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Review Article

Environmental Regulation: Externalities and Markets

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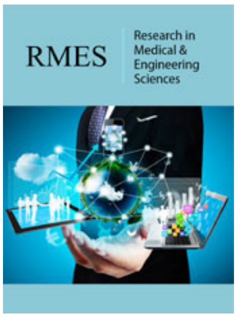

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Abstract

This paper examines normative and positive aspects of environmental regulation. It also discusses the properties of several environmental instruments such as emissions taxes, tradable emission permits, and command-and-control regulation. The main theoretical foundations of environmental regulation are also emphasized although references on contemporary issues related to the discussion of the possibility of having a practice-oriented profile is treated. Beyond brief introduction, the second section defines the externality problem and makes a taxonomy of externalities. The third section deals with externalities and the First-Welfare Theorem, i.e., in a perfect competitive market without government intervention except to keep a Pareto-optimal situation. Other functional concepts such as missing markets and Coase's theorem are also addressed. The fourth section covers optimal environmental regulation through means such as taxes, emission-trading-system, and standards all these in a Second-Best World. The fifth section treats emission reduction policy by analysing carbon pricing alternatives and other solutions. The sixth section delineates a frame of reference to evaluate the relative effectiveness of taxes in emissions abatement. The seventh section rises discussion about diverse instruments to lower emissions. In the eight section some concluding remarks stemming from the tried analysis are drawn.

Keywords: Externality problem; First-best theorem; Second-best approach; Carbon pricing; Optimal policy; JEL: Q11

Introduction

The objective of this work is to help in the understanding of benefits and costs of different forms of environmental regulation and to appreciate the implications for government policy towards environment.

The underpinning research questions are: Why does a perfectly competitive economy fail to produce a Pareto optimal allocation of resources in the presence of environmental pollution? How can pollution problems be regulated most effectively when the government does not have precise information about abatement technology and environmental damage costs? What is the best method for emissions to be reduced? [1,2].

To answer these questions this research analyses the taxonomy of externalities[1], incomplete markets, Lindahl markets, the Coase Theorem [3,4] and basic Pigouvian taxes [5], likewise other economic incentive-based instruments such as control-demand instruments, the least cost property, and permit trading, and then discusses carbon pricing and the key features of an optimal policy in real terms, i.e., taxes and emissions trading in imperfect economies and other regulatory mechanisms such as standards and subsidies.

Throughout the first part of this research, the standing assumption is that the regulator has the "right" intentions, in other words, that governments want to regulate economic activity to restore Pareto efficiency or to maximise social welfare, it is maintained, whereas

[1]The concept of externality was developed by Henry Sidgwick and formalised by Arthur C. Pigou.

in the second part the paper discusses the principle underlying the externality taxation in a second-best world [6], and the political economy aspects of environmental regulations so that the former assumption are relaxed. This paper research was conducted throughout February 2020 and March 2022 in Mexico City.

The externality problem

An externality is present when economic agents' welfare (a consumer´s utility or a producer´s profit or cost) are directly affected by a choice made by others similar agents engaged in line with their inherent socioeconomic functions. Thus, two types of externalities could be distinguished: consumption externality when the choices of some agents (consumers or producers) affect the utility of others and production o externality when the choices of some agents (consumers or producers) affect the profit (or cost) of other producers (Figure 1).

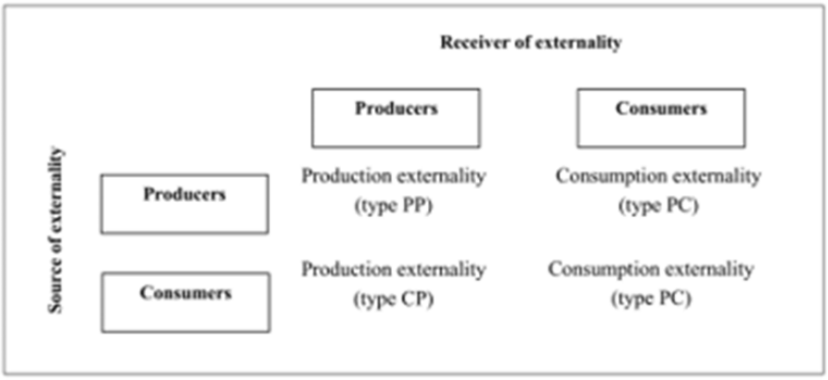

Figure 1: Sources and Receivers of Externalities.

