Upping India's Game: Climbing Up the Value chain in a Sustainable Way

A Dissertation for

Course code and course Title: ECO 214D & Masters of Arts in Economics

Credits: 16

Submitted in partial fulfillment of Masters Degree

MA in Economics

By

VIVEKA MARISA SANTANA DE MELO E GRANJO

Seat number:22P0100052

Under the supervision of

ANKITA CHARI

Goa Business School

MA Economics

Goa University

Date: April 2024

Examined by:

Seal of the school

DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Upping Indias Game:Climbing Up the Value Chain in a Sustainable Way" is based on the results of investigations carried out by me in the MA Economics at the Goa Business School, Goa University under the Supervision/Mentorship of Ms. Ankita Chari and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation. I hereby authorize the University authorities to upload this dissertation on the dissertation repository or anywhere else as the UGC regulations demand and make it available to any one as needed.

V. de Melo

Signature and Name of Student -Viveka Marisa Santana de Melo e Granjo

Roll Number/Seat no: 22P0100052

Date: April 2024

Place: Goa University

COMPLETION CERTIFICATE

This is to certify that the dissertation report **"Upping India's Game: Climbing Up the Value Chain in a Sustainable Manner"** is a bonafide work carried out by **Ms Viveka Marisa Santana de Melo e Granjo** under my supervision/mentorship in partial fulfilment of the requirements for the award of the degree of **MA** in the Discipline Economics at the Goa Business School, Goa University.

Ankita N. Chari

Signature and Name of Supervising Teacher/ Mentor

Date: April 2024

Goa Business School ★ Goa University ★

School Stamp

Signature of Dean of the School
Date:05/05/2023
Place: Goa University

TABLE OF CONTENTS

PREFACE

This Thesis has been completed for the requirement for my master's degree in Economics for the year 2023-2024.

I learnt a lot from this thesis, learnt from my errors and explored my area of research. My area of interest has always been international trade. I decided to work on the concept of global value chains as it is an upcoming interest to researchers and scholars. My aim is to make this concept easy to understand to students who find it difficult to comprehend this concept. The study focuses on Carbon emissions and GVCs and studies the relationship between the two. It also involves evaluating the impact of India's participation in GVCs and employment in GVCs on Carbon emissions. The research paper has made use of secondary data from the OECD data source.

I hope and wish that my research will be of help to anyone looking for references in context to International trade.

ACKNOWLEDGEMENT

I would firstly like to thank the Almighty for being there and giving me the strength to complete this thesis.

I would like to thank All my teachers of Goa university for inculcating and teaching me the ethics and steps of conducting a thesis. I would like to thank my project guide Ms Ankita Chari for the time and efforts she took to enhance my research. A special thank you to sir Aditya Amonkar for all the guidance and help provided. I am extremely grateful to Ms Heena Gaude for supporting and helping in the smooth completion of my thesis. A big thank you goes to my friend Adithi Sharma for her creative suggestions and advice. A special thank you to my classmate Atharva Bapat for his help rendered, and finally a big thank you to all my family and friends for their encouragement and support.

I would like to Acknowledge that this thesis is completed by me and not by anyone else

Viveka Marisa Santana de Melo e Granjo

LIST OF TABLES

ABBREVIATIONS USED

Entity	Abbreviation
Global Value Chains	GVCs
Variance Inflation Factor	VIF
Forward linkage	FL
Backward linkage	BL
Direct employment	DE
Indirect employment	IE

ABSTRACT

The implementation of the new economic policy in the year 1991 enabled India to expand its participation in International trade and gain benefits such as efficiency in production, increased revenues and access to better technology. However, over the years there has been an increase in carbon emissions due to India's participation in trade and recently due to India's participation in GVCs. Carbon emissions are driving climate change and hence necessitating a comprehensive understanding and analyzing the relationship between India's involvement in global value chains and carbon emissions. The study aims to fill the gap by calculating industry wise correlation between carbon emissions and the indicators used to calculate a countries participation in global value chains (domestic value added to gross exports and foreign value added to gross exports), using the Pearson Correlation method to find out the top 5 industries having the highest positive correlation. Regression models are designed to know the impact of forward and backward linkages and employment in GVCs on the dependent variables. The study also calculates the total participation of the top five industries having the highest positive correlation with carbon emissions in GVCs and analyses if these industries are gaining by participating in GVCs and by how much are they benefitting. All data has been obtained from OECD tiva and TiM database. This research allows us to understand the impact of India's participation and employment in GVCs on rising carbon emissions, it is important to know which industries contribute the most towards carbon emissions and how much are these industries benefitting in order to form policies and adopt sustainable practices.

Keywords- Global Value Chains, Carbon emissions, forward linkages, backward linkages, employment in GVCs, Pearson correlation, Regression analysis, participation calculation, OECD tiva, OECD TiM

CHAPTER 1

Introduction and background of the study

1.1 Introduction

High Credits should be given to the architects of the New Economic Policy of 1991 which took the Indian economy to the next level. This policy focused on Globalization and liberalization of trade in India which gave a new direction to the Indian Market. Since the reforms, the average annual growth rate of the economy has increased to 6.5% from the pre-reform period's average of 3.5%. (Kalirajan, n.d.). Trading with other countries has helped India climb up the ladder when it comes to development, from being a primary export oriented country to exporting of services, we can definitely say that India has come a long way in trading with the world. However it is important to note that India’s participation in trade contributes towards carbon emissions which is a contributor towards climate change and is a global threat. Rising carbon emissions contributes to this hazard, leading to an increase in extreme weather events such as heatwaves, droughts, floods, and cyclones in India. These events disrupt agricultural productivity, damage infrastructure, displace communities, and pose significant risks to livelihoods.

India being one of the fastest growing economies, its interaction with the world carries significant implications, the main being carbon emissions. India has a multifaceted relationship when it comes to trading and carbon emissions. On one hand, the country's manufacturing sector, fueled by exports, has led to increased energy consumption and greenhouse gas emissions. Fossil fuels such as coal used for generating power in the industrial sector has contributed significantly to India's carbon footprint. Additionally, transportation emissions associated with the movement of goods within and outside the country further amplify the environmental impact of India's trade.

The new concept of global value chains is a trending topic of interest to many researchers and scholars. A global value chain can be simply understood as the sequence of all functional activities required in the process of value creation involving more than one country.(Banga, n.d.-a) over the years India has become well integrated into global value chains, and enjoys the comparative advantages in sectors such as information technology, pharmaceuticals and textiles. By participating in this production process, India adds value to the chain and enhances its economic interdependence with other countries. By involving ourselves in Global Value Chains, India can reap benefits, use its resources to its full potential and bring in higher economic growth. The study also takes into consideration employment in Global Value chains as an independent variable. It is believed that there exists a positive relationship between employment and carbon emissions. Higher employment means higher income which leads to higher consumption of goods that emit green house gases.

To evaluate a countries participation in global value chains we look at the linkages; forward and backward linkages. The term "forward linkages" describes the relationships between businesses engaged in downstream operations (marketing, distribution, and after-sales services) within a value chain. The flow of products, services, knowledge, and information from producers to consumers is entwined in these connections. Reaching end markets, comprehending client preferences, and developing value-added services that improve the overall customer experience all depend on forward links. Retailers collaborating with manufacturers to create new product lines, logistics firms enabling the effective delivery of goods to retailers, and service providers providing clients with after-sales care are a few instances of forward connections.

Conversely, enterprises involved in upstream operations within a value chain, such as sourcing components, intermediate goods, raw materials, and research and development, are connected through backward linkages. In order to promote innovation and technical advancement, as well

as to guarantee a steady and dependable supply of inputs required for manufacturing, backward connections are essential. In order to create new materials, technologies, and manufacturing methods, suppliers, manufacturers, and research institutes frequently work together through these connections. For instance, a company might work with suppliers to raise the standard or effectiveness of raw materials. Literature says that a country or industry is benefitting from participation in global value chains only if the share of domestic value added to gross exports is higher than foreign value added to gross exports.

The study also takes into consideration the indicators to measure employment in downstream and upstream industries and to see if these indicators have an impact on carbon emissions and how significant are they. there lies a conflict where studies say that an increase in employment also leads to an increase in Carbon emissions and some say it's the opposite. This research study aims at understanding the impact of employment in downstream and upstream industries on Carbon emissions.

The paper aims to understand the relationship between India's participation in Global value chains and carbon emissions. How much does India's participation in GVCs contribute to Carbon emissions. Which industry has the highest correlation with carbon emissions and are these industries benefitting by engaging in global value chains. For a particular country, especially a developing country, linking into GVCs could either be through forward linkages (where the country provides inputs into exports of other countries) or through backward linkages (where the country imports intermediate products to be used in its exports).(Banga, n.d.-a). Going according to this definition a country can evaluate backward linkages by looking at the sum of foreign value added to Gross exports and measure forward linkages by taking into account the sum of domestic value added to gross exports.

