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Impact of Carbon Tax Scheme and CO_2 Control Technologies on Bangladesh Aviation Industry

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Abstract*: Aviation transport action group reported that carbon dioxide (CO_2) emission of airlines in 2017 was 859 million tons which is 2% of global emissions, (Akça, Z. 2018). It adds that the bank has calculated that "under the worst case 'carbon intensive' scenario, living standards will fall by 6.7% for Bangladesh by 2050". This paper investigates how Bangladesh can respond to best optimize to the EU's Aviation Carbon Tax Scheme proposed by the Stackelberg game model. The analytic result shows that the strategy "refusal of pay" is the best one which Bangladesh is taking step of. Numerical simulations specify a quantitative visual of the consequences found. The policy is found to be effectively not flying as much would reduce the CO_2 emission and consequently, purchase of new aircraft, retrofitting and upgrade improvements on existing aircraft, latest designs in aircraft/engines, fuel efficiency standards and alternative fuels etc. reducing the overall emissions. The main contribution of this paper is to study a new international issue for developing country on aviation carbon tax and CO_2 emissions policy suggestions for the aviation technology.

***Keywords*: Aviation technology; Stackelberg game; Carbon tax; CO_2 policy**

I. INTRODUCTION

Climate change is one of the top concerns of the international community in recent years. In the coming decades, it can be seen that South Asia will be affected by the climate change and it is warning the risk of weather changes. Therefore, the worst scenario of 'carbon intensive' will be seen in the living standards that will fall by 6.7% for Bangladesh, 2.8% for India, 2.9% for Pakistan, and 7.0% for Sri Lanka, by 2050" (Carbon Brief). On November 19th 2008, European Union passed a legislation to incorporate the international aviation sector into the European Union Emissions Trading Scheme (ETS) to curb global warming with effect from January 1st 2012. One major impact of this legislation is that all flights landing, passing-by and taking-off in the twenty-seven EU countries have to pay extra cost for carbon emission otherwise they would be forbidden from entering the EU airspaces. Unfortunately, the compulsive taxation behavior of the EU has aroused the worldwide dissatisfaction. The negotiation at a global level failed to bring out any substantial and practical progress in past years due to the conflict of interests between the developing and developed countries. Superficially, the dispute has become further complicated and aggravated as the world's major economic entities, the US, Russia and Japan, took immediate and explicit responses to join the ally of developing countries to fight against the Aviation Carbon Tax scheme. Since May 23rd 2012, more than twenty countries, most of which are world's major political and economic entities including United States, China, Russia, Brazil, and India, have issued counter-declarations or opposition manifesto against incorporation aviation sector into the ETS. Despite the ongoing oppositions, the EU kept tough stance to implement it and would prepare to add marine carbon tax in 2012 to levy carbon dioxide emission of marine industry. The EU's plan to charge for excessive carbon emission of aviation activities, which is widely known as the "aviation carbon tax", is regarded as an attempt to push its Emission Trading Scheme to the international community for first mover advantages. Discussion on aviation carbon tax is from the perspectives of international controversy in trade war, legitimacy dispute and its international ethic dominant position. To begin with, the dispute is in the environment field, but it can arouse global trade war if addressed improperly. The unilateral levy of the EU will increase the cost for aviation companies hence, raise the travel cost for passengers. The countries outside the EU would have been warned for trade wars as a consequence of counter-measures of this unilateral levy. It is also suggested that the international trade would be disrupted once if this kind of unilateral measure takes effect and no global effort stops it. Another important unfairness is the irrationality of the scheme of aviation emission charges. For example, a flight, from San Francisco to London, emits 29% carbon in the U.S. airspace, 37% in the Canada airspace, 25% on the high seas and only 9% in the EU airspace. So, the EU does not have the authority to levy carbon tax in other countries airspaces or on high seas. What's more, the legitimacy of aviation carbon tax has been in a controversial situation since the EU kept pushing it forward. Many countries and a number of scholars argue that relevant regulations of the EU violate sovereign rights and free navigation rights of international law. At the end of 2009, aviation companies of the U.S.

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Filed a lawsuit on aviation carbon tax, but European Court of Justice dismissed the action and affirmed that the EU may take actions beyond the framework of international civil aviation organization. Many countries including India, China, Bangladesh has declared they would continue to prepare for prosecution for the aviation carbon tax.

NDC's rules of Bangladesh are that the unconditional reduction is needed to be below 5% carbon pricing within 2030 and the additional reduction is needed to be 15% that will be conditional target mentioned in carbon pricing (Source: UNFCCC NDC). It is found that Japan is interested in establishing a bilateral offset scheme that is appeared as the model on the CDM, though they are avoiding the Kyoto Protocol process. There is a series of bilateral agreements between Japan and developing countries, and the investors of Japan can invest their fund as well as try to retain the resultant carbon credits from emissions reduction projects in partner countries. Bangladesh included its name singing the bilateral agreements with Japan.

