Climate Change Creates Trade Opportunity in India

Dinda, Soumyananda

S. K. B. University, Purulia, Chandragupt Institute of Management Patna

11 February 2013

CLIMATE CHANGE CREATES TRADE OPPORTUNITY IN INDIA

Soumyananda Dinda

Sidho Kanho Birsha University, Purulia, West Bengal, India

2013

Abstract

Climate change is an emerging challenge to developing economy like India however it also creates opportunity to grow through climate friendly goods production and new direction of trade. This paper focuses India's potential export trade in climate friendly goods. The estimated gravity model is defined as the potential trade and potential trade gap is measured as how well a bilateral trade flow performs relative to the mean as predicted by the model. Potential trade gap means that actual trade is less than predicted trade value. It suggests that there is a scope to increase the export of climate friendly goods (CFG) to trading partners. The total estimated CFG export potential trade gap in India is around 6 billion US dollar (USD) in 2008. This study contributes on the empirical measurement of potential trade of climate friendly goods in India. Paper suggests a possible climate smart export-led growth model in India and mitigates climate change problems.

Key Words: Bilateral trade flow, Climate friendly goods, Export, Gravity model, Potential Trade, Asia, EU, USA, UK.

JEL *Classifications*: F64, F43, Q56, C13, O5

.....

Address for Communication: Department of Economics, Sidho Kanho Birsha University, Purulia Zilla Parishad, Old Administrative Building, P.O. & Dist = Purulia, PIN 723101, West Bengal, INDIA. Email: sdinda2000@yahoo.co.in, s.dinda@cimp.ac.in, sdinda@gmail.com, soumyananda@un.org and s_dinda@hotmail.com Ph +91 3252 225375 (Res), Ph & Fax: +91 3252 224438 (Office).

1. Introduction

Climate change is a new 'avatar' to the developing countries like India. Truly, climate change is one of the greatest threats to the human civilization and the toughest challenge for the economic development in the 21st century. Accumulation of fossil fuel consumption in developed countries during industrialization is the main cause of climate change in the world. They have contributed a lot to change the climate. Less Developed Countries (LDCs) have contributed negligible or little to cause climate change, yet face its harshest impacts and have the weakest capacity to adapt to these impacts. In this context, even there is lot of limitations or obstacles for development; climate change also provides certain opportunity to grow with newly climate friendly products (CFP). Now, question arises as follows: Does climate change create any opportunity in India? Does climate change create trade opportunity for climate friendly goods and technology (CFGT) in India? How do we measure the trade opportunity? Can trade help to mitigate climate change? How much is the volume of trade opportunity for India in climate friendly goods? Who are the potential trade partners within Asia region and in the world? This paper attempts to quantify trade opportunities of CFGT in India.

Climate change emerges as a new constraint and creates obstacle for development as well as opportunity to grow. Truly it provides the opportunity to redesign the economic activities. For the supply driven economy still trade is the engine of growth. Trade can help developing countries with adaptation, through generating export earnings and accessing the updated technologies. Trade has also a role in mitigation of climate change through disseminating and exchanging the low carbon technologies. The objective of the

clean technology is to improve energy efficiency and reduce environmental impacts. The Goods that have relatively less adverse impact on the environment is termed as climate friendly goods (CFG). The paper examines the potential trade in climate friendly goods and technology in India. This study provides evidence focusing on trade opportunity of CFG to form the policy opinion on '*climate change and trade*'.

This study highlights the export potential trade of CFG in India. It deals with the potential trade of India's CFG within Asia, with European Union (EU), North America (the USA and Canada) and rest of the world. This study is mainly based on the application of the gravity model. The gravity analysis is useful to explain determinants of exports potential of CFG in India with Asia, the US and the EU. Gravity model is adopted to explain the role of economic size and endowments, distance between trading partner, membership of multilateral agreement, among others on trade of such climate friendly goods or/and sub-categories. In particular, the gravity analysis considers the bilateral total trade of the CFG exports of India for the years 2008. This study is a cross- sectional data analysis for estimating the gravity equation.

1.1 Climate friendly goods

Climate friendly goods (CFG) are defined broadly as products[1], components, and technologies which tend to have relatively less adverse impact on the environment. CFG constitutes low carbon growth technologies. For example, one subcategory is the clean coal. Clean coal technology aims to improve energy efficiency and reduce environmental impacts, including technologies of coal extraction, coal preparation and coal utilization.

[1] It consists of articles of Iron and Steel, Aluminum, machinery and mechanical appliances, electrical machinery equipment, ships, boats and floating structures, glass and glass ware articles, among others.