The study adopts the Pearson correlation method and running of regression models to achieve the objectives. To calculate the participation of each industry the sum of foreign and domestic value added to gross exports is measured; higher the forward linkage of the industry compared to the backward linkage simply means that the industry is benefitting by engaging in global value chains. This can tell us which industries should be given more attention and focus in order to reduce carbon emissions and plan for a low carbon economy. As a participant in global value chains, India has the potential to adopt cleaner technologies and practices through collaboration with its trading partners. The utilizing of renewable energy sources into the production process and the promotion of sustainable trade practices could help mitigate carbon emissions associated with India's participation in GVCs.

1.2 Objectives

1) To analyse industry wise correlation between forward and backward linkages with carbon emissions

2) To run regression analysis for the top 5 industries showing a high correlation with carbon emissions and also taking direct and indirect employment embodied in gross exports into consideration

3) To calculate and compare the total participation of the top 5 industries in the year 1995 and 2018 with regards to both forward and backward linkages and see if these industries are gaining by participating in GVCs.

1.3 Data

The data needed for this study is quantitative secondary data. To study forward linkages domestic value added to gross exports were used and foreign value added to gross exports were used to evaluate backward linkages. For carbon emissions domestic value added and foreign value added were used respectively. The employment data was obtained from the trade in

employment database from OECD. All the secondary data was collected from the OECD Tiva and TiM database for the year 1995-2018.

1.4 Scope and limitations

India is taken as the country of study as it is one of the fastest growing economies. The period of study is from 1995-2018 and studies and understands the upcoming concept of global value chains which has had a huge impact on India's trade performance especially during the covid crisis. This study can also be used as a reference to understand the correlation and impact of linkages and employment on Carbon emissions and get insights about measuring total participation and gains of industries participating in GVCs.

Following are the limitations faced while conducting the research

1) lack of study pertaining to India with regards to global value chains

2) unavailability of data from 1991, hence the period 1995-2018 is used.

CHAPTER 2

Literature Review

2.1 Introduction

India kept one of the world's most restrictive trade policies for nearly fifty years. It created a system of high tariffs and strict nontariff obstacles, like quotas and licensing, that effectively shut down the economy from the global market. India began implementing economic reform in the middle of 1991 and has since drastically altered its trade policies in an effort to realign itself and become more integrated into the world economy.

The release of greenhouse gases (GHGs), such as carbon dioxide (CO2), is a key contributor to climate change and a serious worldwide threat. The IPCC 6th Assessment Report stated that human activities have caused an average global temperature increase of 1.1 °C since the pre-industrial era, starting in 1750.(Qin Yuting et al. 2023). A significant amount of global emissions, trade-related carbon emissions are vital to the world economy's sustainable growth. Inorder to plan the reduction of carbon emissions, it is important to analyse the effects of international trade on carbon emissions, particularly for large trading partners and developing countries. There exists a positive relationship between participation in international trade and carbon emissions; higher trade volume might result in higher overall emissions. Previous research has studied the relationship between carbon emissions various socioeconomic factors but lacks research in the field of international trade especially with regards to the upcoming concept of global value chains and employment in the downstream and upstream industries

The emergence of global value chains (GVCs), which have increased network trade and divided industrial processes across nations and continents, has further complicated the trade-led development discussion. It is difficult for developing nations to evaluate their proportional benefits from participating in trade. However, policy makers in many developing countries are

beginning to view "linking into GVCs" as the new development problem in and of itself. To accommodate this new aspect of trade, industrial policies are changing. It is important to know whether an industry is gaining from participating in trade and by how much is it contributing towards carbon emissions

The pearson correlation analysis is one way to analyse and understand the relationship and the strength between these variables. Running regression analysis using the ordinary least square method can tell us the significance of change between the dependent and independent variables. Calculating total participation and gains of industries contributing to carbon footprint can help us know where and how much focus and attention should be given to the different industries

2.2 Concept of Global Value Chains

Global value chains, or GVCs, are a fundamental paradigm shift in how the world's trade and manufacturing are organized. They represent, in essence, the division of labor-intensive manufacturing processes among many nations, with each focusing on particular tasks or phases of production. Technological, communication, and transportation developments have made it easier for businesses to effectively coordinate and integrate their activities globally, contributing to this phenomenon. The separation of domestic and foreign operations are blurred by GVCs since products frequently travel across borders before being purchased by customers. Participating in GVC has also grown to be a crucial tactic for businesses looking to expand into new markets, cut expenses, and improve their competitiveness.

Studies have been suggesting for the past three decades that any analyses with respect to gains from trade need should be based on net value-added by trade (Porter 1985, Kogut1985).(Banga, n.d.-a). Participating in global value chains (GVCs) for a specific nation, particularly a developing nation, can be done through forward linkages (in which the nation contributes to the exports of other nations) or backward linkages (in which the nation imports intermediate

products to be used in its exports). A country's participation in GVCs could be defined using this production process definition as the total of its "domestic value-added which goes into other countries' gross exports" (forward linkage of export of domestic value-added) and "foreign value added in its gross exports" (backward linkage or imports of foreign value-added)(Banga, n.d.-a). Manufacturing sectors are seen to grow faster through backward linkages, while service sectors grow faster through forward linkages (Naser dine, 2019).(Epede and Wang 2022). This is an upcoming area of study and has a lot of potential for bringing in higher wealth, growth and standard of living in the country.

2.3 Forward linkages and backward linkages

Forward linkages in global value chains (GVCs) refer to the connections between different stages of production that lead towards the final consumption of goods or services. They cover the flow of goods from the first stages of production through marketing, distribution, and finally consumption. In global value chains, or GVCs, "backward linkages" are the relationships and interdependencies between various production stages, whereby upstream activities benefit downstream operations. Understanding these connections is essential to comprehending the worldwide production and distribution processes of goods. Backward linkages essentially entail obtaining the materials, components, and inputs required for production from other countries. To measure a countries participation in global value chains we calculate the sum of domestic value added to gross exports and foreign value added to gross exports. Higher the forward linkages relative to backward linkages, the higher the gains if involvement in GVCs is quantified in terms of "net value-added." This would suggest that a nation is producing and exporting more as a result of its involvement in GVCs. For this reason, the forward to backward linkage ratio might be a useful indicator of the magnitude of net gains.

2.4 Relationship between India's participation in global value chains and carbon emissions

There exists a multifaceted relationship between India's participation in global value chains and carbon emissions. During the COP26 summit in Glasgow in 2021, Prime Minister Narendra Modi announced India's desire to achieve net-zero emissions by 2070. Strong ties with global value chains (GVCs) are necessary for every nation to achieve strong economic expansion, as GVC exports make up over half of all exports worldwide. In order to make production processes carbon neutral firms need to set up sustainable policies. Reliance Industries, Mahindra & Mahindra, Tata Consultancy Services, and other large Indian corporations are investing heavily in becoming carbon neutral. These kinds of projects will enhance production processes and general connectivity while setting a good example for smaller businesses to follow. Analysing industry wise correlation will help us know which industries should be given attention and help the government frame policies for those industries.

2.5 The concept of Employment in Global Value Chains

Growing economic integration worldwide and the spread of global value chains (GVCs) increases the sensitivity of employment in one country or region to changes in demand in other countries or regions. However, traditional statistics do not reveal the full nature of global interdependencies - notably how consumption in one country may drive production and therefore, sustain employment in other economies or, how employment in an upstream domestic industry may be affected by exporting activities of other domestic industries("Measuring Employment in Global Value Chains" 2020). To measure employment in downstream industries, direct domestic employment embodied in gross exports is used and

for upstream industries indirect employment embodied in gross exports is taken into account. OECD defines these indicators as follows

Direct domestic compensation of employees' content of gross exports, measures the domestic compensation of employees paid directly by industry i in country c to produce the goods or services exported by industry i in country c.

Indirect domestic compensation of employees' content of gross exports, corresponds to the compensation of employees paid by other, upstream, domestic industries (different from industry i) in country c that are embodied in the exports of industry i in country c.

CHAPTER 3

Methodology

3.1 Data collection

The type of data used for this study is secondary quantitative data. The study is done with four variables, the dependent variables used are domestic CO2 emissions embodied in gross exports and foreign CO2 emissions embodied in gross exports. The explanatory variables are domestic value added to gross exports(forward linkage),foreign value added to gross exports(backward linkage), direct domestic employment embodied in gross exports and indirect domestic employment embodied in gross exports. The data source used in this study is OECD.stat and the databases used for obtaining forward and backward linkage values is the trade in value added(tiva) and trade in employment(TiM). The time period of study is 23 years(1995-2018). Using the panel data, industry wise analysis has been done.