By way of illustration, combinations matching sources of externalities and receivers of externalities in Figure 1 are as follows: industrial pollution and agriculture or fisheries (externality type PP)[2], particle waste, waste dumping, congestion, ozone depletion and global warming (externality type PC), congestion (externality type CP), and envy, congestion, noise, and smoking (externality type CC).

Externalities in a perfect competitive market

A competitive equilibrium is Pareto efficiency whenever the following situations are fulfilled,

A. Perfect competition in all markets.

B. Absence of externalities (or public goods), i.e., complete set of markets.

C. and the prevailing of perfect and symmetric information.

The possible outcomes of the first welfare theorem are shown below (Table 1): The solution of externality problems is context dependant. In the first-best world, externality problems might be siphoned off in three ways:

a) by the so-called Lindahl market in which the invisible hand completes the set of markets,

b) by bargaining between the affected parties as the Coasian antidote prescribes,

c) and by centralized intervention in the form of an externality tax as the Pigouvian medicine postulates[3]. Whereas in the second-best world, the problems are minimised either, by information wherever were impossible to observe the externality generating activity directly and/or distortionary taxes which should interact within the overall tax system.

Table 1: The three pareto conditions.

Consumption Efficiency:	$MRS^{A}_{x_i,L_o} = MRS^{B}_{x_i,L_o}$ $MRS^{A}_{x_1,x_2} = MRS^{B}_{x_1,x_2}$	Consumption externality type CC
Production Efficiency:	$MRTS^{x_1}_{l_o,k} = MRTS^{x_2}_{l_o,k}$	Production externality type PP
Product Mix Efficiency:	$MRT_{x_1,x_2} = MRS^{A}_{x_1,x_2} = MRS^{B}_{x_1,x_2}$ $MRS^{A}_{x_1,L_o} = MP^{x_i}_{l_o}$	Consumption externality type CC and PC

[2]The fundamental problem is a production externality. The size of externality -for a given consumption path, is the social cost of carbon (SCC). So that, the solution is to assign a price on carbon at the level of the SCC. If no other market failures exist, this restores efficiency and, in that condition, the first welfare theorem holds.
[3]Optimal environmental regulation requires information on preferences (environmental damage), abatement technology, and emissions from specific sources.

The First Welfare Theorem

Under such conditional framework, the regulation of externalities in the first-best world assumes:

two commodities x_1 and x_2 one input I_0, with consumers prices $q=(q_0,q_1,q_2)$ and with producer prices $P=(P_0,P_1,P_2)$,

A. perfect competition and constant returns to scale.

B. no taxes levied for optimal tax reasons and more importantly,

C. an observable and quantifiable externality.

In this way, considering one array of two types of consumers, A and B the consumption of $A\ (i=1,2,3.........n)$ generates an externality of e_{Ai} while the consumption of $B\ (i=1,2,3.........n)$ receives an externality which is non-depletable: $e_B=\sum_{i=1}^{n} e_{Ai}$. All this derives in the following scheme:

$$Privatebenefit: V_{Ai}(q,m^A,e_{Ai})=m^A+v^{Ai}(q,e_{Ai})where\frac{\partial v^{Ai}}{\partial e_{At}}>0 \text{ -----(1)}$$

$$Negativeexternality: V_{Bi}(q,m^B+e_B)=m^A+v^{Ai}(q,e_B)<0where\frac{\partial v^{ti}}{\partial e^B}<0 \text{ ------(2)}$$

The assignations stemmed from the above features lead to the following sort of nirvana state (Figure 2).

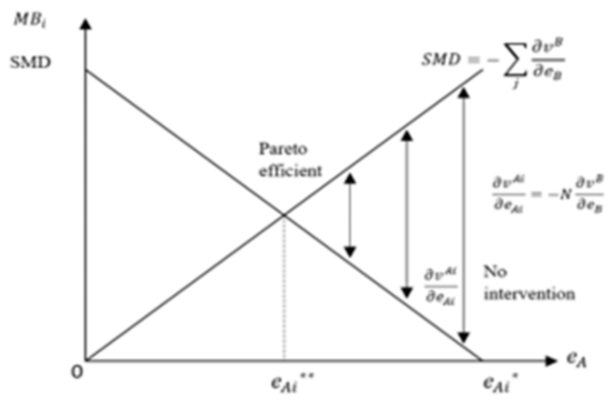

Figure 2: Allocations.

