a₹tha

E - JOURNAL OF FRTL @ IIM CALCUTTA

June 2024, Volume 12, Issue 1

INDIAN INSTITUTE OF MANAGEMENT CALCUTTA

INDIAN INSTITUTE OF MANAGEMENT CALCUTTA

FRTl
Financial Research & Trading Laboratory

Carbon Pricing and Carbon Markets

Utkarsh Majmudar

The last millennia have seen a huge transformation in our natural systems. The Stone Age hunting technology led to many mammals' extinction. Next came the agricultural revolutions that transformed forests into farmlands. The Industrial Revolution led to the most dramatic changes on Earth. The need for minerals led to the carving of the earth; the need for water led to the creation of dams and reservoirs that manipulated the flow of rivers; synthetic fertilizers led to the indiscriminate disruption of the nitrogen cycle. The worst impact was the restructuring of the global carbon cycle due to greenhouse gas (GHG) emissions at an unprecedented scale. The clearance of forests led to a reduction in the capacity of nature to absorb carbon. In contrast, industrialisation has led to homes being illuminated by a coal or natural gas-fired power plant. Every petroleum-powered train, plane, and motor vehicle has contributed to the net accumulation of carbon dioxide in the atmosphere.

The high levels of greenhouse gases in the atmosphere have led to climate change. While many attempts were made to achieve a global consensus (Rio Summit, Kyoto Protocol, etc.), the breakthrough came with the Paris Agreement in 2015, where countries agreed to limit temperature change to 1.5 degrees Celsius above the pre-industrial era. A key ingredient to achieving the target is to reduce greenhouse gas emissions. There are many ways to achieve this reduction. One is eliminating GHG emissions by shifting from fossil fuel to renewable energy. Another is to use technology to reduce GHG emissions. Governments are using economic intervention such as carbon pricing to move companies to adopt either of the two approaches.

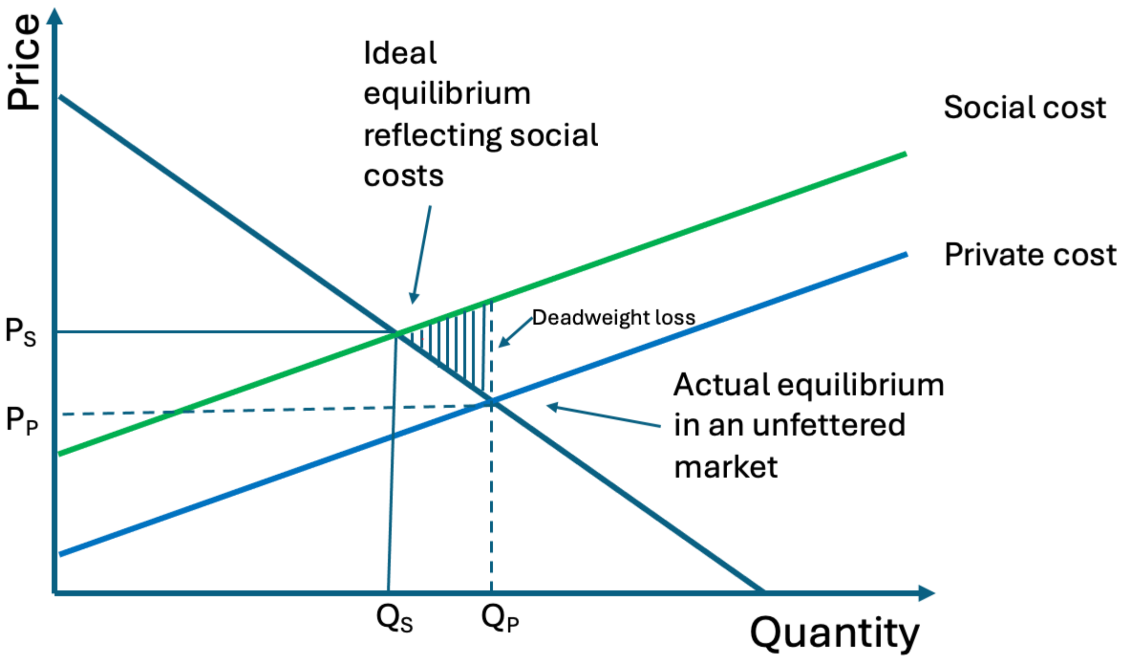
In this article I explore the role of externalities in carbon pricing, mechanisms of estimating a carbon price, the carbon markets and its components and the benefits of carbon pricing.

