

Figure 2: Dataset 2

Dataset 2: extent to which fossil fuel prices paid by consumers do not reflect the fuels' full financial and social costs, expressed as an aggregate value for each fuel and economy.

I have created data pipeline to fetch the data from the source. The pipeline was instrumental in fetching data from the source, merging it. The process included data cleaning, transformation, and validation to ensure data flow reliability.

	Country	ISO3	F2015_C	F2015_F	F2016_C	F2017_C	F2017_F	F2018_C	F2018_F
1	Argentina	ARG	-15.944	3.47844577773985	-13.312	-19.797	0.0353144850975254	-13.466	0.34631912864912
2	India	IND	132.19	0.0056485809118871	132.366	102.065	0.47333636484162	106.103	0.691667256367925
3	Japan	JPN	-125.796	0.115784760686885	-141.123	-139.049	0.316691122537984	-160.618	0.399463071316779
4	Lithuania	LTU	-5.97	0.794726697002769	-5.304	-5.521	1.27086868842957	-5.94	1.13004739146699
5	Turkey	TUR	-23.612	0.0242207787391167	-15.745	-13.741	0.271668190230375	9.286	0.540135171518346

Figure 3: Merged Dataset

This merged dataset combines creating a comprehensive view of both CO2 emissions and fossil fuel subsidies over several years for multiple countries.

3. Analysis

I analyzed the trends in the CO2 emissions trade balance between the five countries Argentina (ARG), India (IND), Turkey (TUR), Japan (JPN), and Lithuania (LTU): for the specified time, This allows for comparison of emission trends between the countries across the years.

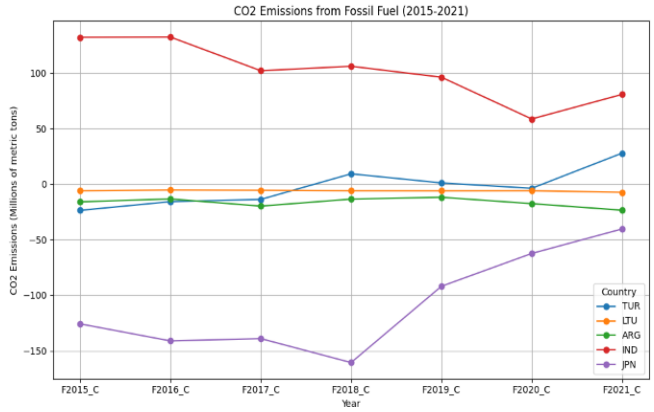

Figure 4: C02 Emissions from Fossil Fuel Line Chart

The x-axis of the graph represents the years from 2015 to 2021, labeled as F2015 through F2021. This shows the time period over which CO2 emissions are being tracked.

The y-axis represents CO2 emissions from fossil fuels measured in millions of metric tons. The scale ranges from approximately -150 to 150 million metric tons, allowing for both positive and negative emission values.

1. Argentina (ARG):

- A notable decrease occurred between 2019 (-11.8%) and 2021 (-23.5%), which could be attributed to the COVID-19 pandemic's effects on commerce and economic activities.
- Argentina's exports appear to be more carbon-intensive than its imports, possibly as a result of its resource-based and agricultural economy, as indicated by the country's continuously negative balance.

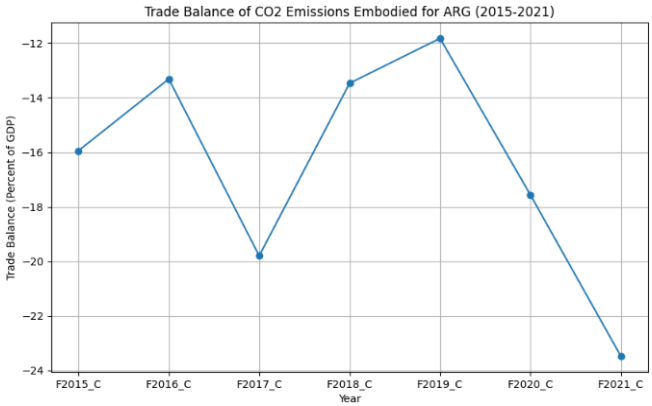

Figure 5: C02 Emissions for Argentina

2. India (IND):

- India is a notable net importer of embodied CO2 emissions, as evidenced by its highest positive values out of all the countries.
- The data indicates a significant decrease from around 132% in 2015-2016 to 59% in 2020, which may indicate a change in India's trading patterns or local production techniques.

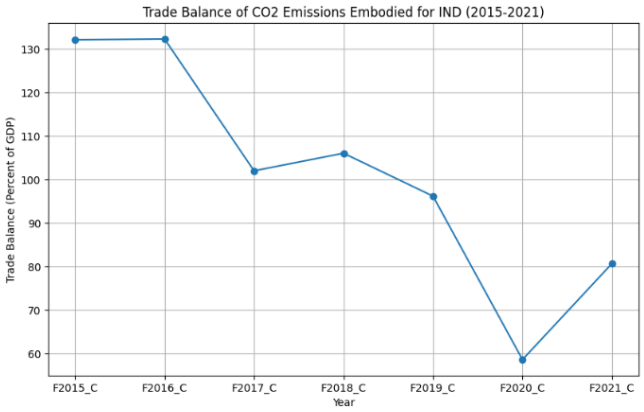

Figure 6: C02 Emissions for India

- The strong recovery in 2021 (81%) could point to a post-pandemic increase in economic activity or imports.

