Advances in Economics and Business Management (AEBM)
p-ISSN: 2394-1545; e-ISSN: 2394-1553; Volume 6, Issue 2; January-March, 2019, pp. 90-95

http://www.krishisanskriti.org/Publication.html

Taxes or Permits: Which is a Better Instrument to Solve the Global Carbon Emissions Problem?

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Abstract—*Global warming is a member of a special type of economic activity known as global public good. Actions undertaken in one country has consequences felt all over the globe. It is a form of global externality with a very long life. No one owns the atmosphere, and under the current market system it is treated as a common pool resource with no enforceable property rights which in turn leads to inefficiencies and market failure. Through this paper, I have made an attempt to analyse the two economic instruments that can be used for mitigating carbon emissions- carbon permits and carbon tax and what could work as the efficient solution at the global level. Although carbon permits as an instrument is already in use globally (Kyoto Protocol and Clean Development Mechanism), it hasn't been quite successful in mitigating carbon emissions. In fact, over the last few years, economists have been advocating for a harmonized carbon tax. I have discussed the working and impact of this tax in reducing emissions globally and how it fares better than permits.*

Keywords*: Global Public Goods, Externality, Global Warming, Kyoto Protocol, Harmonized Carbon Tax, Environmental Economics*

Introduction

Greenhouse gases (GHG) emissions, associated with the combustion of fossil fuels, deforestation, agriculture and other industrial processes are a form of global atmospheric pollution with a high probability of external costs of climate change in the future. The production of greenhouses gases (the major ones being carbon dioxide and methane), as a by-product of many production processes for products we value in consumption, are adding to the global stock of greenhouse gas emissions, causing over the coming decades and centuries significant changes in climate, such as global warming, changes in rainfall patterns, and more frequent and adverse extreme weather events (IPCC, 2007).Various climate models (based on past climate variations) estimate that an increase that doubles the amount of CO_2 or the equivalent in the atmosphere compared with preindustrial levels will, in equilibrium, lead to an increase in the global surface temperature of 1.5°C –4.5°C, an increase in precipitation and evaporation, and a rise in sea levels of 10–90 cm over this century (Nordhaus, 2007).In turn, these climate changes will bring much higher costs in the future for adaptation of, for example, agriculture, water supply, integrity of infrastructure, loss of biodiversity and population relocation relative to the costs of reducing emissions (Stern, 2006, and Garnaut, 2008).

Global warming is a member of a special type of economic activity known as *global public good.* Actions undertaken in one country has consequences felt all over the globe. It is a form of global *externality* with a very long life. No one owns the atmosphere, and under the current market system it is treated as a common pool resource with no enforceable property rights which in turn leads to inefficiencies and market failure.

With the industrial development policies being implemented across various developing countries and the economies moving ahead in their growth path, energy consumption is bound to increases across all sectors including the industrial sector, agricultural sector and households. The pollution problem stands to worsen in the coming years. Although there is no denial about the fact that environmental deterioration is an unavoidable cost of industralisation, at the same time carbon emission will lead to serious threats to civilisation in the future.

Now climate change depends only upon cumulative GHG emissions that remain in the atmosphere and the time path of emissions, not on the geographic location of emissions. Therefore, at a minimum, some investment in reducing greenhouse gas emissions universally is seen as a prudent form of insurance rather than each country dealing with it specifically. The key environmental issue is global emissions, and the key economic issue is how to balance costs and benefits of global emissions reductions. The major issue arising then is that of governance. There's a weak or nonexistent world government that can efficiently coordinate solutions. Through this paper, I have attempted to analyse the two economic instruments that can be used for mitigating carbon emissions- carbon permits and carbon tax and what can work as the efficient solution at the global level.

The paper has been structured in the following manner. In section I, I have discussed discuss the problem of externality attached with carbon emissions. Section II introduces the two economic instruments that can be used in correcting this market failure. I have compared the two instruments in section III. In section IV, I turn to the real world where Kyoto Protocol uses the carbon permits as an instrument in mitigating carbon emissions and provide empirical evidence. I further introduce the carbon tax and how does it work. I then conclude my discussion.

