A Case Study of Greenhouse Gases and Trade for the years 2004 – 2014: India

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Abstract: Global warming can be defined as the rise in mean temperature of the Earth's climate system caused by anthropogenic carbon dioxide and carbon dioxide equivalent, also known as greenhouse gases (GHG). Since the 20th century, evidence shows a substantial prevalence of global warming and it will continue through the 21st century. This will continue to increase if no efforts are made to reduce greenhouse gases. Came into force in 2005, the first international treaty on climate change commits the states to reduce emissions of greenhouse gases. Relating to this objective, climate policies are made based on the countries' capacity that is grouped in Annex Iand Non - Annex I parties of United Nations Framework Convention on Climate Change (UNFCCC). Annex I parties consist of industrialized and developed countries. Countries that belong to low income developing countries are part of Non - Annex I parties. Although the developing countries are not faced by binding constraints, they volunteer for sustainable development through Nationally Appropriate Mitigation Actions (NAMAs). However, the developed and industrialized countries do face binding constraints for the emissions. Due to this reason, several developing countries will be adversely affected by the reduced production caused by the obligations to reduce emissions. Using the Computable General Equilibrium model, the paper assesses the impact of Kyoto policy of reduction in carbon in the developed country's exports on developing country's imports. Further, the paper analyses the welfare loss due to the implementation of policy by the Kyoto protocol. The trends are taken within a time span from 2004 till 2014. The paper makes use of secondary data from WTO, IMF, World Bank. In this study, the researcher uses a descriptive method and excel as the tool of analysis by which the paper shows the trends of carbon dioxide emissions and net exports for ten years ranging from the years 2004 till 2014.

Keywords: Carbon dioxide, developing country, developed country, Computable General Equilibrium Model, Welfare loss

I.   Introduction

Global warming can be defined as the rise in mean temperature of the Earth's climate system caused by anthropogenic carbon dioxide and carbon dioxide equivalent, also known as greenhouse gases (GHG). Since the 20th century, evidence shows a substantial prevalence of global warming and it will continue through the 21st century. The first international treaty on climate change commits the states – Annex I and Non-Annex I to reduce emissions of greenhouse gases. The targets for the same included (1) Reduction in emission intensity by 35%, (2) Increase use non - fossil fuel in energy mix capacity to 40% and (3) Creation of 2.5 bn tons of carbon sink. The targets can be achieved through – due to change in the level of technology or due to reduction in the level of production. The former is beyond this paper's capability to assess and hence an analysis on the latter has been done. The emission of greenhouse gases is viewed as a global externality. One such externality can be seen in the net exports. A reduction in production is caused due to reduction in carbon dioxide by the Annex – I states. This in turn affects the net exports of the Non – Annex – I states whose demands are catered by Annex – I parties. This phenomenon of the market structure so formed is explained using computable general equilibrium model. Computable general equilibrium (CGE) model is a class of economic models that use actual economic data to estimate how an economy might react to changes in policy or other external factors. The policy that has been implemented in the area of study is the reduction in the carbon dioxide emissions.

Towards the end section, welfare for India has been assessed. To determine the welfare, change consumption patterns using trend analysis for the years 2004 till 2014 has been used as proxy.

II.   Literature Review

Kelly Levin and **Jared Finnegan** in their paper, "**Assessing Non-Annex I Pledges: Building a Case for Clarification**" presents the common accounting rule for Annex I parties to ensure the integrity towards the environment. The results of the study focus on the need for transparency of data to combat the problems of misinterpretations of the word lines of different parties. A formal process is to be defined along with proper methodologies for proper functioning in the process of assessment in the case for Non-Annex I parties.

Wei-Hong Hong, Hui-Chih Chai, Y.-H. Henry Chen, John M. Reilly and **Sergey Paltsev** in their paper, "**Implications of Updating the Input-output Database of a Computable General Equilibrium Model on Emissions Mitigation Policy Analyses**" provide an analytical framework that includes input-output data that is affected by carbon dioxide mitigation. The paper talks about

how an increase in the cost of fossil fuels will increase technological innovation and improve adaptability, altogether, hence lowering the level of carbon dioxide emissions and therefore reaching the economy at a sustainability state.

