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2018

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MPRA Paper No. 93031, posted 10 Apr 2019 13:47 UTC

Climate Friendly Goods and Technology Trade: Climate Mitigation Strategy of India

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2018

Abstract

This study focuses on India's climate change mitigation strategy through trade and how India gradually moves forward towards the goal of sustainable development path. The paper highlights trade performances of climate friendly goods and technology (CFGT) in India during 2002-20017 and suggests possible solution through trade channels that might mitigate climate change through disseminating and exchanging the low carbon and clean technologies, which improve energy efficiency and minimizes environmental impacts. The products associated with clean technologies which have relatively less adverse impact on the environment. This paper attempts to realize India's CFGT export and import, and quantify trade opportunities of CFGT in India. With these it also identifies constrains and helps to widen capacity and strengthen its capability in the advancement of capturing new opportunities in production and trade in CFGT. India should adopt few policies to improve and raise CFGT production while trade ensures availability of technologies.

Key Words: Climate Change, Climate Mitigation, Energy Efficiency, India, CFGT, Trade, Climate Friendly Goods and Technology, Export and Import.

JEL Classification: C₂, O₃, Q₄,

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1. Introduction

In this 21st century climate change¹ emerges as a new challenge for the economic development in emerging economy like India. Holding updated technologies the developed world creates pressure on developing world to adopt and mitigate climate change issues. What should be the climate mitigation strategy for India? This study focuses on how India mitigates climate change issues through trade channel and proceeds towards the goal of sustainable development trajectory overcoming global and local obstacles.

During industrialization developed nations consumed huge fossil fuel energy and released carbon emissions. Ultimately, accumulated fossil fuel consumption has contributed a lot to change the global climate. In this context, contribution of less developed countries (LDCs) are negligible (compared to industrially developed nations) or little to cause climate change, however, they are facing its consequences² (Dinda 2014, 2015). LDCs have low capacity to adapt to the harsh impacts of climate change³. LDCs have already several hindrance or obstacles for their developmental activities; now climate change adds as an additional constraint. However, emerging economies like China and India have managed to achieve high economic growth rate with significant reduction of poverty which is based on *export-led development paradigm*. Trade plays significantly role for sustainable development maintaining a balance between *negative scale effect* and *positive technological effect*. Trade may provide solution of climate constraint. Climate change provides also certain opportunity to grow with new products such as climate friendly goods and technology (CFGT), or environmental goods and services (EGS), which are considered to be material, equipment or technology which may address particular environmental problem or climate change issues (Nguyen and Kalirajan 2015). One

¹ *Climate Change* refers to any significant change in the climate over time. It is a significant shift of climate lasting for an extended period of time. In the natural process the climate has always been changing slowly. The current impact of human activities is causing the climate to change in an unnatural way and at a faster pace than ever before. Climate change is a global phenomenon which has certain impacts on the world. The human activity induced climate change is causing shifts in the normal climatic conditions such as rainfall, temperature etc., which in turn have impact on natural environment and living beings.

² Climate change impacts include a rise in weather related incidents such as floods, droughts, destructive storms, frosts and hailstones; extinction of countless flora and fauna; the loss of agricultural crops in vulnerable areas; the changing of growing seasons; the melting of glaciers; the disruption of water supplies; the expansion of infectious diseases; the rising sea levels and much more. Both the year 2011 and 2012 produced a record number of extreme climate events in the world including floods, heat waves, droughts, fires and snowstorms (Dinda 2018).

³ See, UN Special report 2003, Khatun 2010, Coondoo and Dinda 2002, World Bank 1992, 2008.

product is said to be environmental good, which is less harmful to environment, which is environmentally preferable to similar or near products. EGS or CFGT help to measure or prevent or minimize environmental damage or correct climate changes (OECD 1999). Trade might ensure availability of CFGT for LDCs where domestic industries are unable to produce CFGT in sufficient scale at affordable prices. In this context, trade also plays a major role in innovations and disseminating technologies. Liberalized trade is a potent driver for technological innovation. Advanced know-how and environment friendly technologies will be readily available through liberalised trade (World Bank 2008, Meyer-Ohlendorf and Gerstetter, 2009). So, trade liberalization is good for the environment (Antweiler et al. 2001, Liddle 2001, Copeland and Taylor 2004, Blyde 2000). Free trade has a contradictory impact on the environment, both increasing pollution and motivating reduction of it.

Now, questions may arise as follows: Can trade promote to mitigate climate change in emerging economies? Does climate change create any business opportunity in emerging India? What is the trade opportunity for CFGT in India? Who are the potential trade partners of emerging India within South Asia region, in Asia and the world? This paper attempts to realize India's CFGT export and import, and quantify trade opportunities of CFGT in India. With these it also identifies constraints and helps to widen capacity and strengthen its capability in the advancement of capturing new opportunities in production and trade in CFGT.