Wind technology another sub- category of CFG focuses on wind energy generation and is composed of three integral components: the gear box, coupling and wind turbine.

The climate friendly goods (CFG) is a part of the wider group named environmental goods and services (EGS). An environmental good can be understood as equipment, material or technology used to address a particular environmental problem or as a product that is itself 'environmentally preferable' to other similar products because of its relatively benign impact on environment. Environmental services are provided by ecosystems or human activities to address environmental problems and help to minimize the environmental damages and protect the bio-sphere of the earth. EGS can be also classified as *Environmental Goods* comprising of pollution management products, cleaner technologies and products, resource management products and environmentally preferable products. EGS also has environmental services comprising of sewage services, refuse services, sanitation and similar services and others. The EGS were first discussed as part of the liberalizing agenda[2] in the DOHA round of the multilateral trading round in 2001. The countries had wanted the tariff and non-tariff barriers to go down for trade of such EGS as this may lead to adoption of cleaner and cost effective technologies by firms and country at large and possibly mitigate climate change and improve energy efficiency. The CFG (a subset of EGS) were discussed at the multilateral forums as countries wanted a smaller list to liberalize and where in negotiations could be easier done than concentrating on the entire list of environmental goods[3].

[2] Liberalization has followed three routes namely the list approach, project/integrated approach and request for offer approach. Environmental Goods were always part of trade agenda but were subsumed within industrial or agricultural negotiations.

[3] For example WTO came out with a list of 153 goods for liberalization. The World Bank identified 47 products out of 153 products list proposed by proponents of Environment Goods liberalization in the WTO.

Free and liberalized trade can make available such goods for countries which have no access to the CFG or where in domestic industries are unable to produce them in sufficient scale or at affordable prices. For exporters additional market access can provide incentives to develop new products or technologies with less green house gas emissions. As a whole global climate impact will reduce definitely.

Most of the exporters of EGS are the developed nation but some of the developing countries are also becoming important players in the heat and energy management equipment, noise and vibration abatement, and in environmental services like air pollution control and solid waste management[4]. In this context developing country like India should focus on CFG trade and emphasis more on it.

This paper is organized as follows. Section 2 reviews the literature. Section 3 describes data and methodology. Section 4 presents results. Finally, Section 5 draws some concluding observations.

2. Literature Review

The gravity model of trade is based on the idea that trade volumes between two countries depend on the sizes of the two countries and the distance[5] between them. This simple model has been used extensively in analyzing trade and has been successful to a high degree in explaining trade[6]. There is debate on trade resistances that might limit or promote trade between particular trading partners, often relying on a number of variables to proxy total trade resistances, including trade related costs. Recently global climate change itself creates new resistances on international trade. This climate change

---

These 47 products comprised diverse products from wind turbines to solar panels to water saving shower. Similarly OECD and ICTSD had their own lists of environmental goods and services.

[4] See, Veena Jha (2008) for more details.

[5] Distance could be physical, cultural or/and political.

[6] Harrigan (2001) and Anderson and van Wincoop (2004) contain comprehensive reviews.

resistances also create the opportunity for trade in new direction in the name of green businesses. The review of literature demonstrates the new direction of potential trade in climate friendly goods.

Anderson (1979) introduced the gravity model theoretical legitimacy. He derived the gravity equation from expenditure systems where goods are differentiated by country of origin and distance is the proxy of all transport costs. The theoretical foundations of the gravity model as described by Anderson (1979), Bergstrand (1985), Helpman (1987) and Deardorff (1995) start with the assumption of frictionless trade or iceberg transport costs and then, with the exception of Bergstrand, derive a model where trade volumes between country pairs are proportions of the product of incomes or total world trade. Bergstrand (1985) made the next significant contribution to giving the model a theoretical underpinning and deriving the model as a 'partial equilibrium subsystem of a general equilibrium model'. Prices are generally considered endogenous in gravity models because they are general equilibrium models with exporter supply and importer demand clearing, but Bergstrand (1985; 1989) introduces and justifies the use of prices from underlying production functions and utility functions where he argues that strong assumptions, such as perfect international commodity arbitrage, are clearly not met in reality. Helpman (1987) derives the gravity model from an imperfect competition model and Deardorff (1995) derives it from the Heckscher–Ohlin model. Indeed, the gravity model can be derived from numerous trade theories in one form or another and can be used to find empirical evidence of many trade theories with different assumptions about preferences and whether goods are differentiated or homogeneous (Deardorff 1995; Harrigan 2001).