Section I:

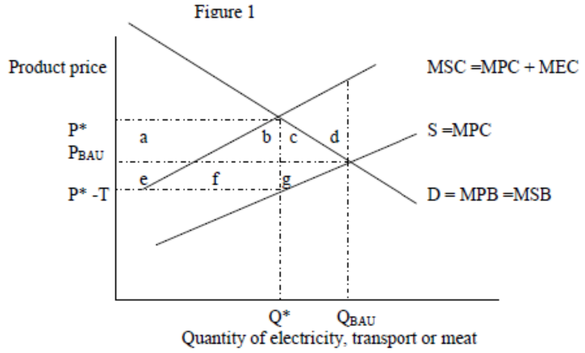
Global public goods are economic or other activities whose impacts are indivisible. The problem of excessive carbon emissions occurs because of the presence of externalities. Externality describes the fact that the costs of carbon emissions are not taken into consideration by the decision-makers while under-taking production activities which cause these problems.

For any desired consumer goods, we have a competitive market supply and demand model. The demand curve, D, represents the MPB (Marginal Private Benefit) of the product to consumers, while the supply curve, S, represents the MPC (Marginal Private Cost) of capital, labour and materials. Since no one owns the atmosphere and no market for clean air exists, the producer has to pay nothing for the carbon emissions. Therefore, in this scenario, the production and consumption of the desired product is in excess of what is socially efficient. In Figure 1 this is represented by Q_{BAU}.

From a society efficiency perspective though there is a cost attached to the carbon emissions. On internalizing this externality, the supply curve of the producer shifts upward to the marginal social cost, MSC, which includes both the MPC and the MEC (Marginal external cost). Then, the efficient level of production and consumption of the electricity, transport, etc falls from Q_{BAU} to Q*.

Since firms fail to internalize this external cost to the society, the quantity of carbon emissions is higher and the net efficiency gain of area'd' is lost. This is the argument for correcting the market failure associated with the pollution.

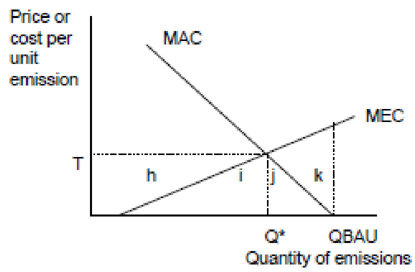
Figure 1



➢ AGGREGATING ACROSS ALL PRODUCTS:

A more general representation for the economy of the social benefits and costs of the pollution externality useful for studying policy intervention options is given in Figure 2. The marginal abatement cost function, MAC, shows the cost of reducing carbon emissions from the business as usual output Q_{BAU} to Q^*, aggregating across all carbon emitting activities. As the pollution emissions are reduced, increasing costs per unit of reduced pollution are incurred by both consumers and producers. The marginal external cost function, MEC, is shown as increasing with the level of pollution. The efficient level of pollution is at emissions level Q* where MAC = MEC, or where MSC = MSB for each product.

Figure 2



This further strengthens our point that we need to internalize this externality to remove this market failure.

Section II:

Now the question arises of how to internalize this externality.

We introduce two economic instruments that can be used to obtain the socially optimal outcome.

Cap and carbon permits: In the global-warming context, quantitative limits set targets on the time path of GHG emissions of different countries. Countries then can administer these limits in their own fashion. While it fixes the overall level of emissions, the mechanism allows countries to trade emission allowances among themselves. Consequently, a market for carbon permits has developed. *Lassiez-faire*, the price hence reached is the carbon permit price at equilibrium.

Carbon Tax: On the contrary, under the market instruments, the level of emissions is determined indirectly. The government fixes a tax and corresponding to the price of emissions, the firm chooses its emission level. In case of GHG emissions, carbon taxes can be levied on the countries, which in turn can pass it on to the firms. The firms then undertake their cost-benefit analysis and reach the optimal level of emissions.

Working of the instruments under perfect information:

Consider initially the operation of, and efficiency and distributional implications of, the carbon tax and tradable permit systems in a simple one period situation where we have close to perfect information, and in particular of the MAC and MEC functions.

- Permits:

In the context of Figure 2, a tradable permit scheme would limit the quantity of emissions to Q*. The market price of the tradable permits would be at price T.