The Lindahl market

The Lindahl market tries to depict the interaction between externalities and missing markets. For instance, one missing market is that of smoking in special places - a dining room for instance- which are significantly difficult to be banned. For this kind of market, the market structure is made of smokers which are consumers type A and non-smokers which are consumers type B. Thus, to assign the property right to one consumer type B, i.e., a situation in which each receiver gets the right to decide the total amount of the externality derived from smokers A. Likewise, to emit one unit of emission each smoker A needs to buy a unit-permit from each consumer type B at the personalised price of P_i^B.

Permit trading in carbon emissions

The basic idea underlying permit trading (or cap-and-trade) is simple. Government must decide one fundamental thing: how much carbon dioxide (CO_2) should human be permitted to emit? Once this portion is determined upon several permits amounting to total quantity is issued. Then agents are allowed to buy and sell permits at the market rate to match their productive plans. As from the demand side of the permit market, each type A consumer demand the same number of permits from each type B consumer. Profit maximization is depicted as follows: $Max_{Ai}=v^{Ai}(q,e_{Ai})-e_{Ai}\sum_{j=1}^{N}P_j^B$. At the equilibrium point: marginal benefit equals marginal costs, $\frac{\partial v^{Ai}}{\partial e_{Ai}}=\sum_{j=1}^{N}P_j^B$. The source i of demand for permits in market j will be: $e_{Ai}\sum_{j=1}^{N}P_j^B$. As for the supply side of the permit market, each consumer is implicitly deciding on the total number of permits. So that, profit maximization here implies: $Maxv^B=(q,e_{Bj})-P_j^B e_{Bj}$.

The market equilibrium point is reached at when marginal benefit is equals marginal cost, $P_j^B=-\frac{\partial v^B}{\partial e_{Bj}}$. The total supply of permits from the perspective of the receiver of externalities will be: $e_{Bj}^s(P_j^B)$. Once the exchanging conditions are set up for both supply and demand, it is possible to establish the clearance of the missing permits market, i.e., to determine the price of permit for both types of consumers: $e_{Bj}^s(P_j^B)=\sum_{i=1}^{n}e_{Ai}^d(\sum_{j=1}^{N}P_j^B)$. Total demand is the same in all markets: $e_{Bj}=e_B$ for all j. So, in equilibrium the above market is given by: $e_{Bj}=e_B$, there for: $\frac{\partial v^{Ai}}{\partial e_{Ai}}=\sum_{j=1}^{N}P_j^B$ for the market demand side. From the supply side, $P_j^B=-\frac{\partial v^B}{\partial e_B}(e_B)$.

As a result, it is shown that a set of N competitive externality markets can restore Pareto optimality i.e., $\frac{\partial v^{Ai}}{\partial e_{Ai}}=-\sum_{j=1}^{N}\frac{\partial v^B}{\partial e_B}$.

Notwithstanding, in dealing with externalities in a first-best world without government intervention encounters problems such as:

A. Enforceable property rights to the receptor need to be defined,

B. There are high transaction costs associated with these markets and

C. With only one supplier in each market, the assumption of perfect competition is dubious.

So, remaining in the first best-world there are other solutions that work out in restoring equilibrium such as the Coasian Theorem and the Pigouvian tax approaches.

The Second-Best World

Standard and charge approach

In the first instance an acceptable standard $(\bar{E})$ is not related to a given damage. Then, how can this standard be implemented at least cost when abatement technologies are not known to the regulator? Abatement (a_i) is correlated to cost (c_i) so that when the total cost eventually increases the abatement amount becomes less significate. Considering this basic relationship, then $e_i=e_i^*-a_i$ where e_i^* is emission in absence of abatement effort. Therefore:

$$E=\sum_{i=1}^{n}(e_i^*-a_i) \text{ ---------------------(3)}$$

Least cost solution

As the aim is: $\min_{a_i}\sum_{i=1}^{n}c_i(a_i)$ subject to: $\sum_{i=1}^{n}(e_i^*-a_i)\le\bar{E}$, the solution expected will be: $\frac{\partial c_i}{\partial a_i}=\lambda$ where $\lambda=$ shadow price of emission. Therefore, $E(\lambda)=\bar{E}$. So that, the marginal abatement is equalized across all firms (Figure 3).