Externalities and Carbon pricing

An externality is a positive or negative outcome of a given economic activity that affects a third party that is not directly related to that activity.(What Is an Externality?, n.d.). Externality can be of two types – positive and negative. GHG emissions are a negative externality impacting people’s health and well-being.

In the case of GHG emissions, the polluter decides purely on the direct costs and the profit opportunity from production. She does not care about the indirect costs to those harmed by the pollution. The indirect costs include a higher cost of healthcare and reduced income due to illness caused by pollution. Since the polluter does not bear the indirect costs, they are not passed on to the end-user of the product produced by the polluter. Thus, the social (or total) cost of production is higher than the private cost of production. The economics of this is described in Figure 1. The Figure shows the classic graph of supply and demand. There are two supply curves – the lower supply curve (in blue) incorporates only the direct costs (also called private costs) and the upper supply curve (in green) incorporates the direct as well as the indirect costs (social costs). Where only the direct/private costs are considered, price PP and quantity QP are obtained. After incorporating indirect/social costs, price PS and quantity QS are obtained. The optimal quantity for society (where demand and supply curves intersect) is QS; however, the real market equilibrium is at QP. The shaded triangle represents the deadweight loss – the economic value lost due to externality.

Figure 1: The Impact of Negative Externality



Source: Author

Externalities are an important cause of market failure. Market efficiency requires equal private and social returns. There is a gap between the two in the presence of an externality. Price intervention can help close the gap and restore equilibrium. Greenhouse gas emissions are a cause of externality.

Greenhouse gas emissions have increased from the pre-industrial era level of 278 parts per million (ppm) to 417 ppm in 2021 (Met Office, 2021). At the same time, global temperatures have risen by 1.1C. According to a study by the Institute of Policy Integrity, climate change could cost the world some $1.7 trillion a year by 2025, increasing to about $30 trillion a year by 2075 (Institute for Policy Integrity, 2021). This provides an impetus to account for the social cost of carbon (GHG) emissions, the difference between PS and PP in Figure 1.

Basics of Social Cost of Carbon

Governments have many policy options to curb carbon dioxide (CO2) emissions and slow global warming. There is a wide range of estimates of the costs that these policies will impose on governments and taxpayers. If the government doesn't do anything or does too little, society will inevitably pay the price.

The social cost of carbon (SCC) is the monetary value (say, dollars) of the economic damages resulting from emitting one additional ton of greenhouse gases into the atmosphere.

The social cost of carbon is a tool that helps policymakers determine whether the costs and benefits of a proposed policy to curb climate change are justified. A higher SCC generally means that the benefits of a particular climate policy to cut CO2 justify its cost; a low SCC makes a policy seemingly cost more than the benefits it ultimately delivers.

Estimating the dollar amount of SCC requires information that links social, economic and physical features into one framework. This information is then fed into computer models. These models integrate four types of information (Cho, 2021):

1. **Predict future emissions** based on population, economic growth, and other factors.
2. **Model future climate responses:** Future emissions are estimated and based on these estimates, the impact is assessed regarding increased temperature and sea-level rise.
3. **Assess the benefits and costs:** What will be the impact of climate change on agriculture? What will be the cost of adaptation to sea level rises? What will be the impact of additional warming on energy use? What will be the impact on worker's productivity?
4. **Convert to present value:** Since benefits and costs will likely accrue over time, policy decisions must be made today. Hence you discount the future costs and benefits to today. At what discount rate? It is the discount rate that indicates a willingness to spend today to protect future generations.

Simulation of the three models is run hundreds of thousands of times using different values for uncertain variables and parameters. As a result, many estimates of SCC emerge. SCC is usually represented as a range rather than a single number. An average of all the estimates is taken at a particular discount rate to deliver a representative SCC. A representative computation is shown below:

We can get a sense of SCC by seeing that it was estimated that India's country-level social cost of carbon emission is the highest at $86 per tonne of CO2 in the world (Ricke et al., 2018). This means the Indian economy will lose $86 by emitting each additional tonne of CO2. Next in scale is the US, where the economic damages would be $48 per tonne of CO2 emission and Saudi Arabia at $47 per tonne of CO2 emission.