- Taxes:

In the context of Figure 2, economic efficiency would have a carbon or emissions tax at tax rate T per unit of pollution, restricting pollution to Q*. Further, the government collects additional government revenue of area h + i.

Therefore, in this static and perfect knowledge world, the carbon tax and tradable permit schemes are essentially the same with identical implications for distribution and for efficiency.

Section III:

The need for a cooperative global agreement to reduce greenhouse gas emissions brings out some interesting comparisons between the carbon tax and tradable permit policy instruments.

➢ Uncertainty:

In the more realistic world, we have imperfect knowledge of the MAC and MEC functions, both in terms of the basic science and in the estimation of social costs and benefits. This leads to some important differences between the tradable permit system, essentially a quantity-based policy intervention, and a carbon or emissions tax, essentially a price-based policy intervention. The chosen tax rate or tradable permit quantity may not be at the point where MSB =MSC. As a consequence, the full efficiency gain (of area d in Figure 1 or of area k in Figure 2) will not be achieved.

Weitzman compared the expected efficiency gains under uncertainty of a price-based approach (as with carbon taxes) and a quantity-based approach (as with cap and permit trade). The relative advantage depends on the slopes of MEC and MAC functions. The quantity-based approach emerges as superior when the MEC is relatively steep; otherwise the Price based approach would be more effective. Several recent studies apply this framework and suggest that a relevant MAC function is steeper than MEC function and hence tend to support Carbon Tax. If the objective is Cost Effectiveness: the achievement of some previously established level of emissions at minimum cost then Cap and Trade gains favour.

Murray et al. (2008) address a different aspect of the uncertainty issue. They argue that a cap-and-trade system with intertemporal banking of allowances has more ability to adjust to new information in the presence of uncertainty than does the Carbon tax. This greater ability to respond to changing expectation gives permits an advantage over the carbon tax in smoothing emissions prices over time.

Hence when the objective is net benefit maximization the carbon tax seems to have an advantage, given the implications of the Weitzman framework when the MEC is relatively flat. On the other hand, cap and trade could have an edge over the carbon tax along the lines considered by Murray, Newell, and Pizer – attaining flexibility to adjust to new information.

➢ Fixing of targets under the dynamic model:
Quantity limits fixed under the tradable permit schemes face trouble in fixing the caps on the emissions. The target level should follow a dynamic model since countries are always in constant move. Economies are evolving. Under such circumstances, setting the targets using baseline emissions from twenty years before the control period (as in Kyoto Protocol) undermines the scheme.
On the contrary, in case of Carbon tax, the base level is zero carbon tax. The countries' efforts can be judged with respect to that baseline. There is no requirement of constructing a historical base year of emissions. Also, there is no asymmetry between early joiners and late joiners. You fix the tax rate and then each country does their own cost-benefit analysis and reduces carbon emissions to their optimal levels.

➢ Pricing of the emissions:
The supply, demand and regulatory conditions evolve unpredictably over time. Because of the uncertainties attached, quantity-type regulations are likely to cause volatile trading prices of carbon emissions. Such rapid fluctuations are costly and undesirable, particularly for an input. This can lead to rapid inflation in the economies. Further the stability of the cost and price increment effects of the tax policy intervention contributes to more effective and efficient decision making by firms and consumers, and also by macroeconomic policy managers.
Also, Orszag (2008) argues that over a number of periods price stability will reduce the long-term costs of reducing emissions, and he estimates cost savings of up to a fifth.

➢ Public finance:
Another point where tax scores over permits is the strong fiscal-policy advantages of using revenue-using measures. Often carbon tax raise prices of inputs (fossil fuels) above efficient levels, further adding to the deadweight loss of the existing system and hence should be counted as a part of the additional costs of global-warming policy. This effect is the ''double burden'' of taxation, analyzed in the theory of the ''double dividend'' from green taxes (Goulder, Parry, and Burtraw 1997; Goulder and Bovenberg 1996). However, the revenue raised from the carbon taxes can lead to reducing other taxes like income tax and wealth tax. As a result, the increased efficiency loss from taxation can be mitigated. But under the permits system, the allocation doesn't raise revenue, rather

increase the prices of the emissions leading to higher cost of production and adding further to the inefficiency losses. While it is possible that emissions permits will be auctioned (thereby generating revenues with which the tax burden can be mitigated), empirical evidence suggests that most of the permits would be allocated at zero cost to ''deserving'' parties, or distributed to reduce political resistance. E.g.: in case of SO_2 allowances and CFC production allowances in US, virtually *all* the permits were allocated at no cost to producers