Trade shares 'fall naturally into a gravity-equation' (Deardorff 1995). This probabilistic method is comparable to the analysis of trade intensities (Drysdale and Garnaut 1982) which uses the relative size of a country's trade as a benchmark for what the country is expected to trade. Although they give the gravity equation theoretical backing, the assumptions of frictionless trade or iceberg transport costs to capture all the frictions are strong but are a poor proxy for trade friction. The 'border puzzle[7]', of large unexplained trade costs when goods are traded across a national border, has been the focus of much of the literature since McCallum (1995). He applied the gravity model to estimate a value for the loss in trade volume accounted for by goods crossing the US–Canada border as compared to intra-national trade (between states or provinces) in both countries. The findings show that international border effects are inferred and that they matter even with two economies that share a large border and are highly integrated through a regional trade arrangement (RTA) such as NAFTA. Trading across borders will cause disconnect in relative prices as insurance, freight, tariffs, non-tariff barriers, and different regulatory structures cause uncertainty and impede trade to some extent.

Linnemann (1966) started a process in the literature of adding trade explicators and inhibitors to the gravity model. Frankel, Stein and Wei (1997) undertake a comprehensive

[7] Anderson and van Wincoop (2003) claim to solve the border puzzle using McCallum's data by deriving the gravity equation from expenditure functions and importantly adding what they call multilateral resistance. The multilateral resistance terms are important and mean that if country *i*'s trade with country *j* is being analysed and there is no movement in the trade determinants, a change in country *k*'s trade with country *i* will affect trade between *i* and *j*, as would be expected. Their specification explains away most of the border puzzle. McCallum (1995) found that trade between US and Canada was lower than trade within their borders by a factor, but Anderson and van Wincoop (2003) reduce this unexplained border effect to the border's lowering trade by 44 per cent. They assumed symmetric trade costs to solve their model, which is a significant but unrealistic assumption. Their results are disputed in an important paper by Balisteri and Hillberry (2006) who find that the theory consistent model of Anderson and van Wincoop (2003) does not explain away the border puzzle. Balisteri and Hillberry (2006) relax the assumption of symmetric border costs and account for structural bias in Anderson and van Wincoop (2003) that arises from the incorrect treatment of an adding up constraint which is implicit in the Anderson and van Wincoop (2003) model. The correct estimation of the Anderson and van Wincoop (2003) derivation shows that the literature still cannot explain the border puzzle, or what we prefer to describe here as unexplained resistances.

study[8] of regional trading blocs using the gravity model as the main tool. The exchange rate volatility had been commonly included as a trade explanatory in the gravity model, Rose (2000) made an important contribution as the first to include a common currency dummy variable to explain trade[9].

The wide use of the model, and the policy implications drawn from its application that are quite significant in absolute dollar terms, have led to concentration in the literature on improving on the accuracy of the econometric specifications and techniques. Differing econometric specifications of the gravity equation are numerous[10]. Baldwin and Taglioni (2006) summarize errors that are frequently repeated in the literature. What they call the gold medal error, so named because of the relatively high effect it has on the estimates of all trade resistance variables, is due to the omission of the Anderson and van Wincoop (2003) multilateral resistance terms which are explained above footnote. The second most

[8] There are many studies that measure the effects of bilateral and multilateral trade arrangements, both discriminatory and nondiscriminatory, but perhaps none as comprehensive and convincing as that of Frankel, Stein and Wei. They are able to quantify the amount by which different preferential trade arrangements (PTAs) and regional arrangements such as APEC, increase trade by adding trade agreement dummy variables into the standard gravity model. Analysis of regional or multilateral trade arrangements using gravity models is now commonplace and important in applied trade theory.

[9] The finding that an economy which is so highly integrated with another economy that there is a common currency, increases trade three fold, as his European Union dummy suggested, had a large impact on the literature with significant policy implications. The idea of increased trade from a common currency is intuitive, but the magnitude was surprising. Baldwin and Taglioni (2006) reduce the magnitude of the common currency effect significantly using Anderson and van Wincoop (2003)'s structural estimation with multilateral resistance.

[10] The question of using population as an explanatory variable is one example where the gravity equation is inconsistent. The theoretical underpinnings derived by Anderson (1979) Helpman (1987) Deardorff (1995), do not justify the inclusion of population, and its effect is positive sometimes and negative other times. A positive effect, implying that a country with a higher population trades more, would be the expected result for developing economies as they tend to be specialised in labour-intensive exports. A negative effect for population size could be due to economies with larger populations having an absorption effect (Martínez–Zarzoso and Nowak–Lehmann 2003). Then why do so many researchers include population? Including the log of GDP and log of population separately in the log linearisation of the gravity model for estimation, is equivalent to including the log of GDP per capita with a restriction on the estimated coefficients of GDP and population separately. However, many papers do not explicitly say this, and the population term is included in the model to control for country size but often ignored in the analysis. The reason GDP per capita is included in so many models is that it has meaning in the context of using the Linder hypothesis in explaining trade flows.

important error they identify is related to when trade between countries *i* and *j* is analyzed as an average of both trade from *i* to *j* and trade in the other direction.