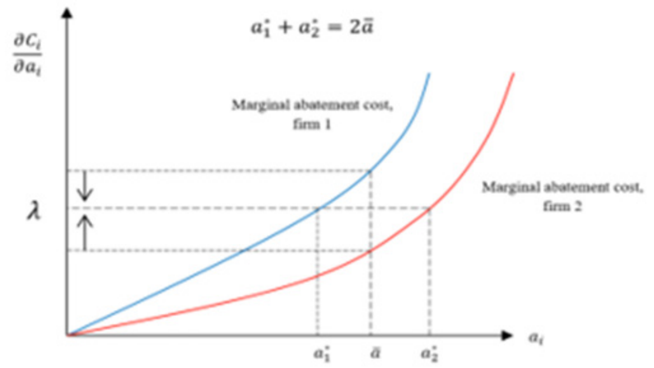

Figure 3: The marginal cost of abatement.

Emissions taxes

The textbook solution to the problem of pollution by a stock of CO_2 emissions is for the government to intervene in the free market and taxing CO_2. Taxes are a powerful economical means for correcting externalities. Thus, if the regulator levies a uniform emission tax () on each firm: $\min_{a_i} c_i(a_i) + \tau(e_i^* - a_i)$, the solution is given by: $\frac{\partial c_i}{\partial a_i} = \tau$ and then marginal costs are equalized too. $E(\tau) = \bar{E}$ only if $\tau = \lambda$.

However, without knowing the shadow price of emission, the regulator cannot set the correct tax *ex-ante*. To achieve it, he must follow an iterative process of trial and error, learning about distribution of costs. Due to that difficulty, a uniform emission tax can implement a given standard at the least cost, but this may involve an adjustment period.

Emission trading system (ETS)

An alternative to price carbon[4] is a cap-and-trade scheme.[5] As aforementioned, a permit gives the right to emit one unit of pollution to certain economic agent. In fact, CO_2 emissions permits can be now freely traded. So, if P^p is the equilibrium price in the resulting competitive market for CO_2 emission permits, and $\bar{e}_i$ permits are given to firm i; the standard is achieved as follows: $\bar{E} = \sum_i \bar{e}_i$, therefore the overall budget composed largely of costs of abatement and the equilibrium prices of permits will be as follows: $\min_{a_i} c_i(a_i) + P^p(e_i^* + a_i + \bar{e}_i)$. The obtained solution assumes the following identity equation:

$$\frac{\partial c_i}{\partial a_i} = P^p \text{ ----------------(5)}$$

The equation (5) implies that the marginal costs are equalized. It also shows that an ETS can implement the standard at least cost without the need for an adjustment period. Assuming that the market is competitive and that transaction costs are sufficiently low, the least-cost theorem postulates that a system of tradable permits can implement any aggregate CO_2 emission reduction target at least cost. The achievement of efficiency is independent of the initial allocation of permits. However, is pertinent to separate efficiency from equity considerations.

Standards

If $\bar{e}$ is a sstandard uniform, $\bar{E} = n\bar{e}$ constitutes the standard obtained. But at what cost?

In this context, the least cost solution cannot be implemented. Even worst, it does not provide any dynamic incentives for emission reduction whatsoever (Figure 4). So, the less cost solution is less attractive than emission taxes and tradeable permits on these grounds. Thus, incentive-based instruments can be used to implement an acceptable environmental standard at the least cost without having precise information on abatement costs and while also providing dynamic incentives for CO_2 emission reduction. By the opposite, command-and-control instruments cannot do that.

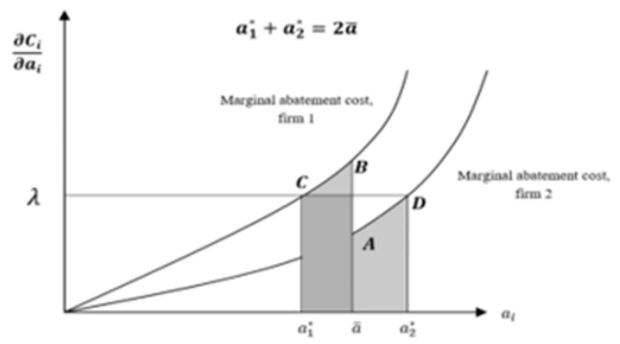

Figure 4: Performance standards.