Because of the flexibility of the open markets, the per capita income is changing and the airlines are giving the facilities to add more routes, frequencies, and seats to capture demand. This is also found that the GDP per capita helps to increase the demand in a more regulated environment, on the other hand, travel growth will be restrained because of the lower service quality and higher pricing. The increasing GDP amount about $5,000 to $10,0007 per annum helps the air travel to develop their demand rapidly. Figure 1 shows the relationship of trips per capita to the GDP per capita by country, with bubble size proportionate to the country's population.

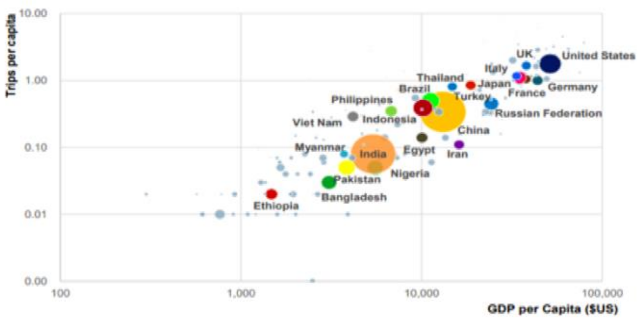


Figure: 1. Propensity Fly in 2015

Source: WBG, Airbus. 2016

The way of collection charges that the developed and developing countries aviation to be enforced under the same standard, which disobeys the principle of "common but differentiated responsibilities" ruled in the United Nations Framework Convention on Climate Change at the Kyoto Protocol. Some relevant international treaties do not prohibit this as marketization measures.

Aviation carbon tax is also a new hot international issue. How to respond and find a win-win solution is our next focus. Quantitative methods can help to find such a solution to this issue and following optimal responses. Moreover, for the sake of newly developing countries, especially of Bangladesh, this paper aims to help Bangladesh government and aviation industry to make reference. In academia, research on aviation carbon tax is limited and very few studies on policy responses exist.

Winkler and Marquard, (2009) mention that, the challenge of regulating a carbon tax rate lies in setting the bottommost tax rate that reaches the required long-term reduction in emission levels. Some scholars have studied the issue in international climate. Asselt & Biermann (2007), Asselt & Brewer (2010), Kuik & Hofkes (2010) and Babiker (2005) studied the issue in international climate and carbon emission. Barrett (1994) studied the condition of self-enforcing international environmental agreements by game theory. Viguier (2004) studied how to increase developing country participation in international climate policy. Dissou & Eyland (2011), Elliott et al. (2010), Eyland & Zaccour (2011), Ismer & Neuhoff (2007) and Zhang (2010) studied the conflict in border carbon tax in international trade.

Game theory is often studied and analyzed in confliction issue. Jorgensen et al. (2010) have studied environment protection and international climate negotiations. Aguirregabiria & Ho (2011) built dynamic oligopoly game to discuss the US airline industry. Stackelberg Game (1934) is a perfect information dynamic game to study the mutual effect of strategies of government and enterprise(s). Lei & Zhou (2017) studied capacity options for air cargo, mechanism design of emission declaration and Coordinating supply chain by Stackelberg Game. Some other applications of the Stackelberg Game also have been studied by the scholars. Lei et al. (2015) built a distribution network design model for deteriorating items based on Stackelberg game. Meng et al. (2012) studied competition and capacity constraints by price Stackelberg. Wang et al. (2004) analyzed the agents and enterprises sales activities. Kong & Yang (2011) studied closed-loop industry chain with Stackelberg game in circular economy. Li et al. (2016) studied pricing decision of the private label based on perceived quality. Shi (1994) studied Incentive strategies for true information in resource allocation.

Consequently, in 2017, the global CO_2 emissions from fuel combustion started rising up with 32.8 billion tons after three years of continuous stability. From the rough data (Figure 2), it is found that this CO_2 emissions grew faster in 2018, and the rising of strong economic growth as well as the slowdown in renewables penetration more than balancing the improvement in energy productivity.

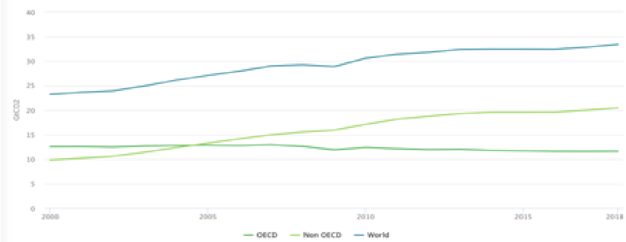


Figure: 2. The use of fuel combustion in Aviation technology emitted CO_2

Source: IEA global energy & status report-2019 This paper proposes four possible policy responses as the "non-resistance", "refusal of pay", "retaliatory taxation" and "creditable threat".