A report by PwC for HM Revenue and Customs titling, "**A multi-regional computable general equilibrium model of the UK economy**" constructs a Multi-Regional Computable General Equilibrium model of the UK economy to assess the impact of a government policy intervention. The paper uses data and model to show the effect of variables like wages, income, expenditure, level of taxation, subsidy, transfers, prices of final goods, the quantity of production, imports and exports. The working of the model is to understand the effects of different economic scenarios.

Mustafa Babiker, John M. Reilly and **Henry D. Jacoby** in their paper, "**The Kyoto Protocol and Developing Countries**" emphasizes on the impact of ratifying to the Kyoto policy in the direction towards developing countries, which might be imported from the developed countries. the results show that the greatest loss will be imposed on energy exporters and hence a country's welfare loss is determined.

III.　　　Objectives

1)　　　To assess the impact of Kyoto policy of reduction in carbon in Annex I Party on Non – Annex I Party's imports.
2)　　　To analyze the welfare loss due to the implementation of policy by Kyoto protocol in India for the years 2004 - 2014

IV.　　　Research Methodology

Data Type: Secondary data is used for the study.
Sources of Data: World Bank, Ministry of Commerce, BP.
Area of Study: Annex I, Non – Annex - II and India.

table 1. 0 area of study

Annex-1	Non – Annex – I	India (Developing Country)

Statistical Tools: Trend Analysis and Tabular form are used for the analysis.

Model: The General Equilibrium Model is used to identify the interaction of agents among each other and find out their welfare status with the help of this model.

V.　　　Analysis

Model Specification

Computable General Equilibrium model is used for the analysis to capture the role of three main agents in the economy. The economic agents are comprised of the consumers, firms and a body responsible for making and implementing policy, the government. The working can be explained by the diagram below:
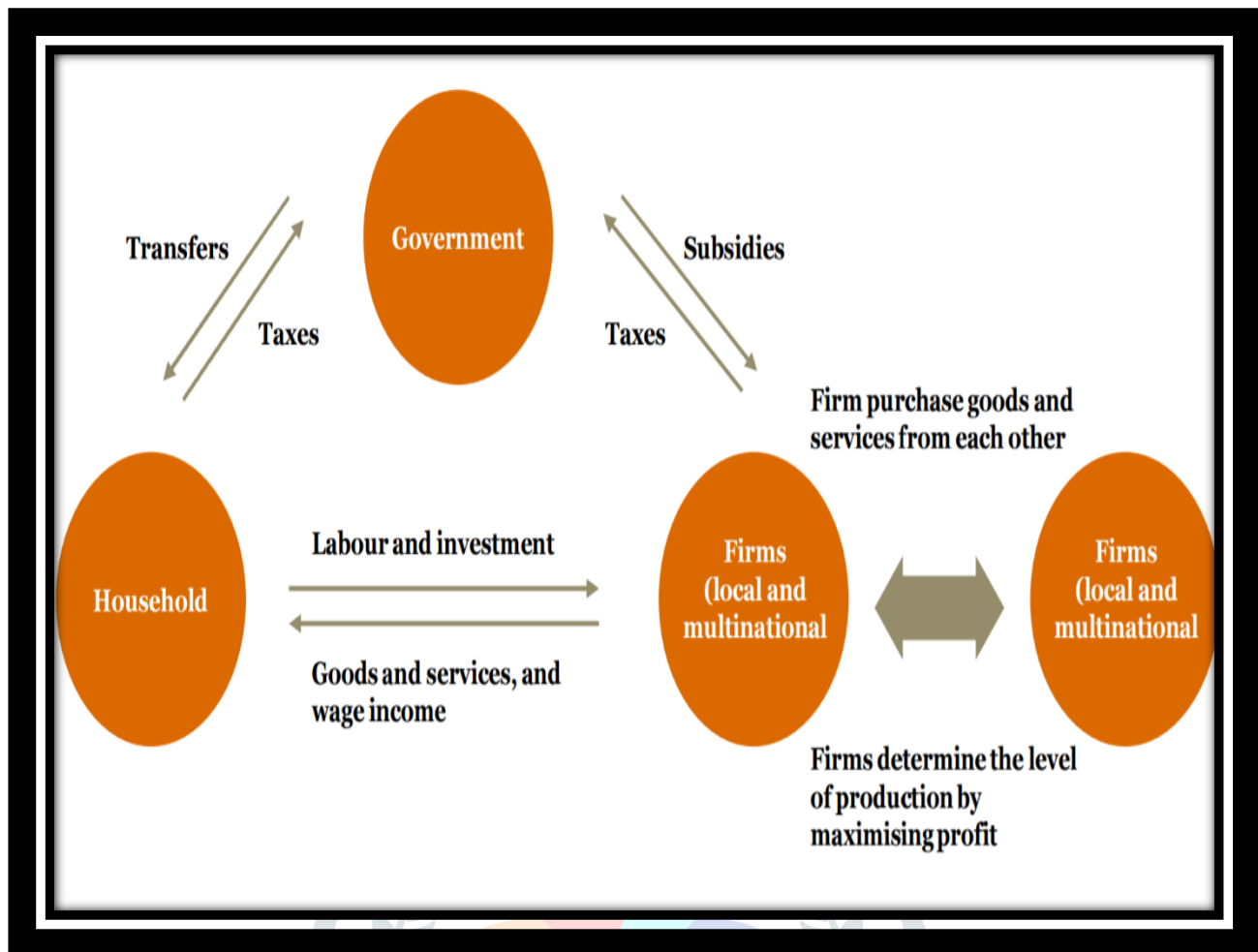
Figure 1: Computable General Equilibrium Model