Carbon Pricing

Taxes

To delineate a frame of reference let us evaluate the relative effectiveness of taxes in reducing CO_2 emissions. Suppose the government taxes every ton of CO_{2e} emissions an amount of $\$\tau^*$, where $\tau^* = SCC$. Consider a firm with an optimized profit $\pi_i(a_i) = \pi_i - c_i(a_i) - \tau^*(e_i^0 - a_i)$ where π_i is revenue minus other costs e_i^0 is pre-regulation emissions (tCO_2e), a_i is abatement and $c_i(a_i)$ is total cost of reducing emissions. Furthermore, if the marginal average costs, $MAC_i = c_i^{'} > 0$, since abatement is costly and that might be achieved through input substitution (using more labour, more green energy, etcetera); output reduction (deciding less output, investing in new production technology (e.g., changing production function), the problem of firm es: $\max \pi_i(a_i) = \pi_i - c_i(a_i) - \tau^*(e_i^0 - a_i)$, where the first-order condition is: $c_i^{'}(a_i) = \tau^*$ and this is true for all firms, so we have that the marginal average cost of firm equal to social cost of carbon, i.e. $MAC_i = SCC_i$. Hence, short marginal costs equal to short marginal benefits $SMC = SMB$ of abatement, and the economy supplies the efficient amount (Figure 5).

[4]In the process of internalising externalities, carbon price consists in the additional payment imposed on polluters.
[5]Tradeable permits (or cap-and-trade) may be preferable if a government is particularly concerned with hitting a specific target for the level of CO_2 emissions.

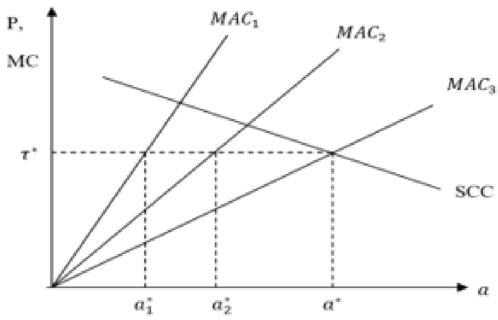

Figure 5: Carbon pricing: taxes.

Thus, we have internalized the externality, and reduce emissions efficiently as firms that can easily reduce emissions (c_i, flat) will do lots of abatement and firms that cannot easily abate, will do less (c_i, steep).

Emissions trading

As an alternative to taxes, the government could create $e^0 - a^*$ permits, each entitling the holder to emit 1 to CO_2e; inducing the allocation of permits somehow, e.g., give for free an amount f_i to each firm I (where $\sum f_i = e^0 - a^*$). Firms are then allowed to buy and sell permits, which will reach some equilibrium price p.

In this scenario, the firm´s problem $\max \pi_i - c_i(a_i) - p(e_i^0 - f_i - a_i)$ The first order condition is: $c_i'(a_i) = p$. And for $\sum_i a_i = a^*$, an equilibrium price must be $p = \tau^*$ (Figure 6) Again, we therefore have $MAC_i = SCC_i$, and hence efficient abatement. Notice that f_i does not impact abatement choice as initial allocation does not matter for efficiency. But initial permit allocation gives rent $f_i p$ to firm i.

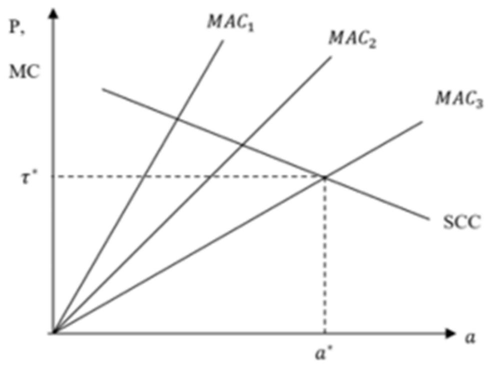

Figure 6: Carbon pricing: emissions trading.