Stackelberg game models are used to compare with the four responses and find out an optimal one. The outcomes found that the response of “refusal of pay”, which is Bangladesh’s current Strategy, is superior to “retaliatory taxation”. This paper is organized as follows: In Section 2, characterize the strategy assumptions and modeling. In Section 3, follow the strategy. In Section 4, conclusions and provides CO_2 control policy making suggestions.

II. MODELS

A. Strategies

To respond the unilateral imposition by the EU, Bangladesh announced to prohibit Bangladeshi Aviations from paying the tax to EU and withdrew the purchase order of 12 European civil aircrafts. Russia planned to ban lines paying for the aviation carbon tax and also did not exclude the possibility of the prohibiting the EU flights flying over the Siberia aviation. The U.S. begins to prepare the retaliatory duties to EU Aviations as well as the Congress will forbid U.S. Aviations joining the European Union Emission Trading System. To sum up, four executable coping strategies are listed as below:

1. Non-resistance: paying for the tax and making routes optimization. It will not only contribute to low-carbon economic development of their countries but also avoid being levied on aviation carbon tax.
2. Refusal of payment: establishing a legislation to prohibit the domestic aviations payment for aviation carbon tax of the EU; modifying the open skies agreement with the EU; and pausing or changing the negotiation about broadening commercial traffic rights.
3. Retaliatory duties: imposing equally aviation carbon tax or other fees to Aviations of the EU members; raising price of the overflying foreign countries to Aviations of the EU; refusing increase of the new EU international lines; establishing certain of place and special trading mechanism of carbon emission; charging EU Aviations for the carbon emission.
4. Creditable threat: trade sanction to EU under the WTO framework and prohibiting economic aids to Euro zone.

There are other completely cooperative or partially cooperative measures, such as establishing a global aviation carbon emission trading system and exempting developing countries from extra emission fees. Besides, Bangladesh is not the only target of this tax. As a matter of fact, Bangladesh's loss in its aviation industry may be less than the other newly developing countries’ when aviation carbon tax would be levied by the EU. From figure 3 we can easily find out that last ten years Bangladesh real GDP increasing growth rate better than others Asia-Pacific’s countries

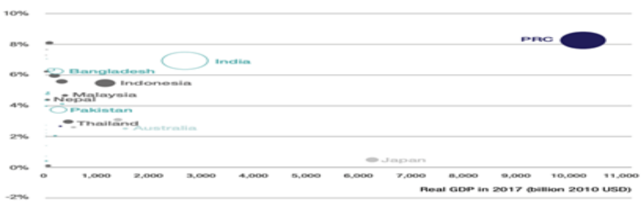


Figure: 3. Asia-Pacific’s countries GDP 2007-2017.
Source: HIS Economics, Airbus GMF 2018

Figure 4 shows that, world real GDP growth helps to change the global passenger travel by air. This real GDP growth also positively impact on aviation industry in Bangladesh. Thus, some developing countries like Bangladesh would prefer to take "free rides" measure on the fence to moderately boycott with U.S.

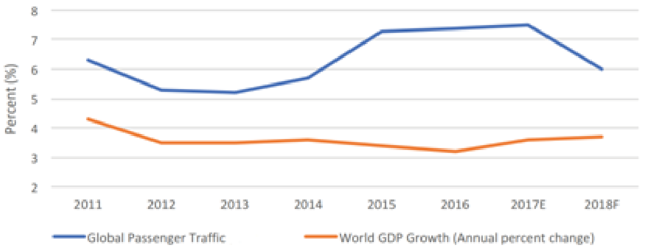


Figure: 4. Global passenger traffic vs world real GDP growth.
Source: IATA and IMF

B. Assumptions and Strategies

Stackelberg models will be established in this section to analyze the main coping strategies of aviation carbon tax. Author assumed that there are two countries, and country 1 represents EU and Country 2 represents the other countries like India, Bangladesh, China, Malaysia and so on; Aviation Company 1 and 2 are supposed to be aviation companies from the two countries respectively. The model merely considers the aviation carbon emission in the international lines involved in the dispute, and ignore the emission from lines only inside Country 1 or 2.

Set the aviation carbon emission of two lines during their flights between the two Countries are $q_1 > 0$, $q_2 > 0$ $q_2 > 0$, and the quantity of total emissions $Q = q_1 + q_2$; t is the tax rate of aviation carbon tax which country 1 imposes on aviation companies of both countries.