Baldwin (1994), Dinda (2011a, 2011b) Nilsson (2000) and Egger (2002) are the most prominent examples in the literature that use the term trade 'potential' as the expected volume of trade between country pairs that the gravity model predicts. They then measure how far above or below potential trade from actual trade. It gives a measure of performance of bilateral trade flow. This study quantifies the gap between expected and actual trade and contributes in the empirical measurement of potential trade gap of climate friendly goods in India. It also highlights the climate friendly export-led growth model for emerging India.

3. Data and Methodology

This study has been able to identify 64 climate friendly goods (CFGs) under 6 digit HS code (2002) by putting together various lists that have been defined by various international organizations recently. The list[11] is arrived by defining concordance series from the list given by the World Bank, ICTSD, WTO, APEC and the OECD. The study considers these CFGs as one category and estimates above mentioned trade indicators for this category. Following the World Bank (2008) we have been able to sub group these 64 goods further into clean coal technologies (HS code 840510, 841181 and 841182), Wind Energy (HS code 848340 and 848360), Solar Photovoltaic systems (HS code 850720, 853710 and 854140) and Energy Efficient Lighting (HS code 853931). The study besides these four sub groups have also considered 'Other Codes' as the fifth group which consists of all HS codes not considered in the four categories above. All these 64 CFG items are considered as single trade item for this study purpose.

[11] List of 64 climate smart goods with HS code is given in Appendix.

Climate friendly goods (CFG) trade data (in value, 1000 US dollar) is taken from UN COMTRADE data (www.comtrade.un.org) for the year 2008. Gross Domestic Production (GDP) and per capita GDP data are taken World Bank Development Indicators (www.worldbank.org/data) for corresponding years. Distance between countries and other dummy variables are taken from the dist_cepii.xls file of CEPII DATABASE (see the website: www.cepii.fr). Total observation is reduced after combining all the variables for each pair of trading partners[12]. This filtered data set is used in the empirical analysis. The following gravity model is considered for the analysis

$$X_{ij} = \beta_0 + \beta_1 GDP_i + \beta_2 GDP_j + \beta_3 PCGDP_i + \beta_4\, PCGDP_j + \beta_5\, DT_{ij} + \beta_6\, D_{contig} + \beta_7\, D_{comlang} + \beta_8 D_{comlang\_ethno} + \beta_9 D_{colony} + \beta_{10} D_{comcol} + \beta_{11} D_{col45} + \beta_{12} D_{smctry} + \beta_{13} Trf_j + \varepsilon_{ij} \qquad (1)$$

Where x_{ij} denotes the value of country *i* exports to country *j*, GDP_i and $PCGDP_i$ denote the exporting country's gross domestic product and per capita GDP, respectively; and GDP_j and $PCGDP_j$ denote the gross domestic product and per capita GDP of the partner of the exporting country, respectively; DT_{ij} denotes the distance between the exporting country and its partner (importing country); Trf_j is the (weighted average) tariff rate imposed by partner of exporting country, D_{contig}, $D_{comlang}$, $D_{comlang\_ethno}$, D_{colony}, D_{comcol}, D_{col45} *and* D_{smctry} are the dummy variables for contiguity, common language, colony, common colony, colony from 1945 and small country, respectively. In our regression analysis we have used the log values of all variables (except dummies).

4. Results and Discussions

Overall trade performance was quite satisfactory in Asia and especially in India in 2008. Initially the preliminary findings are summarized and discussed. Asia's actual export of

[12] This study considers fully matched data only.

CFG trade was nearly 119.74 billion USD in 2008. Out 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 CFG. It is true that internal demand within Asia-Pacific region is very high for the climate friendly goods and over time it will increase with economic development. Correspondingly India's actual export trade value of CFG was nearly 3.55 billion USD in 2008. It was 1.95% of India's total trade to world in 2008.