Carbon Markets

While estimates of the social cost of carbon help companies price their products there are other mechanisms that will help companies manage their emissions. Carbon markets are one of the tools to tackle the climate change problem. The climate change problem is simply the accumulation of greenhouse gases in the atmosphere. Given that there is only one atmosphere, it matters little where the emissions are released. The emissions will soon spread around the earth, creating what is known as the greenhouse effect28. Going by this logic, if a group of people, countries or companies can agree to limit their emissions to a certain amount (a “carbon budget”), it does not matter how much each person emits or where they do so, as long as the whole group does not emit more than what they committed to. Since it doesn’t matter where we reduce emissions, the argument behind carbon trading is that the best way to take climate action is to reduce emissions where it is easiest (i.e. least costly).

To achieve emission reductions, governments around the world have established carbon markets. Here, emissions (or emissions reductions) can be exchanged from one entity to another. In theory, as long as we control the total amount of emissions traded in the market, it does not matter for the climate who buys or sells. Although this works well in theory, in practice, establishing a global or even a national carbon market is fraught with significant challenges. Significant risks are present in the system. Loopholes in the system can result in the policy having little or no impact.

There are two types of carbon markets -- regulatory compliance and voluntary.

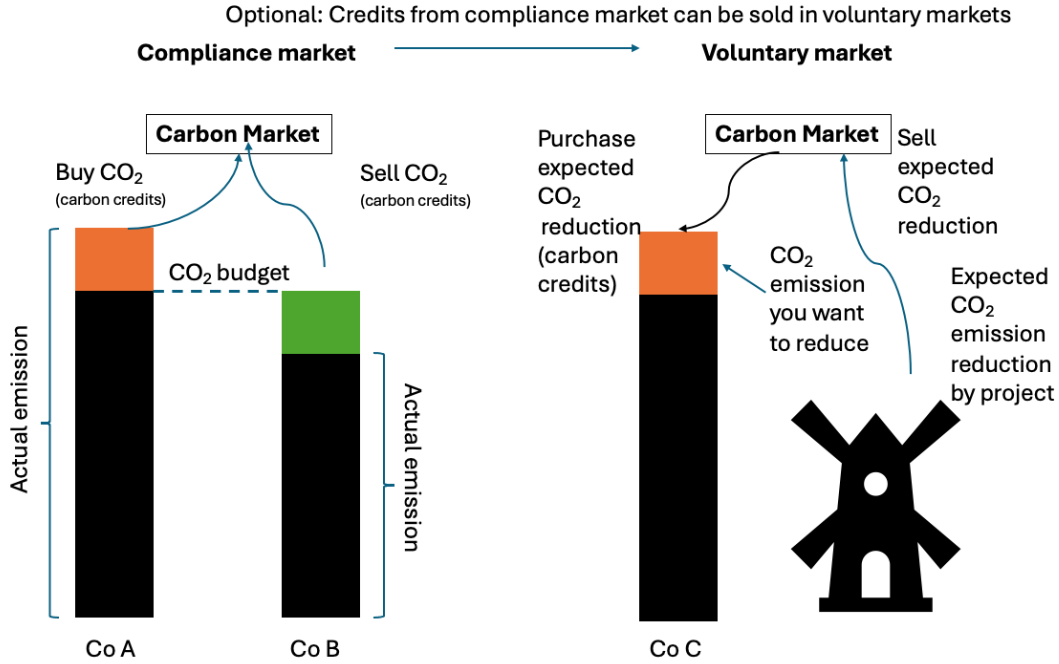
(a) The compliance market is used by companies and governments that, by law, have to account for their GHG emissions. Mandatory national, regional or international carbon reduction regimes regulate it. 218 shift

[28] The greenhouse effect is the process by which radiation from a planet’s atmosphere warms the planet’s surface to a temperature above what it would be without this atmosphere.

(b) The voluntary carbon market is a decentralized market where private actors voluntarily buy and sell carbon credits representing certified removals or reductions of greenhouse gases (GHGs) in the atmosphere.

The operation of compliance and voluntary carbon markets is illustrated in Figure 2.

Figure 2: Compliance and Voluntary Carbon Markets



Source: Adapted from Carbonable.io, 2024

According to the Carbon Pricing Dashboard (Carbon Pricing Dashboard, n.d.), 110 carbon pricing initiatives have been implemented or are scheduled to be implemented in 53 national jurisdictions. In 2024, these initiatives would cover 12.8 GtCO2e29, representing 24% of global GHG emissions.

There are various types of carbon pricing mechanisms (What Is Carbon Pricing?, 2017).