Sometimes the aviation carbon tax sometimes is called aviation carbon fee, it may not be counted as a real tax. The aviations companies will be required to purchase quotas of EU ETS at particular standard and declared actual amount of emissions. However, the aviation carbon tax can be regarded as a cost of the Aviation companies for carbon dioxide emissions regardless of in the form of "tax" or "fee". The model suits for any imposition, and t can be considered as the cost of that. To simplify the model, author will not consider the influence of ticket price, customer attendance, aviation operating costs and so on. The carbon dioxide emissions can be calculated using the flights’ frequency, which means that the more the carbon dioxide emission, the higher flights’ the frequency is and the more the profits can be made. However, if the emissions are too high, the revenues would decrease by oppositions from consumers and the government intervention.

Therefore, cited by Barrett (1994), suppose the total revenue of Aviation companies is a quadratic function of emissions, the revenue function R is:

$$R(Q) = a(Q)^2 + b(Q) \tag{1}$$

Where, $a < 0$, $b > 0$, $\dot{R}_\iota(Q) > 0$, $\ddot{R}_\iota(Q) < 0$, $R(Q)$ is the monotonically increasing concave function of Q, which means that the profit increases by the emissions Q increasing, and the growth speed will firstly increase and then decrease.

The revenue function R_i of Aviation Company i is the share in the function *R*:

$$R_1 = \frac{q_1}{q_1+q_2}[a(q_1+q_2)^2 + b(q_1+q_2)] \tag{2}$$

$$R_2 = \frac{q_2}{q_1+q_2}[a(q_1+q_2)^2 + b(q_1+q_2)] \tag{3}$$

The damage function caused by carbon dioxide emission by reference to Eyland（2011）

$$\forall_i = \frac{\Gamma_i(q_1+q_2)^2}{2} \tag{4}$$

where, Γ_i is a positive parameter, $\Gamma_i > 0$ presents the attention in climate change in different countries. The more the parameter Γ_i is, the higher the country pays attention to climate change.

In the next part, the four possible strategies-"non-resistance", "refusal of pay", "retaliatory duties" and "creditable threat" will be discussed.

III. FOUR STRATEGIES

A. Strategy 1: Non-resistance".

The game divided into two stages: in the first stage, the Country 1 determines the optimal aviation carbon tax rate t. In the second stage, after getting the value of t, two Aviation Companies determine the carbon dioxide emissions q_1 and q_2.

The utility function of Country 1:

$$\varphi_1^1 = \Omega_1^1 + t(q_1 + q_2) - \frac{\Gamma_1(q_1+q_2)^2}{2} \tag{5}$$

The utility function of Country 2:

$$\varphi_2^1 = \Omega_2^1 - \frac{\Gamma_2(q_1+q_2)^2}{2} \tag{6}$$

The utility function of Aviation Company 1:

$$\Omega_1^1 = \{\frac{q_1}{q_1+q_2}[a(q_1+q_2)^2 + b(q_1+q_2)]\} - tq_1 = a(q_1)^2 + aq_1q_2 + bq_1 - tq_1 \tag{7}$$

The utility function of Aviation Company 2:

$$\Omega_2^1 = \{\frac{q_2}{q_1+q_2}[a(q_1+q_2)^2 + b(q_1+q_2)]\} - tq_2 = a(q_2)^2 + aq_1q_2 + bq_2 - tq_2 \tag{8}$$

B. Strategy 2: "Refusal of pay".

This game is also divided into two stages: the Country 1 determines the optimal aviation carbon tax rate t. In the second stage, after two Aviation Companies observe t, they both determine the emissions q_1 and $q_2 q_2$. But the utility function of Aviation Companies and Countries has changed.

The utility function of Country 1:

$$\varphi_1^2 = \Omega_1^2 + tq_1 - \frac{\Gamma_1(q_1+q_2)^2}{2} \tag{9}$$

The utility function of Country 2:

$$\varphi_2^2 = \Omega_2^2 - \frac{\Gamma_2(q_1+q_2)^2}{2} \tag{10}$$

The utility functions of Aviation Company 1 and 2 and Country 1 and 2 in the equilibrium condition:

$$\Omega_1^{2^*} = \frac{-b^2(2a+\Gamma_1)^2}{a(4a-\Gamma_1)^2} \tag{11}$$

$$\Omega_2^{2^*} = \frac{-b^2(a-\Gamma_1)^2}{a(4a-\Gamma_1)^2} \tag{12}$$

$$\varphi_1^{2^*} = \frac{-b^2(0.5a+\Gamma_1)}{a(4a-\Gamma_1)} \tag{13}$$

$$\varphi_2^{2^*} = \frac{-b^2(2a^2+2\Gamma_1{}^2-4a\Gamma_1+9a\Gamma_2)}{2a(4a-\Gamma_1)^2} \tag{14}$$

C. Strategy 3: "Retaliatory duties" like levying tax to Country 1 in another name."

According to the aviation carbon tax rate t of Country 1, Country 2 takes Coping Strategy to Levy tax that the counter tax rate is ξt, $\xi > 0$ is the counter ratio from Country 2 to Country 1. In the first stage, Country 1 determines the optimal tax rate t under the circumstance of facing Coping Strategy from Country 2. The Coping Strategy from Country 2 is an imposition tax to the Aviation Companies from Country 1 to country 2 and the tax rate is ξt. In the second stage, after two Aviations Companies observe t and ξ, they determine the carbon dioxide emissions q_1 and q_2.