3.2 Pearson Correlation Analysis

The Pearson Correlation coefficient is the most used way of measuring a linear correlation between variables. This method measures the strength of the linear relationship between two variables. The values can be between -1 to 1. The value -1 indicates a total negative linear correlation, 0 means there does not exist a correlation between the variables. The values can be interpreted as follows

Pearson correlation coefficient	Strength	direction
Greater than 5	Strong	positive
Between 0.3 and 0.5	Moderate	Positive
Between 0 and 0.3	Weak	Positive
0	None	None
Between 0 and -0.3	Weak	Negative
Between -0.3 and -0.5	Moderate	Negative
Less than -0.5	strong	Negative

To perform the correlation analysis, the software R has been used. The following is the null and alternate hypothesis

Null Hypothesis(H_o): $\rho=0$

The Pearson correlation estimate is significant

Alternate Hypothesis(H_a):$\rho\neq0$

The Pearson correlation estimate is not significant

The study calculates Pearson correlation for industry wise to know which are the top 5 industries that have a strong positive correlation between carbon emissions and forward and backward linkages

3.3 Panel Data Analysis

In order to run a regression analysis, panel data analysis is done using the software R. Panel data, also known as longitudinal data contains observations about different cross sections across time. The following tests have been performed using the panel data

- Pooling effect

The pooled OLS model applies the Ordinary least squares methodology to panel data. This model assumes that all entities in the data set are considered to have the same underlying characteristics. Using the lm and plm package, the pooling test has been performed.

- Fixed effect

The fixed effect assumes that the characteristics of an individual may impact the outcome variables and we need to control this. Fixed effect removes the effect of time invariant characteristics. The fixed effect is calculated using the plm package and the model within.

- Random effect

The random effects assume that the individuals are strictly uncorrelated with the regressors. The random effect is calculated using the plm package and the random model in R.

3.3.1Hausman test

A specification test based on the difference between the fixed effect and the random effect estimators is known as the hasuman test. This test is used to determine whether a random effect or fixed effect model is appropriate for the study

The following is the null and alternate Hypothesis for the Hausman test

H_0-random effect is consistent

H_a-fixed effect is consistent

3.3.2Durbin Watson test

The Durbin Watson test is a test for autocorrelation in a regression model. If values obtained are below 2.0, it means that there is a positive autocorrelation and above 2.0 indicates a negative autocorrelation.

Following are the null and alternate hypothesis for the durbin Watson test

H_o- There is autocorrelation between the dependent and independent variables

H_a- There is no autocorrelation between the dependent and independent variables

The Durbin Watson test is performed in R using the pdwtest command

3.3.3Breusch Pagan Test

The Breush Pagan Test is used for heteroskedasticity in a linear regression and assumes that the error terms are normally distributed. When this assumption is violated we can say that heteroskedasticity is present. To check for heteroskedasticity the Breusch pagan test is used.

The following are the null and alternate hypothesis for the Breusch Pagan test

H^o- There is heteroskedasticity

H_a- There is no Heteroskedacticity

The Breusch pagan test is performed in R using the lmtest package and the bptest command.

3.3.4 Test for Multicollinearity

When two or more independent variables are highly correlated, we can say that multicollinearity is present. To test for multicollinearity the study has used the VIF test in r

studio. A test value of 1 indicates no correlation, a value between 1 and 5 indicates moderate correlation and a value above 5 indicates severe correlation.

3.3.5 Correction of autocorrelation and heteroscedasticity

It is important to note that the correction of autocorrelation and heteroskedasticity is of uttermost importance to make our data more reliable and efficient. The correction of Autocorrelation and heteroskedasticity can be done using various tests. This study has corrected for autocorrelation and heteroskedasticity using the coeftest command in R

3.4 Regression Analysis

This study has done a regression analysis for the top 5 industries showing a high positive correlation. After conducting the Hausman test, regression models have been created for the top 5 industries showing a high positive correlation with CO2 emissions for both downstream and upstream industries after correcting for autocorrelation, heteroscedasticity and multicollinearity.

The following is the regression model

$Yi=\beta 0 + \beta_1 X_i + \beta_2 X_2 + \varepsilon i$

Yi- dependent variable(carbon emissions)

B0- Intercept

X_i- independent variable(Forward/backward linkage)

B_1- coefficient of the X variable

X_2- Second independent variable(direct and indirect domestic employment embodied in gross exports)

εi- Error term

CHAPTER 4

Industry wise correlation analyses

4.1 Introduction

The first Objective of the study is to study the correlation between the independent variables which include domestic value added to gross exports(forward linkages) and foreign value added to gross exports(backward linkages) for 63 industries. The aim is to find out which are the top 5 industries having the highest positive correlation value. The data used is obtained from OECD Tiva database. The unit of measurement for carbon emissions is Tonnes and the unit of measurement for forward and backward linkages in US million dollars. The study has used the statistical software R to perform the correlation test and has the adopted the Pearson correlation method.

The formula for the Pearson correlation test is shown as Eq(1) (Asuero et

al., 2006).

$$r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 \Sigma(y_i - \bar{y})^2}}$$

where,

r_{xy} – correlation coefficient of the linear relationship between variables x and y

xi – values of x-variable in the data

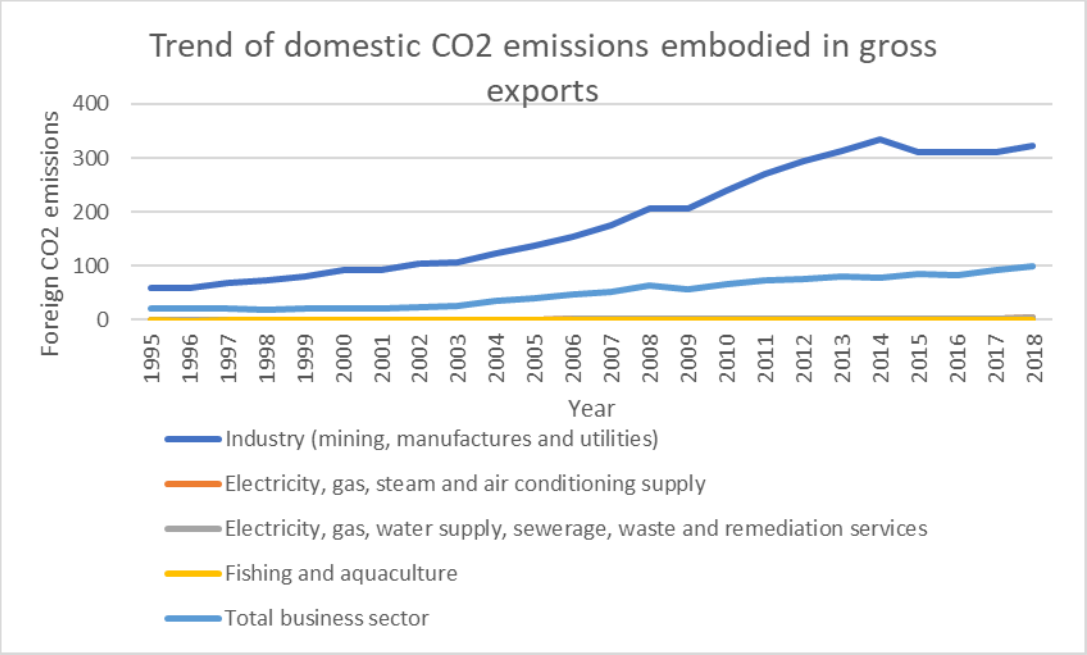
$\bar{x}$ – mean value of x-variable

yi – values of y-variable in the data

$\bar{y}$ – mean value of x-variable

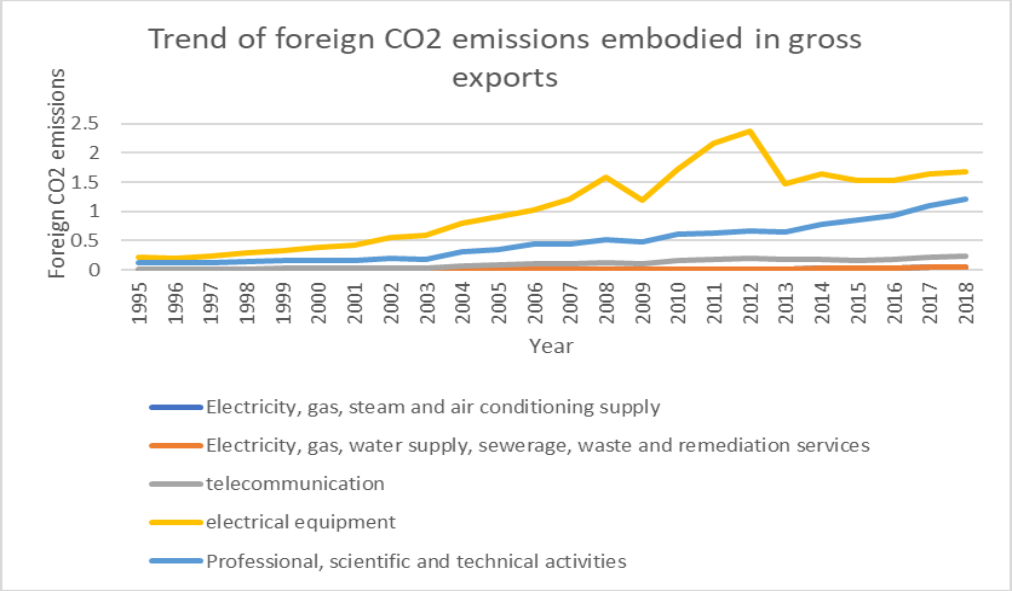
Figure 4(a) and 4(b) show the trends of domestic co2 emissions embodied in gross exports and foreign CO2 emissions embodied in gross exports of the top five industries having the highest positive correlation.