The key design of the economic interactions of the agents is reasonably intuitive. These agents represent the functioning of a country. The two countries interact with each other in terms of trade. The developed country is highly industrialized, producing energy and manufacturing goods out of it. The developing country is the importer of this country. The model focuses on the basic input-output analysis for simplicity to show the impact of the reduction in emissions by the developed country on net exports of the developing country. It is also assumed that the carbon dioxide produced in an economy is anthropogenic and not a natural source like volcano, hot springs, and geysers.

Production

Each domestic production unit produces output to cater to the demand of domestic consumers and foreign consumers. Domestic output produced is a function of inputs of labor (L), energy source(E) and investment(I). However, only energy as an input can be imported. Migration and foreign investments are not taken into consideration. Further, every output produced emits one unit of carbon dioxide. The proportion of output sold in the foreign market and domestic market translates into the determination of prices. The prices of the products produced in the domestic and foreign market are assumed to be equal. This implies that a constant elasticity of substitution (CES) can be experienced. With the determined prices and quantity of output produced, the firms try to maximize the profit. Out of these profits, wages and net taxes are given to households and the government respectively. Net taxes consist of a carbon tax and subsidies for deployment of clean energy technology. The domestic production is driven by investment and demand for domestically produced goods.

Consumption

Income is received by the households in the form of wages for the labor services that they provide, transfers received from the government and the rate of interest for providing savings to the firm. It is assumed that the savings are channelized into the investment with the same amount. This income is spent on goods which are produced by the firms, income tax paid to the government and a part of income is saved. The expenditures made by the government and households creates demand for domestic as well as foreign outputs.

Government

The government is responsible for making policies and making sure the policies are well implemented. The government collects taxes from the households in the form of income tax and collects taxes from the firms as a carbon tax for every carbon dioxide and its equivalent produced while producing outputs. It then allocates the funds in the form of subsidies to the firms for deployment of clean energy technology and transfers to the households. It is assumed that the receipts received by the government are equal to government spending. The level of taxation is uniform and hence government spending is also uniform.

Working of the model: Discussion

The implementation of an emission reducing policy is necessary for sustained growth. The reason for the same can be understood in a way by contradicting the statement. This implies that a comparison is made when there exists Kyoto Policy and the case where there exists no Kyoto Policy. The comparison is illustrated below:

table 2.0: growth lines and emissions

Year	Annex B(MtC)	Non-Annex B(MtC)	Annex-B Kyoto(MtC)
1995	4000	2100	0
2000	4100	2200	0
2005	4800	2700	4800
2010	5000	3000	4000
2015	5100	3100	4050
2020	5700	3800	4050
2025	6000	3900	4060
2030	6100	4000	4070