Now we estimate the potential export of CFG in Asia in 2008. Using econometric techniques the above gravity equation (1) is estimated for analysis purpose. Table 1 presents the estimated results of the gravity model for the CFG in 2008. The coefficients of GDP reporter, GDP partner, per capita GDP of reporter, geographical distance between two countries, common colony and small country are statistically significant at 1% level. The coefficient of common language is significant at 10% level. Considering statistically significant coefficients the estimated export of CFG equation is

$$X_{ij} = -49.27 + 1.605\ GDP_i + 0.94\ GDP_j - 0.28\ pcgdp_i - 0.93\ DT_{ij} + 0.69\ D_{cmcl} + 2.99\ D_{smctry} \qquad (2)$$

The equation (2) is the benchmark for predicting potential export trade of any country in Asia in 2008. The export elasticity of climate friendly goods (CFG) is elastic with respect to gross domestic production (GDP) of reporting country which suggests that export of CFG would be increased by more than 1.6 percent if income of the reporting country increases by one percent. So, the growth of CFG export is more than the reporter country's GDP growth. The CFG export led-growth is highly important to follow sustainable development to all reporting countries in Asia. In terms of scale effect, the export of CFG for reporter country is playing an important role for its economic growth.

The export elasticity of CFG is inelastic with respect to partner country's GDP. It suggest that if partner country's GDP increases by one percent the export of CFG increases by 0.94 percent in reporter country's GDP. From this probably one can guess that one part of partner country's internal demand is fulfilled by their production of CFG. The export of CFG decreases by 0.28 percent as per capita GDP increases by one percent. It is due to internal demand of CFG. It is true that internal demand of CFG increases in each country with their economic growth in Asia. It might help the emerging Asian nations to grow with sustainable development. It is clear that export of CFG increases in Asia due to possibly economics of scale that also raises per capita income which increase internal demand of CFG. Internal demand increases because of the awareness of global climate change and availability of CFG. So the opportunity of green business in Asia is growing and business of CFG is expanding. Countries in Asia are prepared to shape the economy towards sustainable development. The coefficient of distance between country pair is negative as it is expected in the gravity model. This observation supports the existing literature on trade gravity model. The exports of CFG are more in the common colony compared to others. Overall CFG exports are higher in small countries compare to others in Asia. Constant term is statistically significant which might capture other unknown other factors. Detail depth study is required to explore the reasons behind it.

Following Baldwin (1994), Nilsson (2000) and Egger (2002) many Asia countries are far below the expected trade performance as the literature define the term potential trade gap. Potential trade gap is measured as the difference between actual export and predicted value of export of CFG in this study. It is a measurement of how well a bilateral trade flow performs relative to the model predicted mean value for Asian countries. Using the

gravity model we estimate the predicted export trade value of the reporting country with its trade partners. For the analysis purpose this study mainly focuses on the quantification of 'potential trade gap' in Asian countries especially in India. It is a gap that is defined as the actual trade less than predicted value. 'Potential trade gap of CFG' itself suggests that there is a scope to increase the export of climate friendly goods and technology. The total estimated export potential trade gap of climate friendly goods in Asia is around 30 – 35 billion US dollar and that of in India is nearly 6 billion USD in 2008.

Trade performances of CFG export are far below their predicted value in many Asian nations including India. This trade gap suggests that they could increase the export of CFG. These countries could be increased their potential export trade of CFG nearly 7.34 billion USD. Among these countries India (4.2 billion USD) is in the top followed by Russia (1.51 billion USD), Pakistan (0.98 billion USD), Hong Kong China (0.59 billion USD), Azerbaijan (6.7 million USD) etc. These major countries have huge untapped potential trade of CFG.

Intraregional demand for CFG is also very high. Actual intraregional import was 61.2 billion USD in 2008. Some countries could not fulfill its import demand during the crisis period in 2008. These countries could be increased their import trade of CFG nearly 19.84 billion USD only through intraregional trade. The major import potential countries are Korean republic (15.78 billion USD), Pakistan (2.79 billion USD), Armenia (7.37 million USD) and Bangladesh (1.26 billion USD) etc.

Now the paper highlights the potential trade of CFG in India. Using equation (2), total estimated potential export trade of CFG 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 CFG in 2008. India could increase export of CFG by 62.8% in 2008. India can utilize moderately trade of CFG and has potential to increase its trade opportunity in CFG. Roughly total potential trade gap of CFG in India was 4.2 billion USD in Asia and 6 billion USD in the World in 2008.

Potential trade gap is measured for all trade partners of India. Figure 1 and Figure 2 show the trade gaps for countries in Asia Pacific region and European Union, respectively. In figure 1 and 2, 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 CFG is less than estimated potential trade. In other words, bars below the benchmark indicate the untapped trade opportunity for CFG. Definitely it suggests increasing trade with respective partners.