Fig 4.1(a) Trend of domestic CO2 emissions embodied in gross exports



The above line graph explains the trends of the top five downstream industries having the highest positive correlation with CO2 emissions from 1995-2018. The x axis shows the years and the y axis depicts CO2 emissions. All industries have witnessed an increasing trend of CO2 emissions over the years with fluctuations.

Fig 4.1(b) trend of foreign CO2 emissions embodied in gross exports



The above graph depicts trends of CO2 emissions from 1995-2018 of the top 5 upstream industries showing a high positive correlation with CO2 emissions. All industries witnessed an increasing trend of CO2 emissions with fluctuations over the years. The CO2 emissions of the electrical equipment industry witnessed a huge fall in 2012.

4.2 Industry wise correlation analyses between domestic value added to gross exports and domestic CO2 emissions embodied in gross exports

Table 4.1

Industry	**correlation**
industry(mining, manufacturers and utilities)	0.9994823
Electricity, gas, steam and air conditioning supply	0.9984471
Electricity, gas, water supply, sewerage, waste and remediation services	0.9984471
fishing	0.9972419

Industry	**correlation**
total business sector	0.996204
total services	0.9959476
total service(incl construction)	0.9959426
total	0.9956857
Publishing, audiovisual and broadcasting activities	0.994018
telecommunications	0.9936345
Real estate activities	0.9924671
Information and communication	0.9906753
Information industries	0.9905059
Land transport and transport via pipelines	0.9872194
Professional, scientific and technical activities	0.9844329
Chemicals and non-metallic mineral products	0.9841878
Textiles, textile products, leather and footwear	0.9835852
Information, finance, real estate and other business services	0.9814463
Motor vehicles, trailers and semi-trailers	0.9808695
Rubber and plastics products	0.9807747
Computer, electronic and electrical equipment	0.9803142

Industry	**correlation**
food products, beverages and tobacco	0.9802413
Human health and social work activities	0.9783713
Machinery and equipment, nec	0.9782226
Manufacturing nec; repair and installation of machinery and equipment	0.9782226
pub administration ,defence and education	0.9780376
transport and storage	0.9770028
Distributive trade, transport, accommodation and food services	0.9741246
basic metals	0.9737386
other service activities	0.973703
Other social and personal services	0.973703
Basic metals and fabricated metal products	0.9734719
Financial and insurance activities	0.968187
Administrative and support services	0.9651121
education	0.9633931
Fabricated metal products	0.9631716
air transport	0.9623191

Industry	**correlation**
Coke and refined petroleum products	0.961259
Pharmaceuticals, medicinal chemical and botanical products	0.9612124
Warehousing and support activities for transportation	0.9608451
transport equipment	0.9589716
Postal and courier activities	0.9576847
Computer, electronic and optical equipment	0.9507957
Agriculture, hunting, forestry and fishing	0.9452756
Other business sector services	0.9446604
water transport	0.9268822
Wholesale and retail trade; repair of motor vehicles	0.9268822
Chemicals and pharmaceutical products	0.9172714
Paper products and printing	0.9030353
Other non-metallic mineral products	0.8999553
Chemical and chemical products	0.8846714
Other transport equipment	0.8746173
Mining and quarrying	0.8688881

Industry	**correlation**
Accommodation and food service activities	0.8454875
Wood and paper products and printing	0.8308349
Public administration, education, health and other personal services	0.8272315
Electrical equipment	0.7081288
Arts, entertainment and recreation	0.5078475
comp prog n consul	0
construction	0
manufacturing	0
public admin and defense	0
Water supply; sewerage, waste management and remediation activities	0

The above table shows the correlation value between forward linkages and domestic CO2 emissions embodied in gross exports. All industries show a positive correlation and the correlation values range from 0.507-0.999. The industry having the lowest positive correlation is the arts and entertainment industry and the industry having the highest positive correlation is the industry that includes mining, manufacturers and utilities. The top 5 industries having the highest positive correlation are as follows

1)Industry (mining, manufactures and utilities)

2)Electricity, gas, steam and air conditioning supply,

3)Electricity, gas, water supply, sewerage, waste and remediation services,

4)Fishing and aquaculture

5)Total business sector

4.3 Industry wise correlation analyses between foreign value added to gross exports and foreign CO2 emissions embodied in gross exports

Table 4.2

Industry	Correlation value
Electricity, gas, water supply, sewerage, waste and remediation services	0.993933
Electricity, gas, steam and air conditioning supply	0.993932
Rubber and plastics products	0.990532
Electrical equipment	0.989407
Postal and courier activities	0.98885
Distributive trade, transport, accommodation and food services	0.987343
industry(mining, manufacturers and utilities)	0.986802
Real estate activities	0.986798
food products, beverages and tobacco	0.986686
Agriculture, hunting, forestry and fishing	0.986663
Computer, electronic and electrical equipment	0.985896
Information industries	0.984354
Information, finance, real estate and other business services	0.984072
total	0.98373

total business sector	0.983695
total service(incl construction)	0.983695
Chemical and chemical products	0.983398
Textiles, textile products, leather and footwear	0.982861
Public administration, education, health and other personal services	0.982155
Chemicals and pharmaceutical products	0.98209
Coke and refined petroleum products	0.98209
Accommodation and food service activities	0.981494
transport and storage	0.980611
Basic metals and fabricated metal products	0.980346
Chemicals and non-metallic mineral products	0.979772
Paper products and printing	0.978036
Industry	0.977595
Human health and social work activities	0.97724
Land transport and transport via pipelines	0.975615
Information and communication	0.975442
Administrative and support services	0.973816
basic metals	0.97325
Fabricated metal products	0.97322
telecommunications	0.972001
Other transport equipment	0.971187
air transport	0.970023
transport equipment	0.96921
Publishing, audiovisual and broadcasting activities	0.967299

Financial and insurance activities	0.966903
manufacturing	0.964342
Wholesale and retail trade; repair of motor vehicles	0.959134
pub administration ,defence and education	0.955405
water transport	0.955155
Professional, scientific and technical activities	0.954137
Computer, electronic and optical equipment	0.953099
Other non-metallic mineral products	0.950568
Manufacturing nec; repair and installation of machinery and equipment	0.949874
Motor vehicles, trailers and semi-trailers	0.949531
fishing	0.941367
Water supply; sewerage, waste management and remediation activities	0.937325
Mining and quarrying	0.937225
Other business sector services	0.935897
total services	0.931207
other service activities	0.926789
education	0.916705
Pharmaceuticals, medicinal chemical and botanical products	0.899206
Other social and personal services	0.863624
Arts, entertainment and recreation	0.861404

The above table shows the correlation value between backward linkages and foreign CO2 emissions embodied in gross exports .All industries show a positive correlation and the correlation values range from 0.855-0.993. The industry having the lowest positive correlation

is the arts and entertainment industry and the industry having the highest positive correlation is the Electricity, gas, water supply, sewerage, waste and remediation activities industry .The top 5 industries having the highest positive correlation are as follows

1)Electricity, gas, steam and air conditioning supply,

2)Electricity, gas, water supply, sewerage, waste and remediation services

3)Telecommunications

4)Electrical equipment

5)Professional, scientific and technical activities

CHAPTER 5

Running Regression Models for the top 5 Industries having the Highest Positive Correlation

5.1 Introduction

The second objective of the study is to run regression models for the top 5 industries having the highest correlation with regards to backward and forward linkages and taking Direct domestic employment added to gross exports and indirect domestic employment added to gross exports as independent variables with Carbon emissions as the dependent variable. Direct domestic employment embodied in gross exports, measures employment in industry i used in the production of goods and services exported by industry i in country c. Indirect domestic employment embodied in gross exports, measures employment in other, upstream, domestic industries (different from industry i) in country c that is embodied in the exports of industry i(OECD Trade in employment). Running a correlation test with tell you if the what kind of relationship exists between the independent and dependent variables and what is the strength of this relationship, but will not give you an estimate or tell you how one variable affects the other. Regression analysis goes a step further by creating an equation that estimates how much the dependent variable changes on average with a one-unit change in the independent variable. In order to run a regression model, tests of pooling, fixed and random effects have been performed to see which effect is significant for the data. Tests to check for autocorrelation and heteroscedasticity has also been conducted and corrected. The ordinary least square method has been used to run the regression models. All these statistical tests have been performed using the ‘R’ software.