Climate change creates limitation for development in one hand and also provides, on other hand, opportunity to grow with newly clean and CFGT. Truly, it creates the pace for opportunity to rearrange or redesign the economic activities. Trade is the engine of growth in the supply driven economy. Trade certainly promotes developing countries through generating export earnings and accessing the updated technologies and adapting them in their economic system. Trade might mitigate climate change through disseminating and exchanging the low carbon technologies. The main objective of the clean technology is to improve energy efficiency and minimizes environmental impacts. The products associated with certain clean technologies that have relatively less adverse impact on the environment are the main focus of this study. This paper examines the potential trade in CFGT in India during 2003 - 2017. This paper includes also post crisis

period and updated data till 2017 from UNCOMTRADE (downloaded 6 digit HS data on 28th July 2018). This study provides evidence on CFGT trade opportunity in India in the period of 2003 – 2017 and suggests formulating the policy on ‘*climate change and trade*’ for mitigating climate change issues in regional and global levels.

This study highlights the export potential trade of CFGT in India. CFGT trade was non-existent in India in 1990s, however, in post global financial crisis, India emerges as a promising market for CFGT. CFGT might be a newly large industry focusing business on equipment or system supply like renewable energy plant, portable water treatment, noise and vibration abatement etc. (Monkelbaan 2011). This paper deals with the potential trade of India’s CFGT within Asia, with the European Union (EU), North America (the USA and Canada) and rest of the world. This study is mainly based on the application of the partial gravity model⁴ in 2008. This analysis is useful to explain determinants of India’s exports potential of CFGT within Asia, the EU and the US. Gravity model is adopted to explain the role of economic size and endowments, distance between trading partners, membership of multilateral agreement, among others on trade of such climate friendly goods and technology, and its sub-categories. In particular, the gravity analysis considers the bilateral CFGT trade of imports and exports in India in 2008. This paper provides both time series simple trend analysis for the period of 2003-2017 and cross-sectional data analysis for estimating the gravity equation in the pre-crisis 2005 and crisis year 2008.

Background: Export is the most important source of economic growth. In this context, it should be mentioned that export of industrial products positively contributes to economic growth, while, it has certain negative impact on environment. Export promotion of manufacturing products contributes negatively to overall environment, in other word; it degrades environment. Truly, cost of development is observed and measured in terms of environmental degradation. Now, the global concern is to maintain a balance between export and environment for both developed and developing countries (Mani 2014). Particularly emissions of greenhouse gases associated with continued economic expansion need to be put under control by adopting sustainable production and

⁴True gravity model is not suitable and applicable for single economy. Part of the gravity equation is estimated after dropping reporter country’s GDP and its income per capita, which are common for all bilateral trading partners.

consumption. In order to avoid conflicts between trade and environmental degradation, developed nations should assist developing countries in terms of improving their capacities and capabilities such that they can avail the advantage of new opportunities which are emerging in the world trade (World Bank 2007, Mani 2014). Trade in environmental goods is one such new opportunity (Nguyen and Kalirajan 2015), which has emerged from failures of the Doha round trade negotiation meetings. The Doha round did not explicitly cover categories of '*environmental monitoring and assessment equipment*' and '*cleaner or more resource efficient technologies and products*'. Dinda (2018) focuses on the above said categories and highlights on the early 21st century trade status of such items and its potential opportunities in Asia.

Truly, the composition of the trade pattern may shift from high energy-intensive to less energy-intensive and/or clean products over time to fulfil the changing world demand due to growing environmentalists' agitation. In this context, emerging economy like India needs to increase energy efficiency which is possible through switching energy sources from fossil fuel to renewable energy. Energy efficient technologies are required for this purpose. India emerges as a dynamic business leader in South Asia as well as in the world and the centre of gravity of economic activities has shifted to India. Performance of Indian economy is improving with trade diversity during 2002-2017, which also overcomes the *Global financial crisis 2008-09*.

Objective of this study is to investigate trade performance and emerging business opportunities from the *Global financial crisis since 2008*. The global financial crisis 2008-2009 has strongly demonstrated the economic fortunes of emerging India and the rest of the world. The crisis was transmitted to industrial and emerging market economies through both financial and trade channels. Declining demand for imports among advanced economies transmitted the crisis to export-reliant countries in Asia. Major trade dynamics with product diversity is observed in India during 2002-2008.

East Asia and South-East Asia regions have taken a lead role in development and export of energy efficient technologies. Asian countries including India provide affordable renewable technologies through trade and make them available widely for mitigating global climate change issues. So, there is possible emerging business opportunity in India to improve energy efficiency by adopting renewable energy sources and technologies.

This study provides an overview on trade channel for climate mitigation strategy and potential trade opportunities for climate friendly goods and technologies (CFGT) in India in the 21st century with certain focus on the Global financial crisis in 2008-2009.

This study is organised as follows: Section 2 describes data and methodology; Section 3 provides results and trade gravity analysis. Section 3.1 discusses trend analysis, Section 3.2 analyses trade gravity model, and Section 3.3 estimates trade gaps and identifies potential trade partners. Finally, section 4 concludes with remarks.

2. Data and Methodology

This study has selected 64 climate friendly goods under 6 digit HS code (2002) by putting together various lists that have been defined by various international organizations recently (see, Dinda 2018 for details). In the global platforms where in negotiations could be easier done than concentrating on the entire list of environmental goods. Climate Friendly Goods and Technologies (CFGT) trade data (in value, 1000 US dollar at 2008) was taken from WITS (World Integrated Trade Solution) website: <https://wits.worldbank.org> having the UN COMTRADE data for the period of 2002-2017. Gross Domestic Production (GDP) and per capita GDP data were taken from World Bank Development Indicators (www.worldbank.org/data) for corresponding years. The distance between countries and other dummy variables are taken from the `dist_cepil.xls` file of CEPII DATABASE (see the website: www.cepii.fr). The total observation was reduced after combining all the variables for each pair of trading partners⁵. After matching all data sets, this filtered data set is used in the empirical analysis.