- Interactions with other climate policies

  In the presence of Cap-and-trade program, introducing an additional GHG-reducing policy such as a performance standard might yield no further reductions in overall emissions. The reason is that overall emissions are determined by the overall cap or number of allowances in circulation. To the extent that the additional policy yields reductions in emissions by some facilities, the demand for emissions allowances falls. This causes the price of allowances to fall until all the allowances in the circulation are again demanded. Overall emissions do not change.

  In contrast, introducing an additional GHG-reducing policy in the presence of a carbon tax can lead to a reduction in overall emissions. In this case, the price of emission tax does not change when the supplementary policy causes a reduction in emissions. For this reason the reduction caused by the supplemental policy does not lead to "emissions leakage," that is, an offsetting increase in emissions elsewhere. Therefore, overall emissions fall.

Section IV:

Kyoto Protocol: The United Nations took the first formal steps to slow global warming only about fifteen years ago, under the United Nations Framework Convention on Climate Change (FCCC). The first binding international agreement on climate change, the Kyoto Protocol, came into effect in 2005, with about 192 parties currently. The Protocol works on the principle of Cap and trade: it sets binding emission reduction targets for 37 industrialized countries, mostly Member States of the European Economic Area (EU + EFTA) in its first commitment period. These targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012.

Emissions trading, as set out in Article 17 of the protocol, allows countries that have emission units to spare- emissions permitted to them but not "used"- to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of permits to emit carbon. Carbon is now traced and traded like any other commodity. This is known as the "carbon market".

However, there are problems with this mechanism:

- Non-cooperation among countries – With the protocol failing to include United States and major emerging economies, the estimated inclusion of 65% of the 1990 world emissions has declined to 32% in 2002.
- It has led to creation of carbon market only for the participating countries while the problem of market failure still occurring for a major portion of carbon emissions.
- It omits a substantial fraction of emissions (thus failing the spatial criterion) and has no plans beyond the first period (thus failing the temporal dimension of the cost-effectiveness criterion). Hence, the Kyoto Protocol is an extremely costly treaty and makes only modest progress in slowing global warming. Hence, it is a static model while what we require is a dynamic model which can keep up with the changes happening all over.

The RICE (Regional Integrated Climate Economy) model and other studies estimated that the Kyoto Protocol would lead to highly differentiated prices and therefore to an inefficient allocation of abatement across countries.

Harmonized Carbon Taxes:

Now we look at the second approach i.e. a mechanism called harmonized carbon taxes (HCT). HCT is a tax placed on fossil fuels in proportion to their carbon content. Under this approach, there are no binding international or national emissions limits. Rather, countries would agree to penalize carbon emissions at an internationally harmonized ''carbon price'' or ''carbon tax.''

Conceptually, the carbon tax is a dynamically efficient Pigovian tax that balances the discounted social marginal costs and marginal benefits of additional emissions. There would be no country emissions quotas, no emissions trading, and no base period emissions levels. Because carbon prices would be equalized, the approach would be spatially efficient among those countries that have a harmonized set of taxes. If the carbon tax trajectory follows the rules for ''when efficiency,'' it would also satisfy intertemporal efficiency.

Now we divulge into further details/answer a few questions:

- Who should pay the tax?

All the discussion in the literature relates to a consumption-based tax. A production tax would become an extraction tax and, if internationally applied, would benefit 'carbon exporters' such as OPEC and work against net carbon importers such as Japan. If the objective is to curtail carbon consumption, then the tax would have to be consumption-based (Pearce,1991)

❖ <u>What is the optimal size of the tax?</u>

The latest calculation in the deterministic aggregate RICE model suggests that a 2010 carbon price of around $17 per ton carbon in 2005 prices—rising to $70 per ton in 2050—would efficiently balance the costs and benefits of emissions reductions that is, maximize the present discounted value of benefits minus costs (Nordhaus, 2007).