The above table 2.0 indicates megaton of carbon (MtC) emitted, year-wise. The trajectory explains, as the time factor keeps on increasing, the countries, whether developed or developing, are bound to experience growth. This would imply that the countries will follow the path to becoming industrialized. Consequently, more and more emissions will be released, hence causing global warming. If this is the case, the trajectory of Annex B is followed which includes developed and industrialized countries and trajectory of Non – Annex B is followed in the case of developing countries is to be taken. Both the trajectories will keep on increasing if no efforts are taken to reduce carbon dioxide emissions. Now, consider the case if there exist the reductions in the amount of carbon due to the implementation of certain policy, say, for example, ratifying with the Kyoto Protocol. This would make the carbon emissions to fall steeply as indicated by the trajectory 'Annex B, Kyoto' and then the emissions will rise very steadily.

The implementation of policy by the Kyoto Protocol on developed countries to reduce emissions causes an added cost in the manufacturing units which will result in the lower quantities of output produced. The added cost will be attributed to the government in the form of carbon tax. This will create a ripple effect as a part of the energy-intensive goods produced by the manufacturing industry will be exported to developing countries. The developing countries who will be faced by a decreased supply of output will give rise to a consumer's demand that still has to be catered to. In order to cater to the consumers' demand, the country will have to either face higher prices of imports or lesser revenue if the developing country starts its own manufacturing unit or finds an alternative of the energy. The point mentioned here assumes that developing countries are highly dependent on energy sources.

Another implication can be that the demand for carbon-emitting fuels as input will fall as it has become costlier. Therefore, this will pull the price of such energy fuels down. Manufacturing industries in developed countries, facing emission restrictions, will still be dealing with the high cost even though the prices of energy fuels have fallen. This is because of the reason that carbon taxes will keep on increasing, greater than the fall in prices of energy fuels. The developed countries will only be better off if there is carbon leakage. This means that when the Kyoto policy indicates a reduction in carbon emissions, the country will import either energy as an input of production to produce output, or it will import final goods. This way, the country can be compensated for the loss in demand which had been the case of not importing.

Welfare Determination: Case for India

In 2015, India ratified to the second amendment of the Kyoto Protocol, the Paris Agreement. India, being the developing country was faced by the repercussions of implementation of Kyoto policy by the developed countries. This section analyses the welfare of India during the period from 2004 till 2014, which was the period before India had ratified to the Paris agreement and partially during the first amendment period. The welfare has been assessed as a proxy by determining the consumption patterns in India given the

GDP and prices of fuels. Major components of fuel imports by India include coal, natural gas and oil and hence this section assesses consumption patterns on the same lines.

table 3.0 price index with relative consumption

Year	Prices (Rupees)	Relative Consumption				
	Natural Gas	Coal	Oil	Natural Gas (%)	Coal (%)	Oil (%)
2004	138.4145	200.273	122.413	8.41	35.02	56.58
2005	207.9077	168.2113	168.7019	8.79	33.37	57.844
2006	160.067	178.1275	195.2729	8.8	33.65	57.55
2007	164.4646	246.6941	210.981	8.76	33.31	57.94
2008	209.4064	410.3186	272.9756	8.47	32.78	58.75
2009	92.13173	196.3292	173.7154	9.53	31.85	58.63
2010	103.8576	257.0148	220.309	10.81	31.07	58.07
2011	94.86963	337.6563	298.8923	10.52	31.18	58.3
2012	65.20303	257.0148	293.9223	11.27	30.58	58.17
2013	87.72921	226.977	281.8679	7.75	30.63	61.62
2014	102.88	209.45	252.58	7.18	29.53	63.29