An emissions trading system (ETS) is a system where emitters can trade emission units to meet their emission targets. Companies can consider either internal abatement measures or acquire emission units in the carbon markets to meet the emission requirements. Thus, those with excess carbon units can trade them in the carbon markets with those unable to meet their emission requirements. The ETS market creates a demand and

[29] Gigaton Gigaton Carbon dioxide equivalent.

supply for emission units through a trading mechanism establishing a market price for GHG emissions. There are two main types of ETSs -- a cap-and-trade and baseline-and-credit.

Cap-and-trade systems: A cap-and-trade program limits the total amount of CO_2 that can be emitted by certain facilities. In this system or program, the government issues a limited number of emissions allowances (permits). Each of these permits grants the holder the right to emit one ton of CO_2. These allowances are tradeable. The sale and purchase of the allowances yield a market price for the allowance. This is practically the price of one ton of CO2.

Baseline-and-credit systems: Here baseline emissions levels are specified for individual companies. Credits are issued to companies that reduce their emissions below the baseline emissions. These credits can be sold to other companies that have exceeded their baseline emission levels.

Banking and borrowing caps: Some cap-and-trade programs include provisions for the banking and borrowing of allowances over time. Thus a permits issued in one year can be submitted to account for emissions in later years (this is like putting money in the bank). Alternatively, permits for future years can be issued and used in the current year (one is borrowing permits today, which would have been used in the future).

A **carbon tax** is a price set per ton of carbon per ton of CO_2 emitted. CO_2 emissions from the combustion of fossil fuels are proportional to the carbon content of the fossil fuel. Thus the carbon tax is effectively a tax on CO_2. Given that carbon constitutes approximately 3/11th weight of CO2. A $1 tax per ton of CO_2 equals a $3.7 tax per ton of carbon.

An **offset mechanism** designates the GHG emission reductions from project- or program-based activities. These emission reductions can then be sold either domestically or internationally. Often a registry a created for the issue of carbon credits. . These credits can, then, be used to meet compliance requirements.

Internal carbon pricing is a mechanism organizations use in their internal decision-making process to value change impacts and their risks and opportunities.

Result-based Climate Finance (RBCF) is a funding approach where payments are made after pre-defined outputs or outcomes related to managing climate change are met and outcomes like emission reductions are achieved and verified. In many RBCF programmes, verified GHG reductions are purchased, creating a carbon market.

Carbon Border Adjustment Mechanism (CBAM): This is a variation of the carbon tax. Initiated by the EU recently it aims to address the problem of carbon leakage. Carbon leakage occurs when companies outsource their manufacturing to countries with relatively weaker emission norms. The tax will enable the EU to match the carbon price of imports with that of domestic goods. It is intended to provide a level playing field and improve the decarbonisation of industries.

Carbon taxes and cap-and-trade programs differ on the type of certainty they provide. Carbon taxes are certain as companies know how much they will need to pay per ton of carbon they emit. At the same time, it allows companies to get away by paying money. On the other hand, cap and trade programs ensure quantitative reduction in emissions. Unfortunately, the price fluctuations in trading markets make it difficult for businesses to make decisions. Building in cap and floor features in cap-and-trade programs reduces price volatility. Carbon taxes can also be designed to adjust dynamically if actual emissions miss the predetermined emissions path.

Benefits of Carbon Pricing

Carbon pricing policies have several features that make them more efficient or less costly than other policies to reduce carbon dioxide emissions (such as technology mandates, direct regulations, subsidies to zero-carbon energy sources, etc.). These features are:

Flexibility: Carbon pricing mechanism allows companies to choose the method or technology to reduce or mitigate emissions. This is unlike technology mandates where the regulator decides on a single method that is then applied to a wide set of companies. This one size fits all may make it prohibitively expensive for some companies when cheaper methods of emission reduction exist.

Equal Marginal Costs of Abatement[30]: An economy-wide carbon price applies a uniform price on CO_2 emissions regardless of the source. This results in the equalisation of marginal abatement costs across firms and sectors. Regulations, on the other hand, imply different marginal abatement costs across firms and sectors. Thus regulations in sectors with very high marginal abatement costs may require that regulation be removed (as it sis cost-ineffective). At the same time, it will lead to more stringent regulations in cases of low marginal abatement costs. Undertaking such balancing acts are difficult for regulators – something that carbon pricing does effectively.

