Title

Refunded emission taxes: A resolution to the cap-versus-tax dilemma for greenhouse gas regulation[1]

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http://www.sciencedirect.com/science/journal/03014215

http://dx.doi.org/10.1016/j.enpol.2006.10.020

Abstract

Regulatory instruments for greenhouse gas control present a policy dilemma: Market-based instruments such as cap and trade function to reduce regulatory costs; but because they provide no guarantee that costs will be reduced to acceptable levels it is infeasible to set caps at sustainable levels. Emission taxes provide cost certainty, but their comparatively high cost makes it infeasible to set tax rates at levels commensurate with sustainability goals. However, there is a straightforward solution to this dilemma: Just as cap and trade uses free allowance allocation to minimize regulatory costs, an emission tax's cost can be mitigated by refunding tax revenue in such a way that emission reduction becomes profitable. A refunded tax, like cap and trade with free allocation, would be revenue-neutral within the regulated industry. Marginal competitive incentives for commercializing emission-reducing technologies would not be diminished by the refund, and the refund could actually make it politically and economically feasible to increase the incentives by an order of magnitude. Whereas cap and trade merely caps emissions at an unsustainable level while subjecting the economy to extreme price volatility, refunded emission taxes could create a stable investment environment with sustained incentives for emission reduction over a long-term investment horizon.

Regulatory climate policy entails a tradeoff between environmental goals and costs. If the highest-priority policy objective is environmental sustainability, an appropriate regulatory instrument would be a cap and trade system that caps emissions at a sustainable level and seeks to achieve the cap at minimum cost. The economic costs of cap and trade can be minimized by employing emission trading and by allocating emission allowances freely, although there is no guarantee of cost acceptability. But if political imperatives favor cost acceptability over environmental goals, then an appropriate instrument might be an emission tax. A tax effectively caps costs by mandating an emission price, although there is no guarantee that the tax incentive would be sufficient to achieve environmental sustainability.

Cap and trade has become accepted as the mainstay of greenhouse gas regulatory policy, but considering that caps are never set at sustainable levels it is evident that cost control takes precedence over emission control and that emission caps are determined primarily to hit cost targets, not sustainability targets. This is an ineffective and inappropriate use of cap and trade because it is not possible, in the context of rapidly evolving technologies and volatile markets, to predict in advance an emission cap or a schedule of declining caps that will achieve minimum emissions within limits of cost acceptability. When cost considerations take precedence over environmental interests, cap and trade can perversely *reduce* the likelihood of achieving environmental sustainability goals because the only way to guarantee compliance with the emission cap, while also ensuring cost acceptability, is to set the cap so far above the sustainable level that cost acceptability is assured under the most cost-conservative predictive assumptions. Moreover, without any incentive to reduce aggregate emissions below the cap level it is virtually certain that sustainability goals will not be attained.

It would seem that emission taxes, which provide cost certainty, would be more compatible with cost-constrained political priorities, but a carbon tax commensurate with environmental goals would be politically and economically unviable because of the high cost that taxes impose on industry. Taxes can be made more politically palatable by "recycling" tax revenue to consumers, e.g. through reduced income taxes. Indeed, a tax of sufficient magnitude to achieve climate sustainability might conceivably displace income taxes altogether. But the revenue transferred from industry to consumers may be spent in ways that are unrelated to the tax's environmental purpose and that might even increase greenhouse-gas-related consumption. Moreover, tax recycling would make the government's tax base and the economy perversely dependent on carbon emissions, creating a situation in which the government would lose much of its tax base if the policy actually succeeded in achieving carbon neutrality.

A more direct and efficient way to effectuate tax recycling would be to refund the tax to the regulated industry as a production subsidy. For example, taxes in the utility power sector would be refunded in proportion to power generation, so that firms with worse-than-average emission performance (as measured by CO_2 emissions per unit power output) incur a positive net cost from the program, while those with better-than-average performance derive net income. The Swedish Acid Rain program uses a refunded tax of this type to regulate stationary-source NO_x emissions (Ågren, 2000; Isaksson and Sterner, 2006; Wolff, 2000). In contrast to conventional tax recycling, refunding has the advantage that the only net aggregate costs that a refunded tax imposes on industry are regulation-induced costs for emission reduction. New low-emission technologies at their nascent commercial stage would be economically dependent on tax-financed net subsidies, but the subsidies would automatically phase out, without further regulatory intervention, as the technologies gain market share and economies of scale.

Conventional economic analysis tends to focus on the “Prices vs. Quantities” distinction between caps and taxes (Weitzman, 1974), but revenue distribution is also critically important. The political advantage and success of cap and trade can be attributed to the fact that with free allocation a regulated firm need not pay for emission rights to cover its entire emission output; it only has to buy credits to cover any excess emissions over its allotted quota. If it does not need its full quota, the firm can sell its unneeded allowances at a profit. A conventional emission tax, by contrast, requires that all regulated firms – even the most emission-efficient – pay for their entire emission output. The distributional impact of the tax would be similar to cap and trade with auctioned permits, which would be no more politically palatable than a tax. On the other hand, refunding would eliminate the political handicap of taxes relative to cap and trade, and the price stability afforded by refunded taxes would further enhance their political favor.