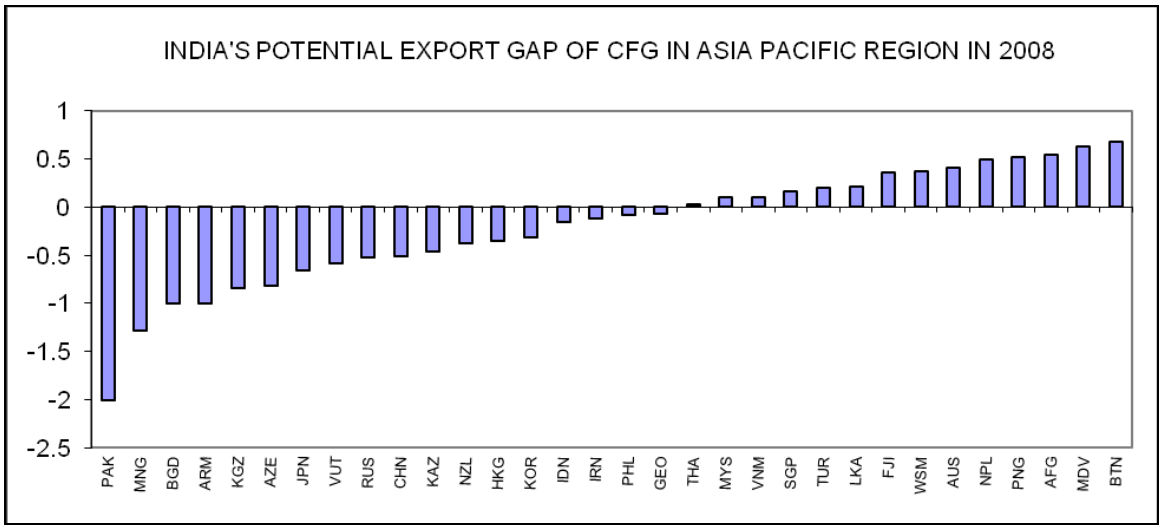

Fig 1: India's trade opportunity in Asia Pacific region

From Fig 1 it is clear that India's potential trade is huge in Asia Pacific region. Within Asia Pacific region, India could increase the CFG export to Pakistan, Mongolia,

Bangladesh, Armenia, Kazakhstan, Azerbaijan, Japan, Vanuatu, Russia, China, Kyrgyz Republic, New Zealand, Hong Kong, Korean Republic, Indonesia, Iran, Philippines.

Fig 2 displays that India has a great potential export trade of CFG to developed countries. The most important and encouraging India's CFG 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 CFG with Canada.

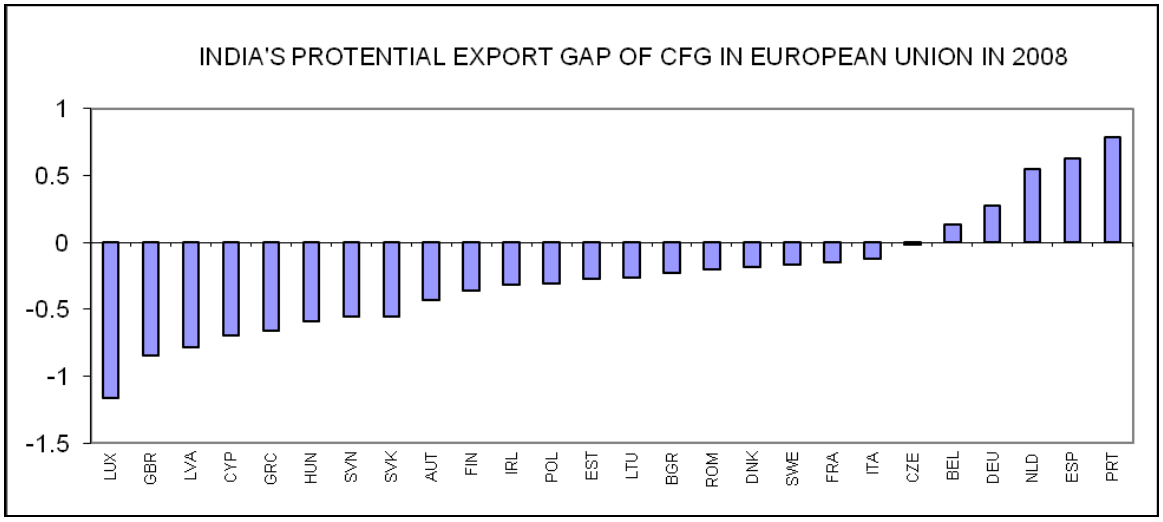

Fig 2: India's trade opportunity in the EU

The estimated India's CFG exports potential gaps are 4.976 billion US dollar within Asia Pacific region and 1.01 billion USD with EU. India's export potential trade gap of CFG is higher in Asia region than EU. India has strong trade potential with Pakistan, Bangladesh, China, Japan, Russia, and South Korea and estimated potential export gap of CFG to these countries is nearly 4.9 billion USD. India's CFG export potential gap to Pakistan

and Bangladesh is 4.4 billion USD. India should explore this potential trade and revise the *East Look Policy* and can stimulate to control climate change in the region.