Model of the study

Domestic CO2 embodied in gross exports=f(domestic value added to gross exports+ indirect domestic employment added to gross exports) –eq(5.1)

Foreign CO2 embodied in gross exports=f(foreign value added to gross exports+ direct domestic employment added to gross exports)- eq(5.2)

The above two equations show that domestic carbon dioxide emissions embodied in gross exports is dependent on domestic value added to gross exports and indirect domestic employment added to gross exports(eq (5.1)). Eq (5.2) says that Foreign carbon dioxide emissions embodied in gross exports is dependent on foreign value added to gross exports and direct domestic employment added to gross exports.

Pooling test, Two way fixed effects and Two way random effects test was performed. Below are the results of the two way fixed and random effect test.

5.2 Results of Pooling, Fixed and Random effects

Table 5.1. Results of pooling test for the whole panel

Coefficients	Estimates	Standard errors	T-value	p-value
Forward Linkage	1.5537e-03	4.2353e-05	36.6846	<2e-16 ***
Direct employment value	1.6970e-03	1.1903e-03	1.4257	0.1686
Backward linkage	5.5152e-04	3.1408e-06	175.5981	< 2.2e-16 ***
Indirect employment value	-5.2962e-06	5.9552e-06	-0.8893	0.374

Pooling test assumes that there is no heterogeneity. The asterisks (*) indicate statistically significant impacts (p-value < 0.05) of "Forward Linkage" and "Backward Linkage" at the 95%

confidence level, according to the p-values, thus we can say that there is no heterogeneity. However, there are no statistically significant effects for "Direct employment value" or "Indirect employment value" (p-value > 0.05).

Table 5.2 Results of the fixed effects model for the whole panel

Coefficients	Estimates	Standard errors	T-value	p-value
Forward Linkage	8.3378e-04 <	1.3468e-05	61.9093	2.2e-16 ***
Indirect employment value	-6.3879e-05	9.8216e-06	-6.5039	1.051e-10 ***
Backward linkage	4.7019e-04	3.0338e-06	154.9831	< 2.2e-16 ***
direct employment value	5.0813e-05	1.8299e-05	2.7768	0.005554 **

Forward Linkage, Backward linkage, and Direct employment value have statistically significant effects (p-value < 0.05) at the 95% confidence level, denoted by the asterisks (*). indirect employment value has a statistically significant effect at a slightly lower confidence level (p-value = 0.005554).

Table 5.3 Results of the random effects model for the whole panel

Coefficients	Estimates	Standard errors	T-value	p-value
Forward Linkage	8.4274e-04	1.3347e-05	63.1416	< 2.2e-16 ***
indirect employment value	-6.5246e-05	9.6936e-06	-6.7308	1.687e-11 ***
Backward linkage	4.8188e-04	3.0521e-06	157.8863	< 2.2e-16 ***
direct employment value	2.3631e-05	1.2258e-05	1.9278	0.0538854.

This model assumes that the effects being measured (Forward Linkage, Direct employment value) might vary across different groups or categories in the panel, but there's also a common underlying effect for all groups. Forward Linkage, Backward linkage, and Direct employment value all have statistically significant effects (p-value < 0.05) at the 95% confidence level, denoted by the asterisks (*). Indirect employment value has a p-value of 0.0538854, which is slightly higher than the typical cut-off for statistical significance (0.05)

To check which model is significant, the study adopted the Hausman test. The results of this test are given below

5.3 Hausman test

H0: random effect is consistent

H1-fixed effect is consistent

Results for domestic value added

chisq = 33.166, df = 2, p-value = 6.28e-08

Results for foreign value added

chisq = 417.62, df = 2, p-value < 2.2e-16

Interpreting the above results, we reject the null hypothesis since p value is less than 0.05 for both the models and thus we can say that the one way fixed effect is consistent.

5.4 Durbin Watson Test

5.4.1 Result of Durbin Watson test for serial correlation for panel models for forward linkages and indirect employment

HO: there is no autocorrelation present

HA: there is autocorrelation present

DW = 0.20489, p-value < 2.2e-16

Since p-value is less than 0.05 we reject the null hypothesis

5.4.2 Result of Durbin Watson test for serial correlation for panel models for backward linkages and direct employment

HO: there is no autocorrelation present

HA: there is autocorrelation present

DW = 0.49906, p-value < 2.2e-16

Since p-value is less than 0.05 we reject the null hypothesis

5.5 Test for heteroscedasticity

5.5.1 Result of Breusch-Pagan test for heteroscedasticity for forward linkages and indirect employment

HO: there is no heteroscedasticity present

HA: there is heteroscedasticity present

BP= 4796.3, df = 2, p-value < 2.2e-16

We reject the null hypothesis since p-value is less than 0.05

5.5.2 Result of Breusch-Pagan test for heteroscedasticity for backward linkages and direct employment

HO: there is no heteroscedasticity present

HA: there is heteroscedasticity present

BP = 6313, df = 2, p-value < 2.2e-16

We once again reject the null hypothesis as p-value is less than 0.05

5.6 Test for multicollinearity

5.6.1 Result of Test for multicollinearity for forward linkages and indirect employment

forwardl directemp

1.150158 1.150158

There is no multicollinearity present since the test values are less than 5.

5.6.2 Result of Test for multicollinearity for backward linkages and direct employment

Backwardl indirectemp

1.027372 1.027372

There is no multicollinearity present since the test values are less than 5.

The coeftest command was used to correct autocorrelation and heteroscedasticity. Following are the results

Table 5.4 coeftest results for forward linkages and indirect domestic employment

Coefficient	estimate	Standard error	T value	P value
forwardl	8.3378e-04	1.2798e-04	6.5148	9.788e-11 ***
directemp	-6.3879e-05	6.2204e-05	-1.0269	0.3046

Table 5.5 Results of coeftest for backward linkages and direct domestic employment

Coefficient	estimate	Standard error	T value	P value
Backwardl	4.7019e-04	1.5691e-05	29.9650	<2e-16 ***
indirectemp	5.0813e-05	6.9424e-05	0.7319	0.4643

TABLE 5.6 Regression analysis using two way fixed effects method with regards to forward linkages

Coefficients	Estimates	Standard errors	T-value	p-value
Forward Linkage	3.29E-04	1.30E-05	25.2848	< 2.2e-16 ***
direct employment value	6.01E-05	1.28E-05	4.6927	7.617e-06 ***

Adjusted R-Square- 0.991

The above table shows the results of the regression model with regards to top 5 industries having the highest positive correlation with carbon emissions. The two independent variables are highly significant and both the variables have a positive impact on carbon emissions. The Adjusted R-Square is quite high singnificating that that the variables are adding more value to the model.

TABLE 5.6 Regression analysis using two way fixed effects method with regards to backward linkages.

Coefficients	Estimates	Standard errors	T-value	p-value
Backward linkage	2.93E-04	1.46E-06	20.0432	< 2.2e-16 ***
direct employment value	1.11E-05	1.51E-06	7.3515	3.318e-11***

Adjusted R-Square-0.976

The above table shows the results of the regression model for the top 5 industries having the highest positive correlation with carbon emissions. in this model too both the independent variables are highly significant and both variables have a positive impact on carbon emissions. the adjusted r square is 0.976 indicating that the variables are significant and adding more value to the model

Chapter 6

Calculating total participation and checking if the top 5 industries with regards to forward and backward linkages are gaining by participating in GVCs

6.1 Introduction

The third objective of the study is to calculate the total participation of the top five industries with regards to both forward and backward linkages for the years 1995 and 2018, compare the participation of the two years and to see if these industries are gaining by participating in GVCs. It is important to ‘gainfully link into GVCs’ in identified industries where the country is able to derive net positive domestic value added gains(Banga, n.d.-b). knowing if the industries that have a high positive correlation with carbon emissions are gaining by participating in GVCs at a high rate, this will help us know which industries should be given more attention and focus to reduce carbon emissions. Knowing how an industry fares within GVCs provides valuable insights for businesses and policymakers to make informed decisions that can drive economic growth in a sustainable way. participation in GVCs, for a particular industry could be measured as a sum of 'foreign value added in its gross exports' (backward linkage or imports of foreign value-added) and its 'domestic value-added which goes into other countries' gross exports' (forward linkage of export of domestic value-added). Higher participation in GVCs may not ensure higher gains. A break-up of forward linkages and backward linkages in GVCs can provide a useful insight into the gains that go to a country from its participation in GVCs. If gains are measured in terms of 'net value-added' by participation in GVCs, then higher the forward linkages as compared to backward linkages, higher are the gains.(Banga, n.d.-b)