The operating principle of a refunded tax can be illustrated by considering the utility power industry. A refunded emission tax applied to power plant emissions would effectively apply the net tax to only a portion of a firm’s CO_2 emissions based on how its “emission intensity” (tons CO_2 generated per MWh power output) compares to the industry average. For example, if a power plant’s CO_2 emission intensity is 1 ton/MWh and the industry average is 0.9 ton/MWh, then a tax rate of $100/ton would effectively apply only to the 0.1 ton/MWh difference, resulting in a net regulatory cost of $10/MWh. If the industry average is 1.1 ton/MWh, the difference would be negative and the firm would receive a net subsidy of $10/MWh. By contrast, an unrefunded tax would apply to the entire 1 ton/MWh emission rate and would equate to $100/MWh. But with or without refunding, the marginal competitive incentive for emission reduction would be the same, e.g., a 0.1 ton/MWh reduction in the firm's emission rate would reduce its tax cost (or increase its net subsidy) relative to its competitors by $10/MWh irrespective of whether the tax is refunded. Thus, the refunded tax would create high marginal incentives for emission reduction without imposing high regulatory costs on industry.

The above points can be formalized as follows: A refunded carbon tax is applied to a regulated industry sector comprising GHG-emitting entities, wherein the i-th entity generates emissions e_i in connection with a quantity q_i of emission-related economic value. For example, in the utility power sector q_i represents a quantity of electricity (MWh) generated during a particular tax accounting period, and e_i represents the associated GHG emissions (tons CO_2) from fuel combustion.

The tax t_i is applied to emissions, based on a mandated emission price (i.e. tax rate) p,

$$t_i = p\, e_i$$

The tax is refunded in proportion to economic value. The refund r_i associated with value q_i is

$$r_i = c\, q_i$$

wherein c is the refund rate, which is determined to achieve revenue neutrality. Defining the sector's aggregate emissions E and associated aggregate economic value Q as

$$E = \sum_i e_i , \qquad Q = \sum_i q_i$$

the revenue-neutrality condition determines the refund rate as

$$\sum_i t_i = \sum_i r_i \quad \rightarrow \quad c = p\,\frac{E}{Q}$$

It follows from the above conditions that (1) an entity's tax-to-refund ratio (t_i / r_i) is proportional to its emission intensity e_i / q_i (i.e. emissions per unit of economic value); and (2) the entity will accrue a net loss or gain from the refunded tax depending on whether its emission intensity is greater or less than the regulated sector's aggregate emission intensity (E / Q):

$$t_i / r_i = \frac{e_i / q_i}{E / Q}$$

(The E / Q ratio represents the sector's value-weighted average emission intensity.) One salient aspect of the above relationship is that an entity's regulatory costs can change through no action of its own, but only from its competitors' actions (which affect the E / Q ratio). Thus a refunded tax employs competitive market incentives to motivate emission reduction.

Under a refunded-tax policy, the net charge (tax minus refund) per unit of economic value incurred by the *i*-th entity is equal to the emission price times the difference between its emission intensity e_i / q_i and the industry average E / Q:

$$\frac{t_i - r_i}{q_i} = p\,\frac{e_i}{q_i} - c = p\left(\frac{e_i}{q_i} - \frac{E}{Q}\right)$$

(If this value is negative it represents a net subsidy.) In a competitive industry, what matters most to an individual firm's market share and profitability is not just its own costs, but how its costs compare to it competitors. The regulation-induced cost difference between two regulated entities (entity i and entity j), per economic unit, is

$$\frac{t_i - r_i}{q_i} - \frac{t_j - r_j}{q_j} = p\left(\frac{e_i}{q_i} - \frac{e_j}{q_j}\right)$$

This difference has no dependence on the average emission intensity E/Q and is the same with or without refunding; hence even with refunding the marginal competitive incentives would be equivalent to an unrefunded tax.

A uniform refund rate would typically be applied throughout a particular industry sector to achieve revenue neutrality within that sector, as described above. However, alternative refunding methods could be employed to achieve more refined policy objectives. For example, in the utility power sector it may be desirable to avoid creating regulatory incentives for fuel switching from coal to natural gas because of possible adverse impacts on industries that rely on natural gas for uses other than electric power generation (e.g., home heating, fertilizer production). Energy security may also be a concern. For example, Germany is currently planning to exempt new power stations from emission limits under the EU ETS in order to avoid inducing a market shift from coal to imported natural gas, which is susceptible to supply disruptions (EurActiv, 2006); and for the same reason a refunded emission tax covering coal and natural gas may be politically unviable in the European Union.