For empirical purpose we apply trade gravity model (Anderson 1979). Following the standard gravity model, Dinda (2014) investigates a new direction of potential trade opportunity for environment friendly goods and provides certain insights regarding trade opportunity of CFGT in India. The trade gravity model is based on the idea that trade volumes between two countries depend on the size of the two countries and the distance between them (Anderson 1979). Distance between pair of nations can be geographical,

⁵ This study considers fully matched data only.

cultural and political. Socio-economic-political and cultural aspects may create obstacle to adopt updated cleaner technology in certain societies or countries. Trade literature addresses these socio-economic and cultural issues in the empirical investigations (Eichengree and Irwin 1998, and Rauch 1999). Baldwin 1994, Nilsson 2000, Egger 2002, Dinda 2011, 2014; etc. use the term *trade potential* as the expected volume of trade between country pairs that the gravity model predicts.

3. Results

3.1 Trend Analysis in the period of 2000 -2017

Initially, we study trend analysis for the period of 2000-2017. We observe positive trends of overall export and import in India that are measured in terms of percentage of GDP in the early 21st century for period of 2000 – 2017. India’s export reached at peaks at 24.27% and 25.43% in 2008 and 2013, respectively. Fig 1 displays the trends of trade in India during 2000-2015, while Fig 2 shows the trends of CFGT export and import (measured in billion US dollar) in India during 2003 - 2017. It is clearly visible that CFGT export increases rapidly during pre-crisis period (2003-2008) and rises slowly in the post crisis period (2009-2017). CFGT import follows similar pattern to CFGT export till 2008, however, import rises rapidly after 2014. CFGT import is more than that of export in India during 2003-2017, and CFGT trade gap increases after 2014.

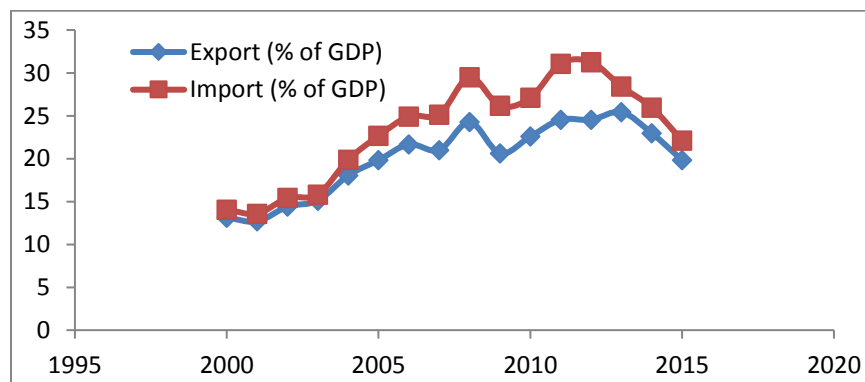


Fig 1: Trends of export and import trade (% of GDP) in India during 2000- 2015

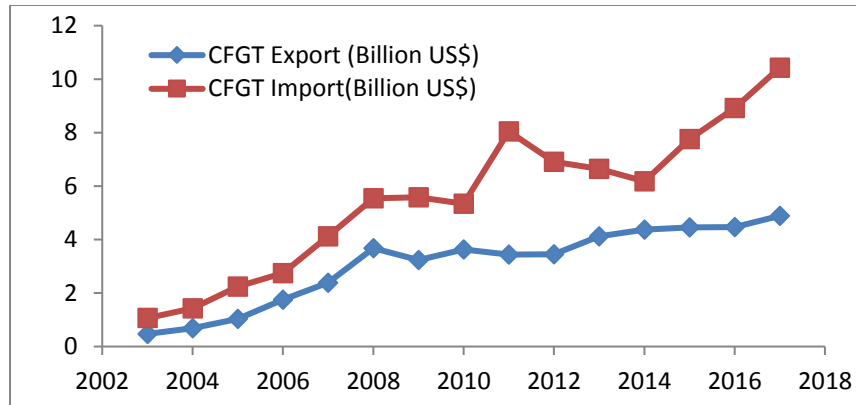


Fig 2: Trends of CFGT Export and Import in India during 2003- 2017

Table 1 displays the trend of shares of CFGT export and import in India in the period of 2003-2017. In 2003, CFGT export share was less than 1% of India's total export while CFGT import share was 1.48% of India's import. CFGT export share reached at peak at 2.05% in 2008 and declined to 1.67% in 2017. However, CFGT import share touched at high at 2.13% in 2009 and declined to 1.37% in 2014 and gained momentum after 2014, reached at peak at 2.58% in 2016 (See, Fig 3).