Carbon pricing vs standards

Another way to induce abatement a^* is to tell each firm it must abate some amount. In theory that could give each firm targets a_i^* that solves $c_i' = SCC$, but in practice it is not informationally feasible as each MAC_i it is not known. Hence, to give all firms the same a^* such that $\sum_i a_i = a^*$, it shall be advisable, i.e., like CO_2 emissions trading without the trading (Figure 7). The expected result is to achieve abatement a^* but not in an efficient way since we do not have $MAC_i = SCC_i$, for all i.[6]

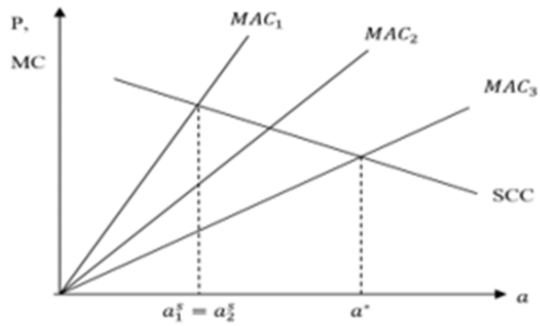

Figure 7: Carbon pricing vs standards.

Optimal policy of regulation

In fact, there is a lot more going on in the real world than just unpriced carbon. Hence, climate policy is more than just internalising the carbon externality, even if this the single most important thing. When choosing between taxes and emissions trading economic instruments, which other consideration matter in practice? It is advisable to do a balancing act between the pros and cons inherent of taxes and CO_2 emissions according to,

a) Efficiency when the abatement costs are uncertain.

b) Commitment versus flexibility.

c) Political economy, and

d) Volatility and policy interaction.

Uncertain abatement costs

As aforementioned, under certainty price (tax) and quantity (emissions trading) instruments are equivalent. [7] looked at the economic costs of each instrument when the position of the MAC is uncertain. So that, to settle which instrument is better it depends on relative slope of the MAC and SCC [8]. Applied to climate change, this suggests taxes may be better over short time periods, but emissions trading over longer periods (Figure 8).

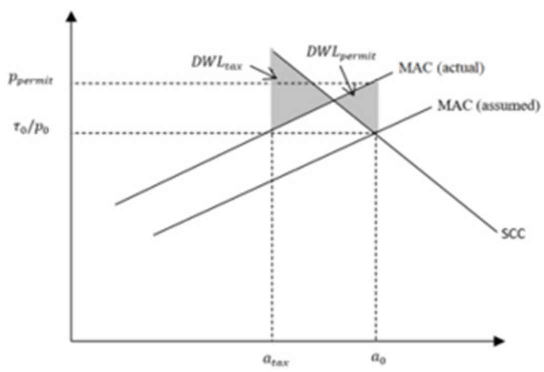

Figure 8: Uncertain abatement costs.

[6] So that, standards are common, for some good and some bad reasons.

Commitment vs flexibility

In many areas of economic policy making (e.g., monetary policy) there is a trade-off between commitment and flexibility. Distinctly, emissions trading tends to be less flexible as permit allowances are legally agreed well in advance, whereas taxes easily adjusted. Flexibility used to bring some benefits such as the possibility to adjust policies if current information about the SCC or MAC comes to light (e.g., falling renewable costs), alike their adjustment to changing macroeconomic conditions.

Notwithstanding, commitment has two benefits: the so-called ratchet effect, i.e., firms do less today with the expectation of weaken policy tomorrow, and the potential that revenues based on forthcoming carbon prices could be lowered as governments might take this away.

Political economy

The political economy trumps all consideration in practice. Pricing and externality generate rents equal to *e* times *p*, where *e* is the total final CO_2 emissions and *p* is carbon price (tax or permit price). Who gets these rents is crucial for the political economy of the emissions reduction policy? Most efficient options opt to give rents to the government (tax or auction permits) due to governments can reduce distorting taxation or spend on other socially valuable things such as health, climate R&D. However, rents can be and often are used to buy off opposition from voters or special interest groups.

Buying off firms might be done easier in CO_2 emissions trading process as the governmental offices entitled could give some permits for free (f_i) to each firm generating rent $f_i p$ (Hepburn 2013). Some organizations used this technique in its early phases and since have gradually moved to auctions. Buying off voters is seen in some countries as Sweden and Canada which have given revenues back to taxpayers. The Conservative Case for Carbon Dividends (2017) advocates a direct "dividend" to US taxpayers.[7]

Volatility and policy interactions

The interaction with other policies may cause that other carbon reduction policies become pointless in an economy regulated by CO_2 emissions trading, i.e., the "waterbed effect", whereas a tax will reinforce other policies. Volatility, by its side, could provoke that some ETS induce volatile prices in practice. This seriously hinders firms' ability to invest based on carbon price. What is the possible solution to these and other problems? Hybrid instruments such as carbon price floor, carbon price ceiling and to get most out of the benefits of both tax and emission trading, for instance.