India's CFG potential trade top partners in EU are UK, France, Italy, Poland, Greece and Austria and the potential trade gap is nearly 1 billion USD. India has potential to increase its export of CFG to Asia and EU approximately more than 6 billion USD.

There is a huge variation in the potential trade gap among nations. Major reasons are lack of awareness and knowledge, insufficient technology, lack of skilled labour for production of CFG, lack of trade facilitations etc.

5. Conclusion

The paper highlights the estimated trade gap of CFG in India in 2008. Applying the gravity model this paper measures the *potential trade gap* and suggests possible expansion of the export trade of climate friendly goods among trading partners. The total estimated export potential trade gap of CFG in India was around 6 - 7 billion US dollar in 2008. This study contributes in the empirical measurement of potential trade of climate friendly goods in India and quantifies potential trade gap of individual partners. It supports the possible emergence of CFG export-led growth model in India and also mitigates climate change problems in future. India might adopt few policies to improve and raise CFG production and trade. The reasons for untapped potential export gap in CFGs might be the lack of awareness, unavailability of technology, lack of skilled labour for production of CFG, govt. policy towards climate friendly goods, lack of trade facilitations etc. Our next agenda is to explore these in details and forecast potential trade of CFG for 2020, 2030 and 2050. More depth study is needed to overcome these

limitations. Next research agenda is to identify and estimate sub- regional and country specific trade potential in Asia and the World.

Acknowledgement: I am grateful to Mia Mikic, UNESCAP, Bangkok, for her suggestion regarding application of gravity model for estimation and conceptualization on the CFG and green technology trade.

References

- Anderson, J.E., 1979. 'A Theoretical Foundation for the Gravity Equation', *American Economic Review* 69(1):106–16.
- Anderson, J.E. and van Wincoop, E., 2003. 'Gravity with Gravitas: A Solution to the Border Puzzle', *American Economic Review* 93(1): 170–92.
- Anderson, J.E. and van Wincoop, E., 2004. 'Trade Costs', *Journal of Economic Literature* 42(3): 691–751.
- Anderson, M., Ferrantino, M., and Schaeffer, K., 2005. 'Monte Carlo Appraisals of Gavity Model Specifications', *US International Trade Commission Working Paper* 2004–05-A.
- Baier, Scott L. & Bergstrand, Jeffrey H., 2001. "The growth of world trade: tariffs, transport costs, and income similarity," *Journal of International Economics*, vol. 53(1): 1-27.
- Baldwin, R. E. and Taglioni, D., 2006. 'Gravity for Dummies and Dummies for Gravity Equations', *NBER Working Paper* No. W12516.
- Baldwin, R., 1994. *Towards an Integrated Europe*, Centre for Economic Policy Research, London.
- Balistreri, E. J. and Hillberry, R. H., 2006. Trade frictions and welfare in the gravity model: how much of the iceberg melt? *Canadian Journal of Economics*, Vol.-39: 247 -265.

- Bergstrand, J.H., 1985. 'The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence', *Review of Economics and Statistics* 67(3): 474–81.
- Bergstrand, J. H., 1989. 'The Generalized Gravity Equation, Monopolistic Competition, and the Factor–Proportions Theory in International Trade', *Review of Economics and Statistics* 71(1):143–53.
- Cheng, I. H. and Wall, H. J., 2005. 'Controlling for Heterogeneity in Gravity Models of Trade and Integration', *Federal Reserve Bank of St. Louis Review,* 87(1): 49–63.
- Deardorff, A.V., 1995. 'Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?', *NBER Working Papers* No. 5377.
- Deardorff, Alan V., 1984. "Testing trade theories and predicting trade flows," in R. W. Jones & P. B. Kenen (ed.), *Handbook of International Economics*, 1st edition, volume 1, chapter 10, pages 467-517.
- Dinda, S., 2011a. Trade Opportunities for Climate friendly goods and Technologies in Asia, paper presented at MSM 1st Annual Research Conference Nov 11-12, 2011.
- Dinda, S., 2011b. Climate Change and Development: Trade Opportunities of Climate Smart Goods and Technologies in Asia, MPRA Paper No. 34883.
- Drysdale, P., Kalirajan, K.P., Song, L. and Huang, Y., 1997. 'Trade Among the APEC Economies: An Application of a stochastic varying coefficient gravity model', Paper presented at 26th Economists Conference, University of Tasmania.
- Drysdale, P. and Xu, X., 2004. 'Taiwan's role in the economic architecture of East Asia and the Pacific', *Pacific Economic Papers* No.343.
- Drysdale, P. and Garnaut, R., 1982. 'Trade Intensities and the Analysis of Bilateral Trade Flows in a Many-Country World: A Survey', *Hitotsubashi Journal of Economics* 22(2): 62–84.
- Drysdale, P., Huang, Y. and Kalirajan, K.P., 2000. 'China's Trade Efficiency: Measurement and Determinants', in P. Drysdale, Y. Zhang and L. Song (eds), *APEC and liberalisation of the Chinese economy,* Asia Press, Canberra:259–71.