Table 1: Share of CFGT Export and Import in India during 2003 - 2017

year	Share of CFGT Export	Share of CFGT Import
2003	0.809	1.484
2004	0.917	1.457
2005	1.036	1.604
2006	1.463	1.561
2007	1.651	1.904
2008	2.056	1.824
2009	1.914	2.136
2010	1.681	1.565
2011	1.195	1.786
2012	1.204	1.449
2013	1.241	1.463
2014	1.380	1.376
2015	1.700	2.043
2016	1.721	2.577
2017	1.666	2.373

From Fig 3 it is clear that India's CFGT export share shows a cycle during 2003-2017. It has three major phases (i) CFGT export share increased at faster rate during 2003-2008, (ii) it declined in the period of 2009-2011 and (iii) recovery started in 2012 and improved at a slowly during 2012-2017. Both CFGT export and import share started to recover after 2014, however, CFGT import share recovered at a faster rate than its export.

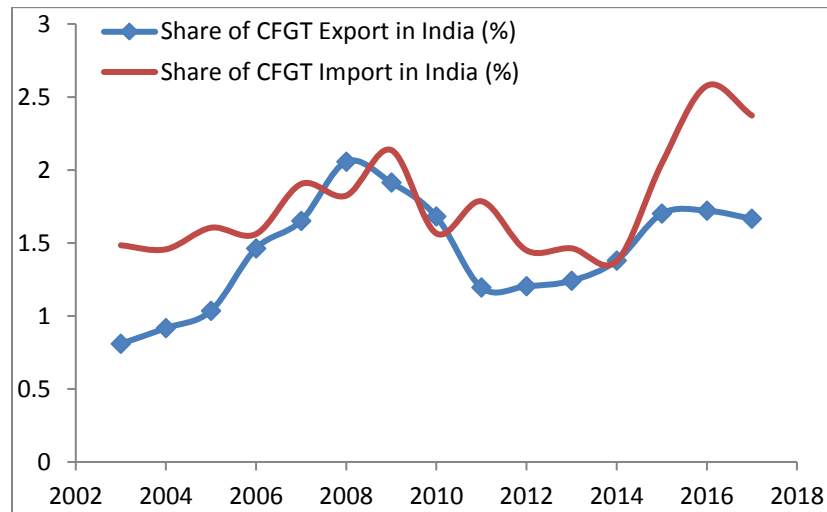


Fig 3: Trends of shares of CFGT export and import in India during 2003 -2017

Now we focus on certain regional destination for CFGT trade in India during 2003-2017. Table 2 provides major regional destinations of India's CFGT export and import measured in billion US dollar for selected years such as 2003, 2005, 2008, 2012 and 2016.

Table 2: Major Region wise CFGT export and import (Billion US \$) in India in 2003, 2005, 2008, 2012 and 2016

Destinations	Trade	2003	2005	2008	2012	2016
EU	Export	0.113724	0.255206	1.09234	0.617542	0.985031
	Import	0.535595	1.089974	2.231958	2.230582	1.753054
US	Export	0.052889	0.21159	0.650346	0.581526	0.702283
	Import	0.143167	0.27131	0.386497	0.680322	0.539844
Asia	Export	0.205621	0.326368	1.017836	1.19316	1.792884
	Import	0.322521	0.779661	2.649123	3.703722	6.313784
South Asia	Export	0.03476	0.054084	0.126209	0.185255	0.277685
	Import	0.010939	0.018206	0.052981	0.04441	0.049915

Note: Author's Calculation

India has imported CFGT mainly from Asia and the European Union. In 2003 and 2005, India imported more CFGT from the EU and exported to Asia, however, it reverse after the global financial crisis. In 2016, India’s CFGT import rapidly increased from Asia and correspondingly that declined from the EU. Actually, India has shifted its import destination from the EU in pre-crisis period (2003-2007) to Asia in post-crisis era (2010-2017). India’s CFGT import from the US rises slowly in post-crisis period except 2016 and its export to the US is more or less stable in post-crisis era. Fig 4 presents bar diagram for selected regions for selected years. Compared to major regional destinations of CFGT trade, South Asia region was not significantly visible in 2003 and 2005 in Fig 4. India has rapidly increased its CFGT export in South Asia from \$ 0.03476 billion USD in 2003 to \$ 0.278 billion USD in 2016 and 0.333 billion USD in 2017 (see, Table 2 and Table 3). India has certain positive role in South Asia to adapt and mitigate climate change issues.