6.2 Calculating total participation of the top five industries in 1995 and 2018

Total participation= domestic value added to gross exports + foreign value added to gross exports-eq(6.1)

Table 6.1Total participation of top 5 downstream industries in 1995

industry	year	backwardl	forwardl	total participation
Industry (mining, manufactures and utilities)	1995	3063.2	22942.1	26005.3
Electricity, gas, steam and air conditioning supply	1995	8.6	1.1	9.7
Electricity, gas, water supply, sewerage, waste and remediation services	1995	8.6	1.1	9.7
fishing and aquaculture	1995	25.8	0.5	26.3
total business sector	1995	8425.2	803.7	9228.9

The above table shows the total participation of the top 5 downstream industries in the year 1995. The industry that has the highest participation in the industry which includes mining, manufacturers and utilities. The industries that had the least participation were the Electricity, gas, steam and air conditioning supply and Electricity, gas, water supply, sewerage, waste and remediation services industry, contributing to only 9.7 us million dollars. It is important to note that India had just started opening up their economy and engaging in trade.

Table 6.2. total participation of top 5 downstream industries in the year 2018

industry	year	backwardl	forwardl	total participation
Industry (mining, manufactures and utilities)	2018	79726.8	192320.1	272046.9
Electricity, gas, steam and air conditioning supply	2018	88.1	289.3	377.4
Electricity, gas, water supply, sewerage, waste and remediation services	2018	88.1	289.3	377.4
fishing and aquaculture	2018	14.1	694.7	708.8

total business sector	2018	19616.7	220207.8	239824.5

The above industries show the total participation for the top five downstream industries having the highest positive correlation with CO2 emissions. The industry having the highest total participation is the industry including mining, manufacturers and utilities, contributing 272046.9 us million dollars, followed by the total business sector, the fishing and aquaculture industry and last the Electricity, gas, steam and air conditioning supply and the Electricity, gas, water supply, sewerage, waste and remediation services industry with only 377.4 million dollars.

After comparing for the two years, we can say that the industry including mining, manufacturers and utilities have the highest total participation for both the years followed by the business sector, fishing and aquaculture and last the Electricity, gas, steam and air conditioning supply and the Electricity, gas, water supply, sewerage, waste and remediation services industries. However the rate of participation has increased drastically for all the five industries.

Table 6.3 total participation of top 5 upstream industries in the year 1995.

industry	year	backwardl	forward	total participation
Electricity, gas, steam and air conditioning supply	1995	1.1	8.6	9.7
Electricity, gas, water supply, sewerage, waste and remediation services	1995	1.1	8.6	9.7
telecommunications	1995	7.4	54.1	61.5
electrical equipment	1995	206.2	929.7	1135.9
Professional, scientific and technical activities	1995	84	567.5	651.5

The above table shows the total participation for the top five upstream industries in 1995 having the highest positive correlation with CO2 emissions. The industry having the highest total participation is the electrical equipment industry, contributing 1135.9 us million dollars, followed by the Professional, scientific and technical activities, telecommunications and last the Electricity, gas, steam and air conditioning supply and the Electricity, gas, water supply, sewerage, waste and remediation services industry with only 9.7 million dollars.

Table 6.4 total participation of top five upstream industries in 2018

industry	year	backwardl	forwardl	total participation
Electricity, gas, steam and air conditioning supply	2018	88.1	289.3	377.4
Electricity, gas, water supply, sewerage, waste and remediation services	2018	88.1	289.3	377.4
telecommunications	2018	506	2098.5	2604.5
electrical equipment	2018	2095.4	5817.6	7913
Professional, scientific and technical activities	2018	1592	15040.8	16632.8

The above table shows the total participation of the top 5 upstream industries in the year 2018. The industry that has the highest participation is the Professional, scientific and technical activities industry accounting for 16632.8 million dollars , followed by the electrical equipment industry, telecommunication and last the Electricity, gas, steam and air conditioning supply and the Electricity, gas, steam and air conditioning supply The industries that had the least participation were the Electricity, gas, steam and air conditioning supply and the Electricity, gas, water supply, sewerage, waste and remediation services contributing to 377.4 US million dollars.

Comparing the two years for the top five upstream industries we can note the electrical equipment industry had the highest total participation in the year 1995 and that the Professional, scientific and technical activities industry had the highest total participation in the year 2018. However it is seen that all industries have witnessed a drastic increase in total participation from 1995 to 2018.

6.3 Calculating gains of the top five industries for the year 1995 and 2018

$$\left(\frac{forwardlinkagevalue}{totalparticipation}\right)\mathbf{100} \text{ – eq(6.3.1)}$$

Table 6.5 forward and backward % share of top five industries with regards to forward linkages in 1995

industry	year	total participation	forward %share	backward %share
Industry (mining, manufactures and utilities)	1995	26005.3	88.22086	11.77914
Electricity, gas, steam and air conditioning supply	1995	9.7	11.34021	88.65979
Electricity, gas, water supply, sewerage, waste and remediation services	1995	9.7	11.34021	88.65979
fishing and aquaculture	1995	26.3	1.901141	98.09886
total business sector	1995	9228.9	8.708513	91.29149

The above table shows the industry wise percentage share of forward and backward linkages with regards to the top 5 downstream industries having the highest positive correlation with CO2 emissions in 1995. Higher the forward linkages compared to backward linkages simply means that the industry is benefitting by participating in GVCs. In the year 1995 the only industry that benefitted was the industry that includes mining, manufacturers and utilities. The

%share of backward linkages compared to %share of forward linkages were higher for the other four industries.

Table 6.6 forward and backward % share of top five industries with regards to forward linkages in 2018

industry	year	total participation	forward% share	backward %share
Industry (mining, manufactures and utilities)	2018	272046.9	70.69373	29.30627
Electricity, gas, steam and air conditioning supply	2018	377.4	76.65607	23.34393
Electricity, gas, water supply, sewerage, waste and remediation services	2018	377.4	76.65607	23.34393
fishing and aquaculture	2018	708.8	98.01072	1.989278
total business sector	2018	239824.5	91.82039	8.179606

The above table shows the industry wise percentage share of forward and backward linkages with regards to the top 5 downstream industries having the highest positive correlation with CO2 emissions in 2018. In the year 2018 we can see that all the five industries are gaining by participating in GVCs. The industry benefitting the most is the fishing and aquaculture industry followed by the total business sector, Industry (mining, manufactures and utilities) Electricity, gas, steam and air conditioning supply and the Electricity, gas, water supply, sewerage, waste and remediation services.

Comparing the two years we can clearly see a huge change in the increased gains received by the industries in 2018 compared to the year 1995. When focusing on reduction of CO2 emissions attention should be given to those industries who are receiving maximum benefits.

$$\left(\frac{forwardlinkagevalue}{totalparticipation}\right)100 \text{- eq(6.3.2)}$$

Table 6.7 forward and backward % share of top five industries with regards to Backward linkages in 1995

industry	year	total participation	backward%share	forward %share
Electricity, gas, steam and air conditioning supply	1995	9.7	88.65979	12.7907
Electricity, gas, water supply, sewerage, waste and remediation services	1995	9.7	88.65979	12.7907
telecommunications	1995	61.5	87.96748	13.67837
electrical equipment	1995	1135.9	81.84699	22.1792
Professional, scientific and technical activities	1995	651.5	87.10668	14.80176

The above table shows the industry wise percentage share of forward and backward linkages with regards to the top 5 upstream industries having the highest positive correlation with CO2 emissions in 1995. It is seen that no industry was gaining during this time period, all industries how a higher percentage share of backward linkages compared to percentage share of foreign linkages.

Table 6.8 forward and backward % share of top five industries with regards to Backward linkages in 2018

industry	year	total participation	forward%share	backward%share
Electricity, gas, steam and air conditioning supply	2018	377.4	76.65607	23.34393
Electricity, gas, steam and air conditioning supply	2018	377.4	76.65607	23.34393
telecommunications	2018	2604.5	80.57209	19.42791
electrical equipment	2018	7913	73.51952	26.48048
Professional, scientific and technical activities	2018	16632.8	90.42855	9.571449

The above table shows the industry wise percentage share of forward and backward linkages with regards to the top 5 upstream industries having the highest positive correlation with CO2 emissions in 2018. there has been a drastic change since 1995, in 2018 all industries benefitted by engaging in GVCs. The industry that benefitted the most was the Professional, scientific and technical activities industry followed by telecommunications. Importance should be given to industries gaining the most from participating in GVCs when planning of reduction of CO2 emissions is done in the country.