Here the utility function of Aviation Company 1 is:

$$\Omega_1^3 = a(q_1)^2 + aq_1q_2 + bq_1 - tq_1 - \xi tq_1 \tag{15}$$

The utility function of Aviation Company 2 is:

$$\Omega_2^3 = a(q_2)^2 + aq_1q_2 + bq_2 - tq_2 \tag{16}$$

The utility function of Country 1 is:

$$\varphi_1^3 = \Omega_1^3 + t(q_1 + q_2) - \frac{\Gamma_1(q_1+q_2)^2}{2} = a(q_1)^2 + aq_1q_2 + bq_1 - \xi tq_1 + tq_2 - \frac{\Gamma_1(q_1+q_2)^2}{2} \tag{17}$$

The utility function of Country 2 is:

$$\varphi_2^3 = \Omega_2^3 + \xi tq_1 - \frac{\Gamma_2(q_1+q_2)^2}{2} = a(q_2)^2 + aq_1q_2 + bq_2 - tq_2 + \xi tq_1 - \frac{\Gamma_2(q_1+q_2)^2}{2} \tag{18}$$

The utility functions of Aviation Company 1 and 2 and Country 1 and 2 Aviation Company 1, Aviation Company 2, Country 1 and Country 2 in the equilibrium condition as following:

$$\Omega_1^{3^*} = -\frac{b^2(2a\xi-2\Gamma_1\xi-2a-\Gamma_1\xi^2)^2}{a(2a\xi+8a\xi^2-10a+4\Gamma_1+4\Gamma_1\xi+\Gamma_1\xi^2)^2} \tag{19}$$

$$\Omega_2^{3^*} = -\frac{b^2(-2a\xi+2\Gamma_1\xi-2a+\Gamma_1\xi^2+4a\xi^2)^2}{a(2a\xi+8a\xi^2-10a+4\Gamma_1+4\Gamma_1\xi+\Gamma_1\xi^2)^2} \quad (20)$$

$$\varphi_1^{3^*} = \frac{b^2(-2a\xi+2a-\Gamma_1\xi^2)}{a(2a\xi+8a\xi^2-10a+4\Gamma_1+4\Gamma_1\xi+\Gamma_1\xi^2)} \quad (21)$$

$$\varphi_2^{3^*} = \frac{-b^2}{a(2a\xi+8a\xi^2-10a+4\Gamma_1+4\Gamma_1\xi+\Gamma_1\xi^2)^2} \quad (22)$$

D. Strategy 4: "Creditable threat".

Suppose that Country 2 announces a credible threat in ahead. If Country 1 still adheres to impose the aviation carbon tax while Country 2 will take a measure under which the loss of Country 1 will be larger than the profit, the loss value M is positive Infinity.

At this time, the utility function of Aviation Company 1 is:

$$\Omega_1^4 = a_1(q_1)^2 + aq_1q_2 + bq_1 - tq_1 \quad (23)$$

The utility function of Aviation Company 2 is:

$$\Omega_2^4 = a(q_2)^2 + aq_1q_2 + bq_2 - tq_2 \quad (24)$$

The utility function of Country 1 is:

$$\varphi_1^4 = \Omega_1^4 + tq_1 + tq_2 - M - \frac{\Gamma_1(q_1+q_2)^2}{2} \quad (25)$$

The utility function of Country 2 is:

$$\varphi_2^4 = \Omega_2^4 - \frac{\Gamma_2(q_1+q_2)^2}{2} \quad (26)$$

If M is large enough, no matter what t that Country 1 chooses in period $[0,\infty]$, here $\varphi_1^4 < 0$. So, under credible threat, the optimal Strategy of Country 1 should be $t = 0 t = 0$, i.e. disclaim to impose aviation carbon tax to avoid higher losses.

Since the model has multiple parameters and analytical solution is hard to give the comparison, the following part will use numerical simulation method to analyze the characters of equilibrium solution.

The model embodies four parameters: a, b, Γ_1 and Γ_2, where *a* and *b* is the parameters of revenue function of carbon emission, $a < 0$ and $b > 0$. Without loss of generality, standardize the parameters of the revenue function $R = a(q_1 + q_2)^2 + b(q_1+q_2)$, and assume $a = -1$, $b = 1$. At the same time, author assume that because of the differences of geographic locations, resource endowment and level of economic development between Country 1 and country 2, the damage and emphasized importance about the climate change are different. Therefore, suppose the damage or emphasized importance about climate change of country 1 is double to that of country 2, and value the $\Gamma_1 = 1$, $\Gamma_2 = 0.5$ in the numerical simulation.