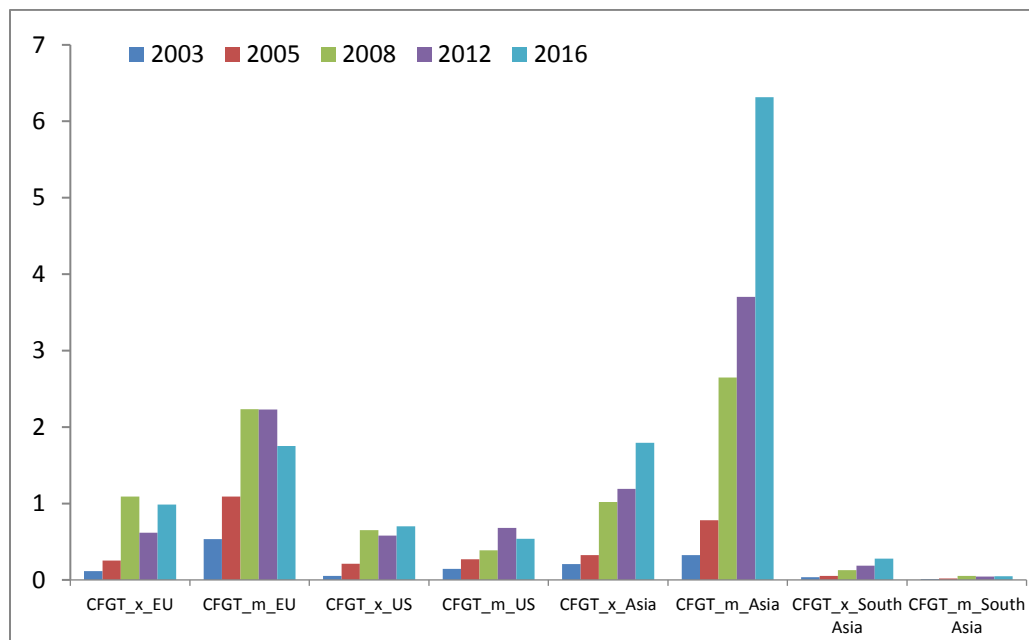


Fig 4: Regional destinations of CFGT export and import in India in 2003, 2005, 2008, 2012 and 2016

Now we investigate in details in India’s CFGT export trade growth in South Asia region during 2003 -2017. The whole period is also divided into two periods – pre and post crisis period, i.e., 2003-2007 and 2010 – 2017, respectively. Pre and post crisis period are

marked as red and green colour in Fig 5. India's CFGT export to South Asia increased at higher rate in post crisis period of 2010-2017 (see, dashed line, $y=0.024x-48.55$, in Fig 5) compared to a slower rate in the pre-crisis period of 2003 -2007 (see, dotted line, $y=0.010x-20.18$, in Fig 5). The slope of the dashed line is steeper than that of dotted line, which indicates a switch over from slower rate in pre-crisis period to higher rate in post-crisis period. In this context, exponential curve might be suitable for Indian's CFGT export to South Asia in the entire period of 2003-2017.

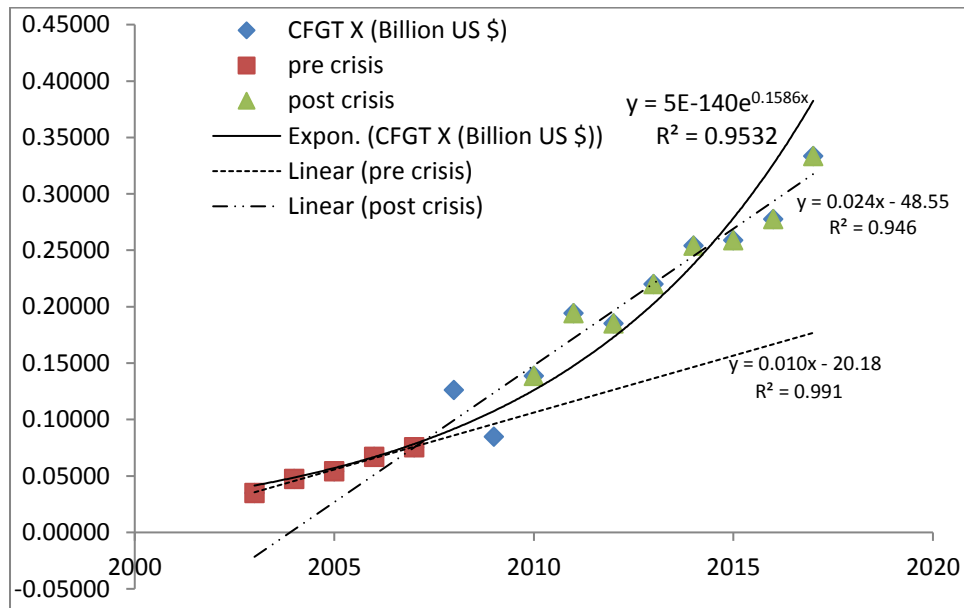


Fig 5: India's CFGT export to South Asia during pre and post crisis in the period of 2003 – 2017

Table 3: India's CFGT export (billion US dollar) to South Asia during 2003 – 2017

Year	2003	2004	2005	2006	2007	2008	2009	
CFGT X (Billion US \$)	0.035	0.047	0.054	0.067	0.075	0.126	0.085	
Year	2010	2011	2012	2013	2014	2015	2016	2017
CFGT X (Billion US \$)	0.139	0.194	0.185	0.220	0.254	0.259	0.278	0.333

Note: Author's Calculation

Table 3 displays India's CFGT export in billion US dollar to South Asia during 2003–2017. Observing the period of 2003-2009 in Table 3 it is clear that CFGT export amount of India to South Asia are below \$ 0.10 billion except in 2008 (\$ 0.126 billion, which is higher than \$ 0.10 billion). Amounts of CFGT export to South Asia are above \$0.10

billion during 2010–2012 and above \$0.20 billion in the period of 2013-2017. Now, it is a need to investigate CFGT export in India in 2008. It is discussed in next section in detail. Year to year change of India’s CFGT export to South Asia is segmented linear growth; however, actually, CFGT export of India to South Asia is growing exponentially in the entire period of 2003-2017 (see Fig 6). India is stepping strong footing in South Asia to promote CFGT to mitigate climate change issues in local, regional and global level.