Standards and subsidies

When are standards/technology subsidies good in practice? Standards (also known as "direct regulation" or command and control) and technology-specific subsidies are not as efficient as carbon pricing in the simple setting we considered earlier. Standards and subsidies are similar in that both specify a particular technological solution. But can play a significant role in an optimal policy mix, for at least two reasons:

Firstly, learning by-doing cost reductions as a unit cost today depends on industry-wide past production $c_i(X_{t-1}, X_{t-1}, \ldots\ldots\ldots\ldots)$. If the technology is going to be socially beneficial, then subsidies are justified today because they lower future costs which, incidentally, are not captured by a single firm. [9] for instance, quantifies this effect and finds considerable solar photovoltaic-cells subsidies (separate to the carbon price) become feasible viable.[8]

Secondly, if prices are not working, standards can step in. Energy cost myopia[9] is an example of prices not being acted on and therefore not aligning social costs and benefits correctly therefore consumers under-invest in energy efficiency, i.e., fuel prices do not to guiding choices "like it should". If energy efficiency standards can solve this, they will work better than carbon prices at solving such problem. (Nordhaus 2013) chapter 22 discusses car fuel efficiency standards in the USA (CAFF). Assuming no energy cost myopia, abatements using standards costs $85/t. At this cost, a carbon price is a better policy but with energy cost myopia, standard cost $22/t.

Thence, standards and subsidies can be especially useful at solving specific problems, but they will unlikely be able to guide the whole economy through serious decarbonisation strategy before the probability of not being efficient enough and requires the regulator to pick specific technologies. By contrast a carbon-price policy guides the economy to take the most efficient abatement opportunities, and to develop new ones.

Discussion

Fossil fuels are burnt to produce useful energy. However, this process releases CO_2 into the atmosphere, which is thought to be contributing to a change in global climate. Before that, one option is complete lack of regulation, i.e., to leave the energy market as it is right now, synchronised mostly by market forces without any regard for the carbon pollution generated. But the very nature of global pollution means that nobody can pop-out.

If neither free market nor government decree is the option, then what is? One alternative to be pick up is that of permit trading able to gather and use that would otherwise be kept by individuals and firms, eventually, it is used to zoom in on an efficient outcome. Notwithstanding, stressing direct emission control does not mean that government has no role to fulfil in reducing emissions process. By contrary, government intervention is necessary at least for two reasons: firstly, the system should be universal, secondly,

[7]It is harder, however, to give tax revenues to firms in practice than giving permits.
[8]Also true, to a lesser extent, for offshore wind.
[9]When consumer choices are analysed (for cars, houses) a regular finding is that they invest too little in energy efficiency seeming to underweight future savings. The behavioural economics explanation is that if they not responding efficiently to price signals, hence a carbon price will not work out at all.

careful monitoring of CO_2 emissions is a sine-qua-none condition. Briefly, governmental action is essential in helping to manage the coordination problem of the price system.

However, the price system can be derailed by many practical drawbacks. Regardless of whether fighting CO_2 emissions through permit trading or something else, determining how much CO_2 humans should be allowed to release is a tough question as involve solving a conflict of interests between those who take the burden of climate change with those who benefit from inexpensive energy. Therefore, it is worthy to apprise permit-trading and incentive-compatible system as because of CO_2 emissions are controlled as allowing the discovering of such level in the process itself.

Is a tax the best way to price pollution? How does government share the burden of CO_2 emissions reduction between countries and people and firms within countries while keeping fairness considerations? What is the marginal damage of an extra tone of CO_2 in terms of extra global warming? A further complicating factor is that the marginal damage depends on the timing of emissions and economic agents' expectations about the future, i.e., when the government reduces CO_2. Thus, as the marginal damage of CO_2 is a state dependent issue, are government able to overcome the problem of setting optimal tax rates?

Furthermore, what if emissions could not be observed or verified? It cannot be taxed what is not measured. In addition, it is often costly to install and run monitoring equipment, though technology constantly improving too. However, problems of asymmetric information persist. One possible alternative might be to tax something that is indirectly related to pollution. For instance, the emissions generated by the firm should be levied by a Pigouvian tax (τ), whilst both the goods supplied and the inputs utilized on them can be altogether subjected to a green tax, (τ^Y) and (τ^I), respectively (Figure 9).