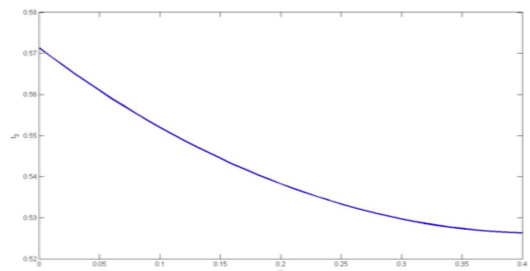
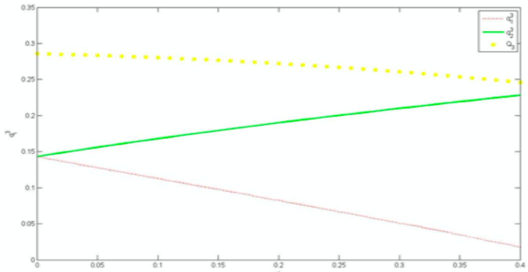


Figure- 5



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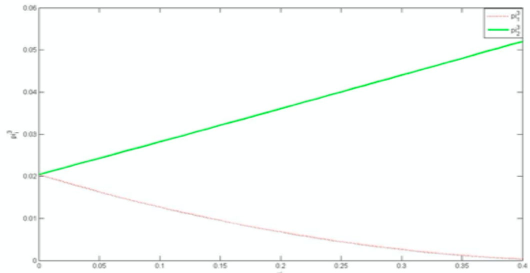

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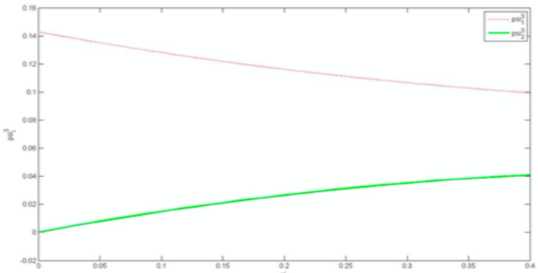

Figure- 8

Figure 5 illustrates the equilibrium value of optimal tax rate *t* of Country 1 in Strategy 3

when $0 \le \xi \le 0.4$. When $\xi = 0$, the value of t in figure 5 is the equilibrium value of t in Strategy 1. It could be clearly observed from the figure that the optimal tax rate of Country 1 decreases by ξ increases with increase in ξ, when Country 2 takes responses.

Figure 6 shows the effect of ξ on quantity of carbon emission from Aviation companies, that is, with the increase of ξ, q_1 decreases while q_2 increases, and the total quantity of emission Q gradually decreases.

The change of the carbon emission q_i is determined by two factors; one is that the progress of low carbon technology makes q_i decreasing, and the other is that the cut of lines and flights makes q_i decreasing.

However, this is hard to reduce carbon dioxide emission at a large scale in a short period using the low carbon technology. It could be easily seen from figure 6, the carbon dioxide emission quantity in Strategy 3 is the lowest and in Strategy 2 is the largest.

Figure 7 shows that the Strategy of "counterspell taxation" takes effects on aviation carbon tax boycott. With the increase of ξ, the profit of Aviation 1 decreases and gradually turns to be unprofitable. The aviation carbon tax scheme must be strongly opposed in Country 1; the aviation industry may strike or demonstrate for pressing the government to cancel this scheme.

Figure 7 and Figure 8 respectively give the profit of Aviations and Countries in the condition of equilibrium. The figures show that without the condition of counterspell tax rate ($\xi = 0$), the profits of two Aviation Companies are the same while the profit of Country 1 is far more than Country 2. With the increasing of ξ, the profits of Aviation Companies 2 and Country 2 are increasing gradually while the profits of Aviation Company 1 and Country 1 are decreasing gradually. The narrowing in profit gap between two Countries shows that counterspell tax rate is of benefit to improve competition between the countries. When $\xi = 0.4$, although the profit of Country 1 is far more than Country 2, the profit of Aviation Company 1 is closed to 0 when two Countries impose tax. That must be aroused the opposite by aviation industry in Country 1. If ξ is still increasing, the Aviation Company 1 is unprofitable and the profit of two Countries is closed to equal or the profit of Country 2 surpasses Country 1.

Based on the evaluation of revenues function from equation 2, it is simple to come to a certain conclusion when the minimum revenue of one scenario is bigger than the maximum revenue of the other.