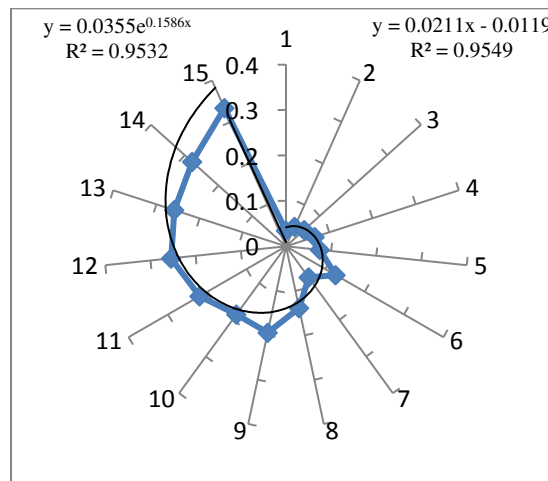


Fig 6: CFGT export growth in India during 2003 -2017

3.2 Findings in the crisis year 2008

This part of analysis is based on cross sectional study. Overall trade performance was quite satisfactory in Asia and especially in India in crisis year 2008. Asia’s actual export of CFGT trade⁶ was nearly \$119.74 billion USD in 2008. Correspondingly India’s actual trade value of CFGT export was nearly \$3.55 billion USD in 2008. It was 1.95% of India’s total trade to world in 2008.

In the earlier section we have discussed about region wise India’s CFGT export destinations. Now we estimate the above said gravity model for selected year 2005 and 2008, and analyse the results (see Table 4). Here, GDP and per capita GDP of the reporting country, India, are dropped because of no variation in a year, such as 2005 or

⁶Out of it, intraregional and interregional trades were 61.19 and 58.55 billion USD, respectively. Intraregional demand was nearly 51% and only 49% for interregional demand of CFGT. It is true that internal demand within Asia is very high for the climate friendly goods and over time it will increase with economic development.

2008. In 2005, coefficients of partner's GDP and per capita GDP, and distances between trading partners are statistically significant at 1% level. India's CFGT export raises with partner's GDP while it declines with partner's development (per capita GDP). Small country and common colony are significant at 5% and 10% level respectively. CFGT export is more in common colony countries compared to others while in case of small country it falls due to low demand for CFGT in 2005.

Table 4: Estimated gravity model for export of CFGT of India in 2005 and 2008

	Export in 2005	Export in 2008
Constant	-5.03 (-1.53)	-10.275*** (-3.66)
lnGDP Partner	0.984*** (10.93)	1.196*** (15.49)
lnPer Capita GDP Partner	-0.3845*** (-3.31)	-0.638*** (-5.8)
lnDistance	-1.0678*** (-3.71)	-0.7015*** (-2.72)
Contiguity	1.43 (1.26)	0.597 (0.59)
Common Office Language	-0.042 (-0.06)	-0.305 (-0.5)
Common Ethno	0.402 (0.61)	0.746 (1.32)
Colony	1.19 (0.62)	-0.259 (-0.15)
Common Colony	0.8434* (1.86)	0.748* (1.83)
Small Country	-3.79** (-2.15)	-3.12** (-1.98)
R ²	0.5528	0.6784
Adj.R ²	0.5265	0.6593
RMSE	1.8415	1.6459
N	163	162

Note: Figures in parentheses are t-value. '***', '**' and '*' denote the statistical level of significant at 1%, 5% and 10%, respectively.

The estimated coefficients are almost similarly significant except constant term in 2008 (Table 4). Constant term is highly significant in 2008, not in 2005. Magnitude of the estimated coefficient of partner's GDP is more than one. It suggests that it is elastic and more sensitive in 2008 compared to 2005. Similarly the coefficient of distance is less sensitive in 2008 compared to 2005. In terms of model fitting criteria gravity model in 2008 is better fitted than that in 2005.

As per statistically significant coefficients the estimated India's export of CFGT equation in 2005 is

$$\ln X_{ij} = 0.984 \ln GDP_j - 0.38 \ln pcgdp_j - 1.068 \ln DT_{ij} + 0.84 D_{commoncolony} - 3.79 D_{smctry}$$

Considering statistically significant coefficients the estimated equation of CFGT export of India in 2008 is

$$\ln X_{ij} = -10.275 + 1.196 \ln GDP_j - 0.638 \ln pcgdp_j - 0.7015 \ln DT_{ij} + 0.748 D_{commoncolony} - 3.12 D_{smctry}$$

It is interesting that the significant variables in 2005 are also significant in 2008 and difference is a constant term which is significant in 2008. Constant term is statistically significant which might capture other unknown other factors in India. Detail depth study is required to explore the reasons behind it.

3.3 Potential Trade Gaps

Using these estimated gravity models we can estimate the potential export of CFGT in India in 2005 and 2008. 'Potential trade gap' is measured as the difference between actual export and predicted value of export of CFGT in this study as mentioned in the earlier paper. 'Potential trade gap' is a measurement of performance of a bilateral trade flow relative to the model predicted mean trade value for India for given year. Using the gravity model we estimate the predicted export trade value of India with its trade partners. For the analysis purpose this study mainly focuses on the quantification of 'potential trade gap' in India. 'Potential trade gap of CFGT' itself suggests that there is a scope to increase the export of CFGT with respective trading partners.