The above table 3.0 shows that in the first column, a ten-year time period is given from 2004 till 2014. The second column depicts the average global prices of oil, natural gas and coal, measured as an energy index where prices in 2000=100. in the third column, the relative consumption patterns of coal, Natural Gas and Oil by India, measures in terawatt per hour (TWh) has been shown. The impact of developed countries ratifying the agreement and thereby reducing the carbon emissions can be seen in a developing country like India. The impact is determined using consumption patterns in the three types of fuels – Coal, Natural Gas, and Oil - as a proxy to assess welfare. The trend shows that as the price index of the oil rises (and falls), the relative consumption also rises (and falls). This implies that the relative consumption and price index of the oil is positively related. Hence, the welfare of the Indian economy in terms of relative consumption in oil is unaffected by the implementation of Kyoto policy in developed countries who are the net exporter of oil. The exception to the case is post-2008 where a slight fluctuation can be traced due to the global financial crisis. Since the first amendment ended in the year 2012, the relative consumption trend shows a slightly steeper increase, although the price index is not that much compared to the previous years' price indices. An observation of same rising trend is included for natural gas relative consumption where the price indices have been on a rising post the end of the first amendment, in 2012. This proves that there has been welfare loss in India in the oil and natural gas relative consumption when the implementation of Kyoto Policy took place. The relative consumption in coal shows a decreasing trend throughout, although the price index fell drastically for the years 2005 and 2009. This explains that welfare in terms of relative consumption in coal is independent of the implementation of the Kyoto policy.

VI. Discussion

The results of this study are showing that the domestic output produced is a function of inputs of labor (L), energy source (E) and investment (I). However, only energy as an input can be imported. Migration and foreign investments are not taken into consideration. Further, every output produced emits one unit of carbon dioxide. The proportion of output sold in the foreign market and domestic market translates into the determination of prices. The prices of the products produced in the domestic and foreign market are assumed to be equal. This implies that a constant elasticity of substitution (CES) can be experienced. The key design of the economic interactions of the agents is reasonably intuitive. These agents represent the functioning of a country. The two countries interact with each other in terms of trade. The developed country is highly industrialized, producing energy and manufacturing goods out of it. The developing country is the importer of this country. The model focuses on the basic input-output analysis for simplicity to show the impact of the reduction in emissions by the developed country on net exports of the developing country. It is assumed that the savings are channelized into the investment with the same amount. This income is spent on goods which are produced by the firms, income tax paid to the government and a part of income is saved. The government collects taxes from the households in the form of income tax and collects taxes from the firms as a carbon tax for every carbon dioxide and its equivalent produced while producing outputs. It then allocates the funds in the form of subsidies to the firms for deployment of clean energy technology and transfers to the households. . This section analyses the welfare of India during the period from 2004 till 2014, which was the period before India had ratified to the Paris agreement and partially during the first amendment period. The welfare has been assessed as a proxy by determining the consumption patterns in India given the GDP and prices of fuels. Major components of fuel imports by India include coal, natural gas and oil and hence this section assesses consumption patterns on the same lines.

VII.   Conclusion

In concluding, an attempt is made to assess the impact of the implementation of the Kyoto policy in reducing carbon emissions by developed countries on the developing countries' net exports. The paper makes use of a computable general equilibrium model to show the impact. The results bring out the case if developing countries are highly dependent on developed countries' products, they will be adversely affected due to Kyoto policy. Further, the paper includes India as a case study to assess the relative consumption in the three types of fuels is taken as a proxy to determine the welfare in India. The time period from 2004 till 2014 shows welfare loss in natural gas and oil, whereas relative consumption in coal has been unaffected.

VIII.   Suggestions

Kyoto Protocol has targeted only developed countries to reduce carbon emissions. The countries such as the USA, China and India are major carbon-emitting countries, however, none of them face binding constraints. USA did not ratify because China and India are developing nations and are not obligated to be bound by emitting carbon, hence making it unfair for the USA to sign an agreement facing binding constraints. Policies should be such that is not uniform considering the development diversities of countries.

IX.   References

1. The World Resource Institute on "A Critical Decade For Climatic Policy: Tools and Initiative to Track Our Progress".
2. A Report by PwC for HM Revenue and Customs on " A Multi-Regional General Equilibrium Model of the UK Economy" in March 2014.
3. Kelly Levin and Jared Finnegan in their paper, "Assessing Non-Annex I Pledges: Building a Case for Clarification".
4. Wei-Hong Hong, Hui-Chih Chai, Y.-H. Henry Chen, John M. Reilly and Sergey Paltsev in their paper, "Implications of Updating the Input-output Database of a Computable General Equilibrium Model on Emissions Mitigation Policy Analyses".
5. Mustafa Babiker, John M. Reilly and Henry D. Jacoby in their paper, "The Kyoto Protocol and Developing Countries".
6. A work on " Nationally Appropriate Mitigation Action s (NAMAs)" by United Nation Climate Change.