Chapter 7

Analysis and Conclusion

4.1 Summary

The study explains the concept of global value chains and gives a brief understanding of the evolution of Indias participation in this chain and studies the impact of this concept on Carbon emissions. Literature tells us that a country can participate in global value chains either through backward linkages and forward linkages. Forward linkages are measured in terms of domestic value added to gross exports and backward linkages are measured in terms of foreign value added to gross exports. Higher participation in GVCs may not ensure higher gains. If gains are measured in terms of 'net value-added' by participation in GVCs, then higher the forward linkages as compared to backward linkages, higher are the gains. This would imply that by its participation in GVCs, a country is creating and exporting more domestic value-added than the foreign value added which it is importing.(Banga, n.d.-a). The dependent variable used is carbon emissions(domestic CO2 emissions embodied in gross exports for forward linkage and foreign CO2 emissions embodied in gross exports for backward linkage) and the independent variables used for this study is domestic value added to gross exports, direct domestic employment embodied in gross exports, indirect domestic employment embodied in gross exports and foreign value added to gross exports. The datasource used is OECD tiva database and trade in employment database. The period of study is from1995 – 2018.

The first objective is to conduct a correlational analysis for all the 63 industries using the Pearson correlation method. The correlation value obtained with tell us if the relationship between the variables is a positive or a negative one and how strong is the relationship. The analysis is done for all 63 industries in order to know which are the top 5 industries having the highest positive correlation with regards to downstream and upstream industries.

The second objective is to run regression models using the ordinary least square method. Regression models are created for the top 5 industries showing a high positive correlation with regards to forward as well as backward linkages. This will tells us the amount of change in the dependent variable for each unit change in the independent variables and if the variables used are significant or not.

The last objective is to calculate total participation and gains for the top five downstream and upstream industries for the years 1995 and 2018, compare the results and see which industries should be given more attention when planning of reduction of CO2 emissions is done in the country. To achieve this objective the sum of domestic value added to gross exports and foreign value added to gross exports is calculated to attain total participation and further using this value, percentage share of forward and backward linkage is found for each industry using the percentage method. This will tell us if the industries that are having a high positive correlation with carbon emissions are gaining by engaging in global value chains and will provide insights on which industries should be given more attention.

4.2 Findings

- forward and backward linkages are significant and is positively related to carbon emissions in India from 1995-2018
- industry wise correlation analysis show that the correlation value for all industries range from 0.86- 0.99
- the results show that there exists a very high positive correlation between all the industries and carbon emissions
- the top five industries having the highest correlation with carbon emissions with regards to forward linkages are the

Industry (mining, manufactures and utilities)

Electricity, gas, steam and air conditioning supply,

Electricity, gas, water supply, sewerage, waste and remediation services,

Fishing and aquaculture

Total business sector

- the top five industries having the highest correlation with carbon emissions with regards to backward linkages are

  Electricity, gas, steam and air conditioning supply,

  Electricity, gas, water supply, sewerage, waste and remediation services

  Telecommunications

  Electrical equipment

  Professional, scientific and technical activities

- The correlation value between carbon emissions and forward linkages range from 0.996-0.999
- The correlation values between carbon emissions and backward linkages range from 0.989-0.993
- The two industries, Electricity, gas, steam and air conditioning supply, Electricity, gas, water supply, sewerage, waste and remediation services feature in the top 5 industries with regards to both, forward as well as backward linkages
- The pooled ordinary least square regression method results show that both regression models have a high adjusted r square and highly significant F-statistics (p-value < 2.22e-16), indicating that the models are statistically significant.
- The fixed-effects model addresses a limitation of Pooled Least Squares (PLS) regressions by removing unobserved individual effects. After controlling for individual

effect both regression models have a a high adjusted r square and highly significant F-statistics (p-value < 2.22e-16), indicating that the models are statistically significant.

- the Random Effects is another approach to account for unobserved individual effects like the fixed-effects model. However, unlike fixed effects, random effects assume these effects are random variables and not fixed over time.
- The hausman test interpretation for eq(55.1) is as follows

  chisq = 33.166, df = 2, p-value = 6.28e-08 suggest we reject the null hypothesis. This means the random-effects model is likely inconsistent for the relationship between forward linkages, Direct employment and carbon emissions. The fixed-effects model is likely a better choice in this case.
- The hausman test interpretation for eq(5.2) is as follows

  chisq = 417.62, df = 2, p-value < 2.2e-16

  Also lead to rejection of the null hypothesis. This suggests the random-effects model might not be suitable for the relationship between backward linkages, indirect employment and carbon emissions. The fixed-effects model is likely preferable here as well.
- The durbin Watson test interpretation for eq(5.1) is given below

  DW = 0.20489, p-value < 2.2e-16

  Since p-value is less than 0.05 we reject the null hypothesis. This suggests strong positive autocorrelation exists.
- The durbin watson test interpretation for eq(5.2) is

  DW = 0.49906, p-value < 2.2e-16

  again leads to rejecting the null hypothesis. This indicates positive autocorrelation exists.

- The The Breusch-Pagan test results for eq(5.1) which checks for heterosckedasticity are as follows

  BP= 4796.3, df = 2, p-value < 2.2e-16 leads us to reject the null hypothesis. This strongly suggests heteroscedasticity is present in the model
- The Breusch Pagan test results for backward linkages are given below

  BP = 6313, df = 2, p-value < 2.2e-16 again leads to rejecting the null hypothesis. This indicates heteroscedasticity is also present in the model
- The correction of autocorrelation and heterosckedasticity was done using the coeftest command in r studio.
- The industry that had the highest participation in 1995 with reference to the five downstream industries is the industry which includes mining, manufacturers and utilities.
- The industries that had the least participation in 1995 were the Electricity, gas, steam and air conditioning supply industry and the Electricity, gas, water supply, sewerage, waste and remediation services industry
- The industry that had the highest participation in 2018 with reference to downstream industries is the industry including mining, manufacturers and utilities
- The industries that had the least participation in 2018 were the Electricity, gas, steam and air conditioning supply industry and the Electricity, gas, water supply, sewerage, waste and remediation services industry.
- The industry that had the highest participation in 1995 with reference to the five upstream industries is the electrical equipment industry.
- The industry that had the least participation in 1995 with reference to the five upstream industries is the Electricity, gas, steam and air conditioning supply industry and the Electricity, gas, water supply, sewerage, waste and remediation services industry.

- The Professional, scientific and technical activities industry had the highest total participation in 2018 with reference to upstream industries
- The industry that had the least participation in 2018 with reference to the five upstream industries is the Electricity, gas, steam and air conditioning supply industry and the Electricity, gas, water supply, sewerage, waste and remediation services industry.
- the electrical equipment industry had the highest total participation in the year 1995 and that the Professional, scientific and technical activities industry had the highest total participation in the year 2018.
- All the industries witnessed a drastic increase in total participation from 1995-2018
- The dowmstream industry that gained the most in 1995 was the total business sector
- The fishing and aquaculture downstream industry benefitted the most in 2018
- Not a single industry upstream industry benefitted by engaging in GVCs in 1995
- The professional,scientific and technical activities industry benefitted the most in 2018 by participating in GVCs.

4.3 Conclusion

India has come along way in international trade. Right from being an underdeveloped country to a developing country, right from exporting primary products to exporting secondary and tertiary goods and services. According to the World Bank, a one percent increase in GVC participation is estimated to boost per capita income levels by more than one percent – about twice as much as conventional trade. However it is important that we participate in Global value chains keeping in mind the environment, so that the future can reap benefits as well. Climate change has bought drastic changes in the health and lifestyle of the people. CO2 emissions is one main reason for this problem. This paper highlights the importance of participating in GVCs in a sustainable way. Understanding the correlation between each industry and carbon emissions will help us know the intensity of the situation. The study has

adopted four independent variables(domestic value added to gross exports, foreign value added to gross exports, direct domestic employment embodied in gross exports and indirect employment added to gross exports). The second objective studies the estimates of the independent variables on the dependent variables. Employment is adopted in the study keeping in mind that More employed people means more income, which often translates to increased consumption of goods and services. Production of these goods and services usually involves energy use, and depending on the energy source, this can lead to higher carbon emissions. For example, if more people are employed in manufacturing industries that rely on fossil fuels, emissions could rise. The study shows that domestic and foreign value added to gross exports are more significant compared to direct and indirect domestic employment embodied in gross exports. Since we already know the top five industries having the highest positive correlation with CO2 emissions, the research wants to find out which of these five industries are gaining the most by engaging in GVCs, only than we can make decisions on which industry should be given more attention and focus when planning on reduction of CO2 emissions with regards to Global Value Chains. The results show that the fishing and aquaculture industry gains the most from the top five industries, certain sustainable practices such as investing in more fuel-efficient fishing vessels and upgrading engines, powering aquaculture facilities with renewable energy sources like solar or wind power can help in significantly reducing carbon emissions. in a similar way, measures such as promoting car pooling, encouraging video conferences to reduce carbon traffic due to travelling, installing solar panels, and investing in smart thermostats to regulate heating and cooling are some practices that can be implemented in the professional, scientific and technical activities industry as this upstream industry benefits the most by engaging in GVCs. It is high time we give importance to this area of research as it leads to growth in the economy, higher productivity, job creation, and raise living standards.