Now this paper highlights the potential trade of CFGT in India. Using estimated export gravity equation in Asia we also show the estimated potential export gap in Fig 7 and Fig 8 for 2005. Potential export gap is measured and display graphically for all trade partners of India. Figure 7 and Figure 8 show the trade gaps for countries in Asia-Pacific region and the European Union, respectively. In Figure 7 and Figure 8, the horizontal line is the benchmark line and bars indicate trade gaps. These bars are standardized trade gaps. Bars below the benchmark line show that actual trade of CFGT is less than estimated potential trade. In other words, bars below the benchmark indicate the untapped trade opportunity for India in CFGT trade.

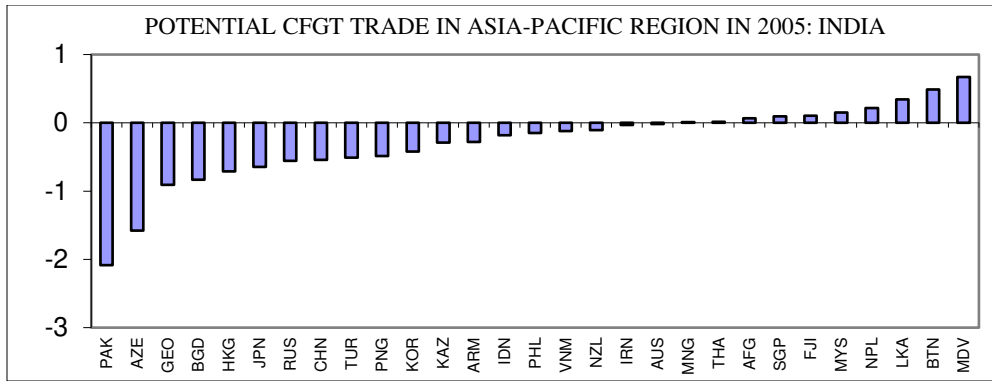


Fig 7: India's trade opportunity in Asia and Pacific in 2005

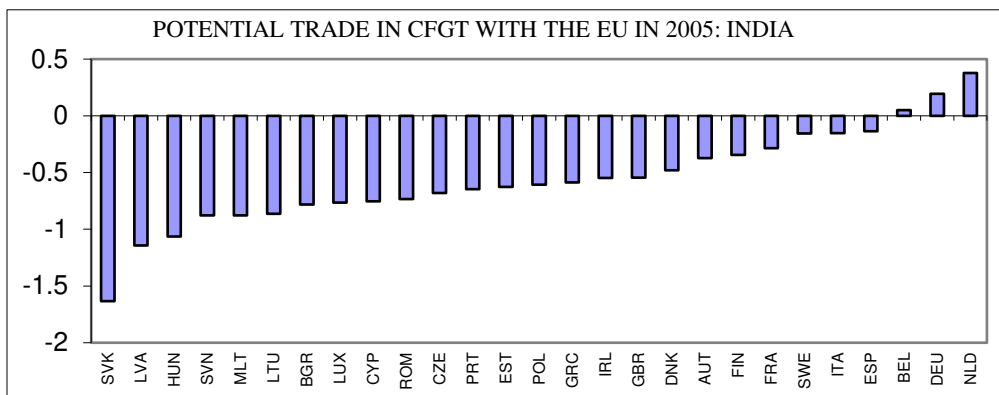


Fig 8: India's trade opportunity in the EU in 2005

Total estimated export potential trade gap of CFGT in India is nearly \$6 billion USD in 2008. This trade gap suggests that India could increase the export of CFGT around \$6 billion USD in 2008.

Following gravity equation, total estimated potential CFGT export was \$9.536 billion USD in India in 2008 while actual export was only \$3.55 billion USD. Actually India utilized only 37.2% of its potential export trade of CFGT in 2008. India could increase export of CFGT by 62.8% in 2008. India can utilize moderately trade of CFGT and has potential to increase its trade opportunity in CFGT. Roughly total potential export gap of CFGT in India was \$6 billion USD in the World out of \$4.9 billion USD was in Asia in 2008. Definitely it suggests increasing trade with respective partners.