Nevertheless, the principle of targeting postulated that in a competitive economy, the optimal policy should address the source of the distortion as directly as possible as indirect instruments create deadweight losses that could be avoided.

So, in its simple setting taxes and emissions trading are equivalent. Setting a tax τ^* induces abatement a^*, while creating permits requiring abatement a^* induce permit price τ^*. They are efficient because marginal abatement costs equalized across all firms. Unlike standards which are inefficient. Both taxes and permits require exactly same (very large) amount of information, to calculate either τ^* or a^*. For instance, need to know economy´s $MAC = \sum_i MAC_i$. Need to know SCC. But in imperfect real economies, there are important differences as it has been [10].

An influential attempt to construct an economy-wide MAC is the so-called McKinsey Curve that even though is weakened because the exact number probably are not right, it shows what we mean by a MAC, and how much information it summarizes [11]. A supplementary insight is that stated by the report *State and Trends of Carbon Pricing* of the [12] which shows that a lot of countries are pricing carbon and that the evidence show that emissions trading is more popular than tax, but tax also has overspread its usage. Nevertheless, the problem that carbon price is less than the SCC is a distinctive feature everywhere. The world´s biggest carbon pricing scheme is EU Emissions Trading launched in 2005 but faces two drawbacks, firstly, that after tax does not work out and that the permit price has not been stable [13].

On the other hand, recent experience with market-based environmental regulation has brought green taxes and the "double-dividend" approach to the fore since climate change became self-evident. An argument often used in favour of environmental tax reform is that it might produce a double dividend: environmental quality is improved and by substituting distortion taxes on labour and capital with taxes on pollution the efficiency costs of raising a given revenue can be lowered. This proposition, however, theoretically, and empirically should be evaluated [14].

From a global perspective, climate policy is a public goods game and then a prisoner's dilemma in which international environmental agreements work by transforming the game to get a better equilibrium. In fact, there are big gains to cooperation but achieving those means finding a way to deter free riding. However, that is hard because punishment must be credible. Without external punishment, often only small/shallow coalitions sustained. So that, there is much room to be fulfilled in that perspective, even more when it is known that only with trade sanctions is possible to full cooperative outcome [15].

Conclusion

Incentive-based instruments are superior to command-and-control policies whenever the regulator has imperfect information. Indirect instruments used to create distortions that should be traded off against the benefits of internalizing the externality.

Carbon prices are the most important single policy for reducing emissions and therefore for tackling climate change. Taxes and emissions trading both have their advantages and disadvantages, which is best? That is contingent upon our own perspectives. [15] categorically assure "*either one*", [16], however, pronounces "*all*" (including standards).

Notwithstanding, there are other important market failures, so a carbon price alone (even at the correct SCC curve) would not solve the problem, for instance, research, development, and deployment (RD&D), imperfect capital markets, co-benefits, and energy- cost myopia, which must also be addressed when making climate change policy. Political economy considerations trumps everything else in practice, but that does not mean society should not think about efficiency [17-25].

The government has several potential policy instruments to encourage reductions in CO_2 emissions. In that endeavour, government must procure that users face the correct kind of incentives to reduce emissions in an efficient way. Policy could be changed to reduce the differences -e.g., across households' carbon prices and/or taxes on energy consumption, while addressing other policy concerns to achieve the emissions reductions targets in a less costly fashion. An effective policy should not assume otherwise perfect economy is stated [26-33].

Statements and Declarations

We, the authors, declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contribution

Benjamín García-Páez performed the literature review, analysed, and interpreted the data, prepared, and edited the manuscript draft. Elvira B. Rodriguez Ríos helped in the interpretation and analysis of data. Likewise, she has to do with manuscript preparation and manuscript editing.

Highlights

A. Dealing with externalities in a first-best world without government intervention, and their solutions.

B. Discussing the least-cost property, the observability problems, and the principle of targeting.

C. Delving into the principle underlying externalities taxation in a second-best world and discussing how green taxes can be used to resolve environmental problems.

D. Making de breakdown of an emissions abatement policy given emphasis to carbon pricing and portrays an optimal policy in practice.

Forwarding political economy considerations as they used to grant concession to some parties in both the law-making process and in its enforcement. However, it stands for none allowance of gross inefficiency in the handling of environmental pollution.

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