Table: 1. Strategies dependent on aviation revenue range

R/Q	0, 0.127	0.127, 0.263	0.263, 0.5
0, 0.185	*R, R*	*R, Q*	*R, Q*
0.185, 0.372	*R, R*	*R, Q*	*R, Q*
0.372, 0.5	*Q, R*	*Q, R*	*Q, Q*

Table 1 demonstrations that the aviation revenue range is the way of the consideration to climate change *R* largely influences to the selection of strategies. Therefore, country strategy makers need to calculate the weight *R* and estimate the range when making decisions.

In reality, the results of the models are rational. Firstly, retaliatory duties are difficult to be powerful. International law and the WTO rules make little possibility for the non-EU countries levying retaliatory taxation on the EU in trade field. Even if the retaliatory duty could be supported by the WTO ruling, tax rate setting is not optional. Tax rate could be set only according to the principle of justice and within the framework of the WTO. Therefore, retaliatory duties are hard to be powerful.

Table: 2. Tax revenues USD mm

R	Ticket tax	Fuel Tax	Revenue
δ=1	30.7	25.1	0
δ=1.25	102.8	57.3	-1.67
δ= 1.50	148.5	69.5	-0.58

Secondly, the premise of counterspell taxation is the acceptance of aviation tax, which will give the EU an excuse to develop navigation tax. Table 2, the best strategies of each scenario assessment are underlined in the tax revenue following the above analysis. The counterspell taxation means that this country has accepted the unfair tax in the name of climate change. As to the EU, once other countries have accepted

the action of its imposed aviation tax, whether their counter measures will truly be carried out is still unknown. However, once the pattern of imposed aviation tax is allowed, the EU will continue its well-prepared navigation tax, which will cause much greater economic loss for many other countries.

Finally, unilateral taxation will create confusion in global economic order and may lead to serious consequences. The imposition of such aviation tax by the EU is to holds the banner of "slow climate change" to attempt to stake out the moral high ground, realize its own interests and affects other countries. Once some countries choose to impose retaliatory tax, which means they accept the EU's aviation carbon tax. Meanwhile, despite of the potential responses, the EU is looking for gaining worldwide leadership in carbon emission control and further interference with other countries' environment protection strategies. However, the viability of the responses to the aviation carbon tax has not been verified and the future implementation may not be powerful or effective. Moreover, the EU aviation carbon tax will become a 'stare decisis' practice of 'unjust taxation' once it takes effect and countries may follow this precedent and disrupt international order.

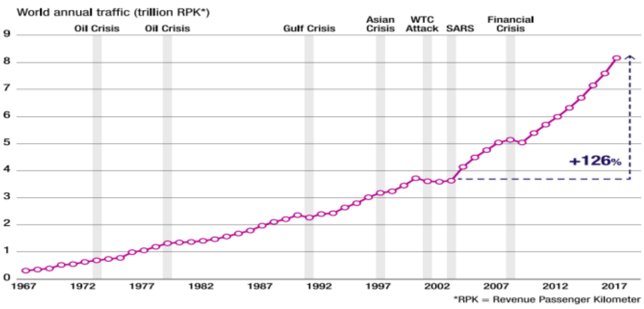

Figure: 9. Air travel has the resilient to external shocks

Source: ICAO, Airbus GMF 2018

The above-mentioned figure 9 is showing that, in spite of some external shocks, the aviation industry is not affected as customers travel by air frequently that is a good sign of economy for aviation industry. Besides this, there is found negative effect on environment because of the emissions of CO_2 from fuel combustion in Aviations technology.

The very welcoming news that the aviation industry is trying to enable these benefits and trying to continue into the future while considerably the reduction of emitted CO_2 per unit of delivered benefit. The track record of it shows that to reduce its environmental impact, the aviation industry works seriously following its responsibility.

The reduction of fuel-burn per passenger-kilometre is seen about 70% over the last half-century while a background of gradually contraction regulations for noise emissions.

The industry is sharply determined in its energy to reduce its emissions strength, as the demonstration does not only come by the proof of aircraft operators by changing their fleets with newer, more effective aircraft, but also by major research and advance investment within the aerospace design and manufacturing sector to confirm that the engines and aircraft for future generation will be more effective. In table 2 show that how new technology push to the reduce the CO_2.

Table: 2. CO_2 reduction options from technology improvements on a baseline aircraft.

Timelines and examples of technology	Impact
Retrofits	***7-13%***
Further advanced engine components for superior burning and airflow	9%
Lighter stuffs for equipping in the cabin	12%
Aircraft develop aerodynamics and reduce fuel burn	8-13%
Less energy-consuming lighting and in-flight entertainment	9%
Production Updates	***7-18%***
Advanced engines for current aircraft production series	12-17%
Lightweight composite material instead of aluminums	10-18%
New aircraft design before 2020	***25-35%***
Open rotor engine will reduce fuel burn around	25%
Counter-rotating fan will reduce fuel burn	10-15%
Advanced turbofan will reduce fuel burn around	15%
Geared turbofan engine will reduce fuel burn	10-15%
New aircraft design after 2020	***25-50%***
Revolutionary engine architectures	20-23%
Fuel cell system for on-board energy	25-43%
Blended wing body, rather than the classical tube-and-wing architecture	27-39%

Source: IATA, A global approach to reducing aviation emissions.