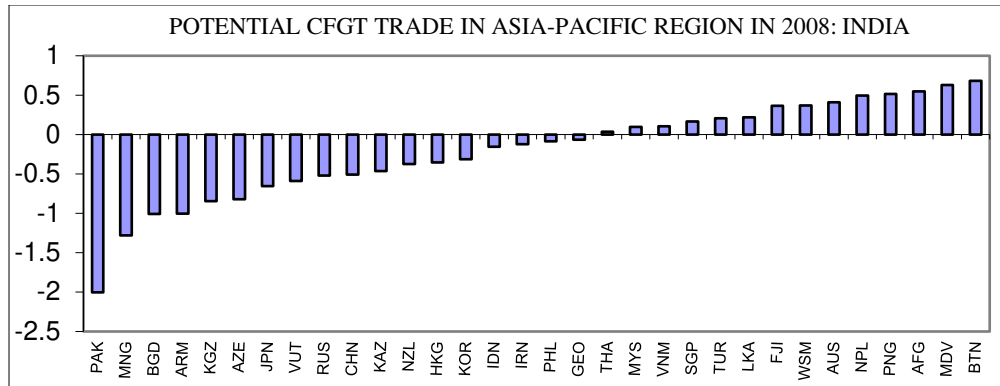


Fig 9: India's trade opportunity in Asia and Pacific Region in 2008

From Fig 9 it is clear that India's potential trade is huge in Asia and Asia-Pacific region. Within Asia, India could increase the CFGT export to Pakistan, Mongolia, Bangladesh, Armenia, Kazakhstan, Azerbaijan, Japan, Vanuatu, Russia, China, Kyrgyz Republic, Hong Kong, Korean Republic, Indonesia, Iran, Philippines.

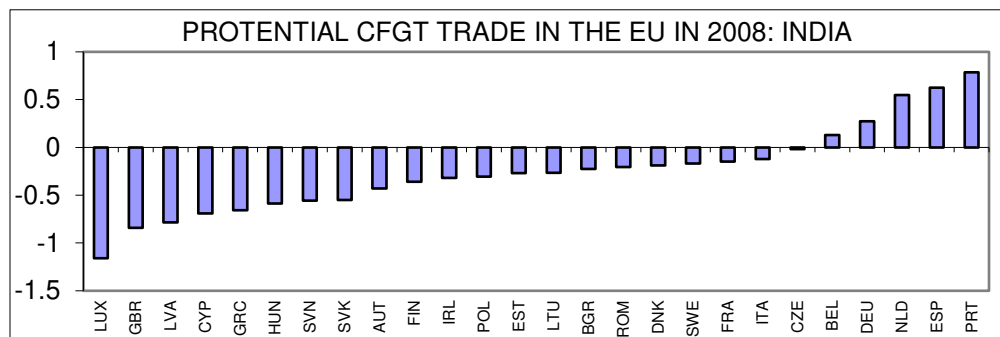


Fig 10: India's trade opportunity in the EU in 2008

Fig 10 displays that India has a great potential export trade of CFGT to developed countries. The most important and encouraging India's CFGT trade partners are Luxembourg, UK, Latvia, Cyprus, Greece, Hungary, Slovenia, Slovakia, Austria, Finland, Ireland, Poland, Spain, Lithuania, Bulgaria, Romania, Denmark, Sweden, France, Italy and Czech Republic. India has trade potential to increase trade of CFGT with Canada.

The estimated India's CFGT export potential gap in 2008 was around \$5 billion US dollar within Asia and \$1.01 billion USD with EU. India's export potential trade gap of

CFGT was higher in Asia than the EU. India has strong trade potential with Pakistan, Bangladesh, China, Japan, Russia, and South Korea and estimated potential export gap of CFGT to these countries was nearly \$4.9 billion USD. India's CFGT export potential gap to Pakistan and Bangladesh was \$4.4 billion USD. India should explore this potential trade after revising its *East Look Policy* and could stimulate to control climate change in the region.

India's CFGT potential trade top partners in EU were UK, France, Italy, Poland, Greece and Austria and the potential trade gap was nearly \$1 billion USD in the crisis period. India had potential to increase its export of CFGT to Asia and the EU approximately more than \$6 billion USD in 2008. There was a huge variation in the potential trade gap among nations due to lack of knowledge, back dated technology, lack of effective skilled labour and entrepreneurs, lack of trade facilitations and infrastructure etc.

Truly cross-sectional study could not capture this dynamics. To capture time dynamics it is an essential need to examine time series analysis to overview trade performance in India.

4. Conclusion

This paper highlights how emerging India mitigates climate change issues through trade channel. This study provides India's trade performances during 2002-20017 and suggests possible solution through possible trade channels. CFGT import of India increases gradually over time in the period of 2003-2017. India's CFGT import share rises in each interregional level. It was high in the EU in pre-crisis period while it increases at a faster rate in Asia especially after global financial crisis. India's CFGT export share has increased in South Asia, Asia, and the EU in the post-crisis period. India's CFGT export to South Asia grows around 3.5% in post crisis period (2010-2017) compared to 2.1% in pre-crisis period (2003-2007).

The paper shows the trend of CFGT trade in the period of 2003-2017 and highlights the estimated trade gap of CFGT in India in 2005 and 2008. Applying the gravity model this paper measures the *potential trade gap* and suggests possible expansion of the export trade of CFGT among trading partners. The total estimated export potential trade gap of CFGT in India was around \$6 billion US dollar in 2008. This study contributes in the

empirical measurement of potential trade of CFGT in India and quantifies potential trade gap of individual partners. It supports the possible emergence of CFGT export-led growth in India and also mitigates climate change problems in future. India might adopt few policies to improve and raise CFGT production and trade. The reasons for untapped potential export gap in CFGT might be the lack of awareness, unavailability of technology, lack of human capital for CFGT production, the government policy, lack of trade facilitations etc.

Our next agenda is to collect more information on supply chain and explore these in details using updated econometrics tools like Global VAR model and forecast potential CFGT trade for 2020, 2030 and 2050. More depth study is needed to overcome these limitations.

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