[30] Abatement cost is the cost of reducing negative externalities like pollution. The marginal cost of abatement measures the cost of reducing one more unit of pollution.

Encouraging Conservation: Conventional regulations put a limit of emissions per unit of output. This leaves little incentive for companies to undertake reductions if they are meeting the regulatory requirements. In contrast, carbon pricing provides incentives to reduce emissions per unit of output, but also charges a price for every additional ton of CO_2 that is not reduced through increased efficiency. With carbon pricing, costs can increase for high emitters as it charges a price for every additional unit of CO2 that is not reduced through increased efficiency. This motivates companies to improve their carbon efficiency.

Revenue: A carbon price creates a new revenue stream (for example, money earned by selling carbon credits) that can be used in a number of ways.

Carbon Pricing Design: There are many elements that go into the design of carbon pricing instrument.

Price: Economic theory suggests that the maximum benefits if carbon pricing accrue when carbon price is equal to marginal cost of abatement. This can be achieved by either setting a carbon tax equal to marginal damage31 or by capping emissions at a level equal to marginal damage.

Stringency: A $50 carbon tax is said to be more stringent than a $5 carbon tax. The more stringent tax it will lead to lower emissions and higher costs. In determining stringency, policymakers face a trade-off between environmental goals and the costs of meeting those goals.

Coverage: The coverage of a carbon pricing policy indicates which sectors and industries or emission types will be covered under carbon price. Take the case of the European Union Emissions Trading System cap-and-trade program. It covers emissions of CO_2, nitrous oxide (N_2O), and perfluorocarbons (PFCs). Also covered are 11,000 energy intensive plants in electric power and manufacturing sectors that emit these emissions. These are spread over 31 European countries.

Point of Regulation: The point of regulation of a carbon price determines who is required to submit permits or pay the tax to the government. For instance, an upstream carbon tax would tax fossil fuel producers for the carbon content of their products. A midstream tax would tax the first purchaser in the supply chain of fossil fuels (say, a refinery) for the purchase of crude oil. A downstream tax applies to the emitter. For example, the coal-based power plan will pay for the emissions.

Revenue Use: Carbon revenue can be used in multiple ways. For instance, a carbon dividend can be distributed to households. Tax swaps can also use the revenue from a carbon price to reduce taxes. Carbon pricing revenue can also finance green spending programs, which aim to reduce emissions through non-pricing methods. Another option is to reduce the government's budget deficit.

---

[31] damage caused by adding one additional ton of carbon dioxide into the atmosphere. This marginal damage is often called the social cost of carbon (SCC).

Carbon markets are a good mechanism to help companies reduce or maintain their carbon emissions below a threshold. While important, they are not a substitute for effort in emission reduction. To achieve the goals of the Paris summit, there is no substitute for speedy and significant carbon emissions reduction.

References

Carbon Pricing Dashboard. (n.d.). Carbon Pricing Dashboard. Retrieved 22 July 2024, from https://carbonpricingdashboard.worldbank.org/

Carbonable.io. (2024, February 29). How Voluntary Carbon Markets Work? Medium. https://carbonable.medium.com/how-voluntary-carbon-markets-work-9fa7da03742e

Cho, R. (2021, April 1). Social Cost of Carbon: What Is It, and Why Do We Need to Calculate It? – State of the Planet. https://news.climate.columbia.edu/2021/04/01/social-cost-of-carbon/

Institute for Policy Integrity. (2021, March 30). Drastic And Rapid Action on Climate Change is Warranted, Say Vast Majority of Economists. Institute for Policy Integrity. https://policyintegrity.org/files/media/Economist_Survey_Media_Release_2021.03.29.pdf

Met Office: Atmospheric CO2 now hitting 50% higher than pre-industrial levels. (2021, March 22). World Economic Forum. https://www.weforum.org/agenda/2021/03/met-office-atmospheric-co2-industrial-levels-environment-climate-change/

Ricke, K., Drout, L., Caldeira, K., & Tavoni, M. (2018). Country-level social cost of carbon. Nature Climate Change, 8, 895–900.

What is an externality? (n.d.). Sustainable Asset Valuation (SAVi). Retrieved 22 May 2024, from https://www.iisd.org/savi/faq/what-is-an-externality/

What is Carbon Pricing? (2017, May 9). Carbon Pricing Dashboard. https://carbonpricingdashboard.worldbank.org/what-carbon-pricing

****