❖ <u>How do we induce cooperation?</u>

- If non-cooperating countries are net importers of fossil fuels:
  As the demand for fossil fuels reduces in the cooperating countries, international fuel prices decline. This gives the non- cooperating countries an incentive to increase their use of fossil fuels, thus partly offsetting the reduced emissions from the cooperating countries. To counter this effect, the government of the cooperating countries can then set quantitative limits on the exports.
- If non-cooperating countries are net exporters of fossil fuel:
  The government of the cooperating countries can impose tariff on the fuels and at the same time give subsidies to the producers of cleaner fuels. This reduced demand for fuels will lead to reduced international fuel prices. In the long run, probably these countries will then cut down on their supply of fossil fuels.

Conclusion:

Benefits over Kyoto Protocol:

1. The benefits of reduced concentrations of the other pollutants such as nitrogen oxides, sulphur oxides and suspended particulates (dust and smoke)can be counted in as benefits to CO_2 reduction policies. Since carbon-reduction measures would also need to target transportation, yet further benefits accrue in the form of reduced accidents, congestion and other road costs. A Norwegian study (Glomsrod etal., 1990) suggests that while a hypothetical carbon tax might cost 2.75 % of forgone GNP in the year 2010, 70% of that cost would be recouped in ancillary benefits.

2. A carbon tax would be set on the basis of the carbon content of fossil fuels. Given the widespread use of these fuels, any tax would inevitably be revenue raising, even though the tax works best if it is avoided through the introduction of low or zero carbon technologies. Governments may then adopt a fiscally neutral stance on the carbon tax, using revenues to finance reductions in incentive-distorting taxes such as income tax, or corporation tax. This 'double dividend' feature of a pollution tax is of critical importance in the political debate about the means of securing a 'carbon convention'.

3.A tax system which automatically recycles money back to the developing country government is more appealing than a tradable permit scheme, and especially one which allocates permits with respect to an historical benchmark (as in Kyoto). We illustrate it further with the help of Figure 3 (Freebairn, 2009). It shows the MAC functions for two countries- MAC_1 for the current year and MAC_2 for a period in the future. Country C is a developing countryand the MAC curve shifts outwards with economic growth. Country E is a developedcountry, and for dramatic effect the MAC is shown to shift inwards with slow economic growth and technological change. For further simplicity, we assume no change in the permit price or tax rate, remains at T. Under the tradable permit system, country C with the shift of MAC_1 to MAC_2 would have to purchase a large number of additional permits at a cost to the developing country of area b+c, and assuming that it buys them from E, country E receives revenue of area f + g. Such a transfer from the developing countries to developed countries will be resented. Hence, this prospect of large revenue transfers becomes a reason for the developing countries to resist joining a cooperative international agreement based on a cap-and-trade system.

By contrast, under the emissions tax scheme, country C would reap a large increase in tax revenues, area b+c, and country E a small fall in tax revenues, area f+g, with no inter-country transfers. This further encourages country C to go for technological innovation to cut down on its tax payments.

Under both policy intervention strategies, the perceived losses to the producers and consumers (ignoring the external benefits of less global pollution) of each country of the greenhouse gas polluting goods are little changed, namely areas d versus b for country C and areas h versus f for country E. On this policy strategy comparison, the tax option has more attractive distributional effects over time, and with similar efficiency implications.

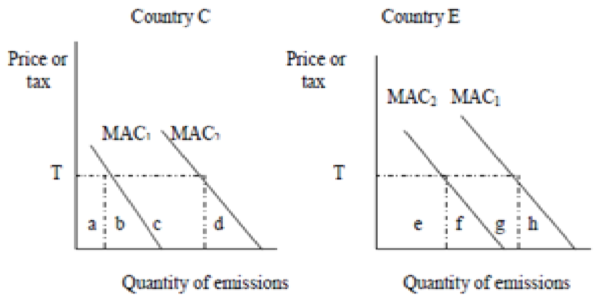


Figure 3

In the end it would seem from the entire study that all in all taxes are superior to permits when it comes to controlling emissions as they are sounder when looking at the fiscal and administrative aspects. However, there is still a far superior option available in the form of Harmonised Carbon Taxes as we can do away with specific limits.

Cooperation by countries is a major factor here. Given the global nature of carbon emission a unified action plan will help reign in the emission levels more efficiently.

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