REFERENCES

8.1 Websites

https://www.oecd-ilibrary.org/science-and-technology/measuring-employment-in-global-value-chains_00f7d7db-en

https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm

https://www.youtube.com/watch?v=abGKu3kR0xI

https://unctad.org/

https://www.wto.org/

https://www.usitc.gov/publications/332/journals/concepts_approaches_in_gvc_research_final_april_18.pdf

https://www.jstor.org/stable/43868323?searchText=indias+unemployment+and+gvc+participation&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Dindias%2Bunemployment%2Band%2Bgvc%2Bparticipation%26so%3Drel&ab_segments=0%2Fbasic_search_gsv2%2Fcontrol&refreqid=fastly-default%3A314f05da21140729a0f1878806b3d1f4&seq=24

https://ourworldindata.org/co2/country/india

https://www.epw.in/

https://wits.worldbank.org/

https://iap.unido.org/articles/what-are-global-value-chains-and-why-do-they-matter

https://www.worldbank.org/en/topic/global-value-chains

https://www.tandfonline.com/doi/epdf/10.1080/00036846.2023.2186365?needAccess=true

8.2 Research Articles

1)Banga, K. (2016). Impact of Global Value Chains on Employment in India. *Journal of Economic Integration*, *31*(3), 631–673. https://doi.org/10.11130/jei.2016.31.3.631

2)Banga, R. (n.d.). *MEASURING VALUE IN GLOBAL VALUE CHAINS*.

Jones, L., Demirkaya, M., & Bethmann, E. (n.d.). *Global Value Chain Analysis: Concepts and Approaches*.

3)Kalirajan, K. (n.d.). *THE IMPACT OF A DECADE OF INDIA'S TRADE REFORMS*.

Li, J., Irfan, M., Samad, S., Ali, B., Zhang, Y., Badulescu, D., & Badulescu, A. (2023). The Relationship between Energy Consumption, CO2 Emissions, Economic Growth, and Health Indicators. *International Journal of Environmental Research and Public Health*, *20*(3), 2325. https://doi.org/10.3390/ijerph20032325

4)Measuring employment in global value chains (OECD Science, Technology and Industry Working Papers 2020/01; OECD Science, Technology and Industry Working Papers, Vol. 2020/01). (2020). https://doi.org/10.1787/00f7d7db-en

Monday, G., & Martha, C. N. (2017). *Testing the Poolability of A Set of Panel Data*.

[No title found]. (n.d.).

5)Qin Yuting, Chin Min Yee, Hoy Zheng Xuan, Lee Chew Tin, Khan Musharib, & Woon Kok Sin. (2023a). Pearson Correlation Analysis Between Carbon Dioxide Emissions and Socioeconomic Factors Across Nations Income Groups. *Chemical Engineering Transactions*, *106*, 181–186. https://doi.org/10.3303/CET23106031

6)Sajid, M. J., Cao, Q., Cao, M., & Li, S. (2020). Sectoral carbon linkages of Indian economy based on hypothetical extraction model. *International Journal of Climate Change Strategies and Management*, *12*(3), 323–347. https://doi.org/10.1108/IJCCSM-11-2018-0075

7)Zhongfu, Y., Jianhui, J., & Pinglin, H. (2011). The Study on the Correlation between Environmental Information Disclosure and Economic Performance-With empirical data from

the manufacturing industries at Shanghai Stock Exchange in China. *Energy Procedia*, *5*, 1218–1224. https://doi.org/10.1016/j.egypro.2011.03.213

8)Assamoi, G. R., Wang, S., Liu, Y., Gnangoin, T. B. Y., Kassi, D. F., & Edjoukou, A. J.-R. (2020). Dynamics between participation in global value chains and carbon dioxide emissions: Empirical evidence for selected Asian countries. *Environmental Science and Pollution Research*, *27*(14), 16496–16506. https://doi.org/10.1007/s11356-020-08166-9

9)Changhong, P. (2019). Foreword. In *Global Value Chains and Production Networks* (pp. xi–xii). Elsevier. https://doi.org/10.1016/B978-0-12-814847-1.00012-9

10(Chen, H., Zhang, C., & Yin, K. (2022). The Impact of Global Value Chain Embedding on Carbon Emissions Embodied in China's Exports. *Frontiers in Environmental Science*, *10*, 950869. https://doi.org/10.3389/fenvs.2022.950869

11)Meng, B. (n.d.). *Tracing CO2 Emissions in Global Value Chains*.

12)Wang, J., Rickman, D. S., & Yu, Y. (2022a). Dynamics between global value chain participation, CO2 emissions, and economic growth: Evidence from a panel vector autoregression model. *Energy Economics*, *109*, 105965. https://doi.org/10.1016/j.eneco.2022.105965

13)Wang, J., Rickman, D. S., & Yu, Y. (2022b). Dynamics between global value chain participation, CO2 emissions, and economic growth: Evidence from a panel vector autoregression model. *Energy Economics*, *109*, 105965. https://doi.org/10.1016/j.eneco.2022.105965

14)Wang, J., Rickman, D. S., & Yu, Y. (2022c). Dynamics between global value chain participation, CO2 emissions, and economic growth: Evidence from a panel vector autoregression model. *Energy Economics*, *109*, 105965. https://doi.org/10.1016/j.eneco.2022.105965

15)Ateş, E., & Şanlısoy, S. (2024). The impact of global value chains on climate change. *Journal of Social and Economic Development*. https://doi.org/10.1007/s40847-023-00320-6

16)Bai, S., Zhang, B., Ning, Y., & Wang, Y. (2021). Comprehensive analysis of carbon emissions, economic growth, and employment from the perspective of industrial restructuring: A case study of China. *Environmental Science and Pollution Research*, *28*(36), 50767–50789. https://doi.org/10.1007/s11356-021-14040-z

17)Chen, H., Zhang, C., & Yin, K. (2022). The Impact of Global Value Chain Embedding on Carbon Emissions Embodied in China's Exports. *Frontiers in Environmental Science*, *10*, 950869. https://doi.org/10.3389/fenvs.2022.950869

18)Liu, T.-Y., & Lin, Y. (2023). Does global warming affect unemployment? International evidence. *Economic Analysis and Policy*, *80*, 991–1005. https://doi.org/10.1016/j.eap.2023.09.028

19)Ma, X., Liu, X., Pan, X., & Liao, X. (2022). Global value chain participation impacts carbon emissions—Take the electro-optical equipment industry as an example. *Frontiers in Environmental Science*, *10*, 943801. https://doi.org/10.3389/fenvs.2022.943801

20)Mitić, P., Fedajev, A., Radulescu, M., & Rehman, A. (2022). The relationship between CO2 emissions, economic growth, available energy, and employment in SEE countries. *Environmental Science and Pollution Research*, *30*(6), 16140–16155. https://doi.org/10.1007/s11356-022-23356-3

21)Sajid, M. J., Cao, Q., Cao, M., & Li, S. (2020). Sectoral carbon linkages of Indian economy based on hypothetical extraction model. *International Journal of Climate Change Strategies and Management*, *12*(3), 323–347. https://doi.org/10.1108/IJCCSM-11-2018-0075

22)Sun, C., Chen, L., & Xu, Y. (2020). Industrial linkage of embodied CO2 emissions: Evidence based on an absolute weighted measurement method. *Resources, Conservation and Recycling*, *160*, 104892. https://doi.org/10.1016/j.resconrec.2020.104892

23)Wang, S., Wang, X., & Chen, S. (2022). Global value chains and carbon emission reduction in developing countries: Does industrial upgrading matter? *Environmental Impact Assessment Review*, *97*, 106895. https://doi.org/10.1016/j.eiar.2022.106895

24)Xin, Y., Yang, S., & Rasheed, M. F. (2023). Exploring the impacts of education and unemployment on CO2 emissions. *Economic Research-Ekonomska Istraživanja*, *36*(2), 2110139. https://doi.org/10.1080/1331677X.2022.2110139