3. Japan (JPN):

- The country with the biggest total shift is Japan, which went from -125% in 2015 to -40% in 2021.
- Notable is the steep increase from 2018 (-160%) to 2019 (-92%), which could be the result of major policy changes or changes in the economy.

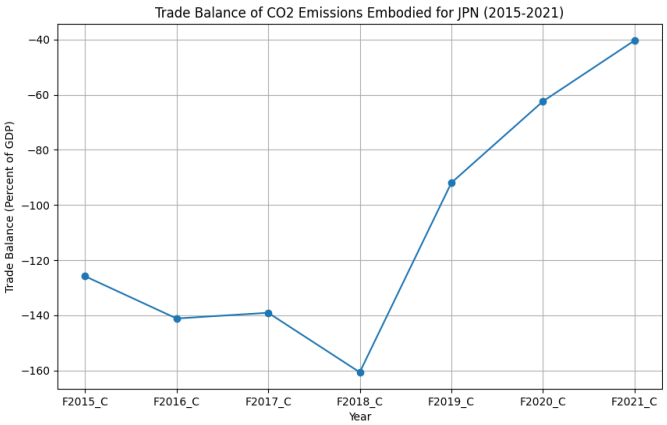

Figure 7: C02 Emissions for Japan

4. Lithuania (LTU):

- Out of all the countries, Lithuania exhibits the most consistent trend, with values averaging -6% between 2015 and 2020.
- The steep drop to -7.3% in 2021 may be attributed to modifications in domestic output or trade patterns brought on by the pandemic.

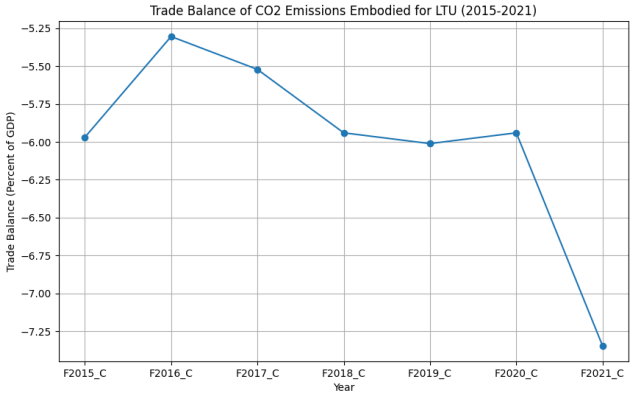

Figure 8: C02 Emissions for Lithuania

5. Turkey (TUR):

- Turkey saw a significant increase to 28% in 2021 after falling to -4% in 2020 and reaching a low of 9% in 2018.
- The transition to a notable positive balance in 2021 would point to a greater reliance on imports, whether as a result of disruptions brought on by the pandemic or adjustments in the capacity of domestic production.

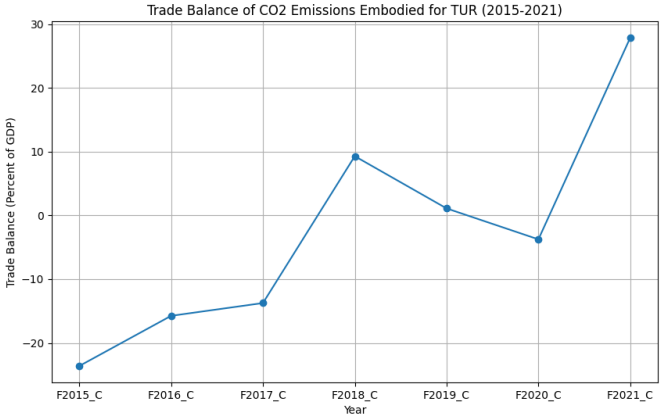

Figure 9: C02 Emissions for Turkey

4. Conclusions

Depending on the economic structure and consumer behavior of a country, domestic consumption patterns and ultimate demand have a considerable impact on its carbon footprint. Because they consume more imported commodities than developing countries, developed countries frequently have high embodied CO2 emissions, but quickly expanding economies face rising emissions from increased domestic demand. A vital role is also played by agriculture, particularly livestock husbandry, and transportation in global supply networks. These elements can be seen in the trade balances of nations like India (expanding economy, rising imports) and Japan (efficient manufacturing, high-tech exports).

There are also some drawbacks of the report like Limited statistical analysis, Lack of specific data, Limited time frame (2015-2021). In conclusion this project provides valuable insights into the relationship between domestic demand and CO_2 emissions, offering a foundation for targeted policy interventions and further research into sustainable development strategies.