IV. RESULT AND DISCUSSION

Nevertheless, it is a great contribution to society of the social and economy of aviation that the essential part for air travel which continues to rise and placing rising pressure on emissions. An agreement on overall scheme for managing its CO_2 emissions [IATA, 2009] from the global aviation industry is seen by several years ago. It is also noted that an important technology research program is essential in order to provide future aircraft with significantly developed fuel efficiency. This type of research program is usually organized and if their scale is good enough, they are being funded at the national or international level. The main contribution of this paper is to analyze the strategies of the EU's aviation carbon tax with the non-cooperation game models for the very first time in Bangladesh aviation industry; the superiority of 'refusal of payment' compared to 'retaliatory taxation' is proved theoretically, hence refusing to pay will be the best option at present situation. The paper categorizes possible responses to the EU's aviation carbon tax into four major types, and gives quantitative analysis to these responses respectively based on Stackelberg game theory model.

According to the conclusion, when the non-EU countries take 'retaliatory tax', the labor unions and aviation corporations of each the EU country will oppose to the aviation carbon tax scheme due to the sharp decrease of profit. Therefore, making the aviation companies within EU to pressurize their government, the implementation of aviation carbon tax may be postponed or terminated. However, 'retaliatory taxation' is still a secondary choice compared to the refusal of payment.

Two primary types of strategy on 'retaliatory taxation' are provided in society. Countries can tax on out-bounding flights from the EU to other countries. Irrespective of which option is adopted, massive loss will be inevitable to all concerned parties. Meanwhile, the existing the WTO rules make it very unlikely for the non-EU countries to implement the retaliatory tax. "Aviation Carbon Tax" is actually a game of interest and profit among nations and corporations under the pretense of so-called "low carbon emission". Despite the limited influence of aviation carbon tax upon aviation industry's profit by far, the EU would become the regular constitutor and leader in climate problem while other countries may eventually lose the speaking right and motivation for initiative once the proposal goes into effect. The EU would be able to manipulate the tax rate arbitrarily and continue levying a series of new unjust tax with a description of so-called "climate change mitigation". It is possible to reduce CO_2 emissions by using a very sustainable aviation fuels (SAF) for the purposes of CO_2 Road-Map. A study, presented by Yale School of Forestry, they found that the extensive discharge of biofuels can decrease greenhouse gas emissions by up to 85%. If government of Bangladesh continue to encourage airspace modernization, and maintain a good collaboration across Europe towards improved Air Traffic Management (ATM). The Aerospace Growth Partnership (AGP) provides a significant support to the Bangladesh aerospace industry technology which shows a remarkable work Bangladesh government. Therefore, Government will show the sincerity to present the access by Bangladesh aerospace industry and provide a good fund for high-value collaborative Research and Development. A new line addition of Boeing 787-9s in Biman Bangladesh help these types of efforts. Kroesen points out that the highly-fuel effective engines on the Dreamliner decrease CO_2 emissions by at least 20% that is compared to the planes they exchanged.

V CONCLUSION

It can be stated that like many other studies, this study also has some limitations. There is needed more direct measures for policy variables that can significantly develop the study. The aviation industry has brought a great change by giving some efforts and advance technology to lower aviation-related emissions: these are the use of alternative fuels, improved airplane designs, new aircraft concepts and fuel-saving operational procedures.

Some measures can be included in this group such as buying of new aircraft, retrofitting and upgrade developments on existing aircraft, new plans in air technology engines, fuel efficiency standards and alternative fuels. These measures include minimizing weight, improving load factors, reducing speed, optimizing maintenance schedules, and tailoring aircraft selection to use on specific directions or services. The regulatory enforcements on carbon emissions reduction is included by measures (i.e. aircraft movement slot management) and other advantages such as better weather forecasting, transparent carbon reporting and training programs.

Nevertheless, a renewable and sustainable fuels can be used for a major longer-term reduction of emissions, such as biofuels established for jet aircraft. According to Zingg, "Certainly, not flying as much would reduce the CO_2 emissions from aviation,". But he mentions his ambition and that of the industry is to make it possible to continue more sustainably. There are some steps that can be taken to lessen emissions without stopping: Select airlines with modern (i.e. more efficient) aircraft, consider flying economy rather than business or first class, fly with airlines with lower CO_2 performance figures, and it can use public transport to get to the airport. Consequently, this type of aviation carbon tax and CO_2 emissions strategy from aviation is praiseworthy for further research.

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