- Egger, P., 2002. 'An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials', *World Economy* 25(2): 297–312.
- Frankel, J. A., Stain, E. and Wei, S. J., 1997. *'Regional trading blocs in the world economic system',* Institute for International Economics, Washington, D.C.
- Ghosh, S. and Yamarik, S., 2004. 'Are Regional Trading Arrangements Trade Creating?: An Application of Extreme Bounds Analysis'. *Journal of International Economics* 63(2):369–395.
- Guillaume Gaulier, Thierry Mayer and Soledad Zignago, 2004. "*Notes on CEPII's distances measures*", www.cepii.eu.
- Harrigan, J. 2001. 'Specialization and the Volume of Trade: Do the Data Obey the Laws?', National Bureau of Economic Research, *NBER Working Papers,* 8675.
- Helpman, E., 1987. 'Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries', *Journal of the Japanese and International Economies* 1: 62–81.
- Helpman, Elhanang; Krugman, Paul R., 1985, "*Market Structure and Foreign Trade*", Cambridge, MA: MIT Press.
- Jha, V., 2009. "Climate Change, Trade and Production of Renewable Energy Supply Goods: The Need to Level the Playing Field", ICTSD Paper
- Kalirajan, K., 1999. 'Stochastic Varying Coefficients Gravity Model: An Application in Trade Analysis', *Journal of Applied Statistics* 26(2):185–93.
- Kalirajan, K. and Findlay, C., 2005. *Estimating Potential Trade Using Gravity Models: A Suggested Methodology*, Foundation for Advanced Studies on International Development, Tokyo.
- Linnemann, H., 1966. *An Econometric Study of International Trade Flows,* North Holland Publishing Company, Amsterdam.
- Martínez–Zarzoso, I. and Nowak–Lehmann, F., 2003. 'Augmented gravity model: An empirical application to Mercosur– European trade flows', *Journal of Applied Economics* 6(002): 291– 316.
- McCallum, J., 1995. 'National Borders Matter: Canada–U.S. Regional Trade Patterns', *American Economic Review* 85(3): 615–23.

- Nilsson, L., 2000. 'Trade integration and the EU economic membership criteria', *European Journal of Political Economy* 16: 807–827.
- Ravallion, M., 2003. 'On Measuring Aggregate "Social Efficiency"', *World Bank Policy Research Working Paper* No. 3166.
- Rose, A., 2005. 'Which International Institutions Promote International Trade?', *Review of International Economics* 13(4): 682–98.
- Rose, A.K., 2004. 'Do We Really Know That the WTO Increases Trade?', *American Economic Review* 94(1): 98–114.
- Tinbergen, J., 1962. *Shaping the World Economy: Suggestions for an International Economic Policy,* The Twentieth Century Fund, New York.

Table 1: Results of the trade gravity model for the export of climate friendly goods in 2008

	Coefficients	Standard Error	t -value	P-value
Intercept	-49.2722***	1.717189	-28.69	6.7E-156
GDP_reporter	1.6052***	0.045923	34.95	1.1E-216
GDP_partner	0.9400***	0.035135	26.75	3.3E-138
pcgdp_reporter	-0.2807***	0.052835	-5.31	1.17E-07
pcgdp_partner	-0.077	0.051787	-1.49	0.137275
Distw	-0.9346***	0.105363	-8.87	1.39E-18
Contig	0.1427	0.439915	0.32	0.74567
comlang_off	0.0177	0.356485	0.05	0.960385
comlang_ethno	*0.577**	0.314579	1.83	0.066769
Colony	0.8370	0.786272	1.06	0.287179
Comcol	0.6899***	0.246621	2. 8	0.00519
col45	1.1235	0.947884	1.19	0.236048
Smctry	2.9954***	0.79718	3.76	0.000176

Note: '***', '**' and '*' denote the statistical level of significant at 1%, 5% and 10%, respectively.