The fuel switching incentive could be eliminated by applying separate refund rates to coal and natural gas, each defined to achieve revenue neutrality in the two respective sub-sectors; but this would also eliminate the incentive to substitute renewable fuel for fossil fuel. Alternatively, the refunding method could be structured to eliminate the regulatory incentive for substituting natural gas for coal, while maintaining the incentive for substituting renewable energy for fossil fuels. This can be achieved by establishing separate refund rates in the coal, natural gas, and renewable fuel sub-sectors based on three defining conditions: First, overall revenue neutrality (across all three sub-sectors) is preserved; second, the regulatory incentive is neutral with respect to fuel switching between coal and natural gas; and third, the refund rate in the renewable fuel sub-sector is the same as it would be with uniform refunding across all three sub-sectors. With this approach, the regulatory incentive would induce the market to reduce both coal and natural gas dependence, rather than increasing reliance on natural gas. (This refunding method is discussed in more detail in Johnson (2006b), Appendix B.)

A possible objection to tax refunding is that while the policy effectively incentivizes low-emission energy production, the refund tends to neutralize the incentive to reduce energy use, e.g. by improving energy efficiency or by reducing consumption of energy-related goods and services. But energy efficiency can be incentivized by applying refunded taxes to energy-consuming commodities such as electric appliances (Johnson, 2006a, Appendix B). (Refunded taxes on retail transactions are sometimes termed “feebates”.) Such policies would not create much incentive to reduce consumption, as would a conventional tax, but there is a positive tradeoff: The refund would make it feasible to impose a substantially higher tax rate (e.g., by an order of magnitude), so the policy would be much more effective at incentivizing emission-reducing technologies.

The Swedish NO_x program illustrates the relative efficacy of technology-focused regulatory policy. The refunded tax motivated emission reductions of about 50% within five years of the program's enactment in 1990. Had the tax not been refunded, the additional reduction from decreased consumption would have amounted to only 2-3%. Moreover, an unrefunded tax of the same magnitude (about $5000 per ton of NO_x) would not have been politically acceptable, so without refunding much of the technology-forcing regulatory incentive would have been forfeited in exchange for a comparatively minuscule reduction in energy consumption (Sterner and Hoglund, 2000).

Refunded taxes have a close connection to cap and trade with free allowance allocation, in that both distribute an economically valuable asset (the tax refund, or emission allowances) in proportion to some measure of emission-related economic utility. For example, in the case of power-sector policies "economic utility" is naturally quantified in terms of energy production output. A similar connection exists between feebates and performance standards (e.g., energy efficiency standards). A performance standard for refrigerators, for example, would typically set energy consumption limits as a function of volumetric refrigeration capacity (cubic feet), and a comparable feebate would apply a tax in proportion to energy consumption and distribute refunds in proportion to a similar function of refrigeration capacity. If the refund were distributed at a uniform rate per refrigeration unit, then large refrigerators would incur high fees (i.e. positive net taxes) simply because they are large, and small refrigerators would accrue large rebates (positive net subsidies) simply because they are small. The policy would function to induce downsizing, but would not be very effective at incentivizing efficient refrigeration technology because the large feebate disparity between large and small units would make a high tax rate infeasible.

Similar considerations apply to transportation policy, which must base vehicle emission standards (or similarly, fuel economy standards) and feebates on some measure of emission-related transportation utility. Vehicle weight represents a natural valuation metric, at least as a crude first approximation, because transportation vehicles operate fundamentally to move mass, and vehicle emissions tend to follow an approximately proportionate relationship to weight. The National Academy of Sciences, for example, has recommended “an approach with fuel economy targets that are dependent on vehicle attributes, such as vehicle weight, that inherently influence fuel use” (NRC, 2002); and fuel economy standards in China and Japan are weight-based (Pew Center, 2004). Similarly, the refund distribution for vehicle feebates could be based on weight (Johnson, 2006a).

An attribute-independent vehicle feebate would tend to induce very large tax revenue transfers from large to small vehicles, and would hence function to force downsizing, which generally entails a loss of economic utility. Hence, the viable tax rate with an attribute-independent vehicle feebate would be about a factor of 3 lower than that of a weight-based feebate (although it would nevertheless be about a factor of 10 higher than an unrefunded tax (Johnson, 2006a)).

The above considerations notwithstanding, weight is an imperfect valuation metric because low-density engineering materials can be used to reduce vehicle weight without compromising economically valuable attributes (e.g., carrying capacity, safety) that are usually correlated with higher vehicle weight. The NHTSA has recently adopted a new fuel economy standard for light trucks (NHTSA, 2006), which avoids this limitation by basing the standard on vehicle “footprint” (defined as the rectangular area inscribed by a vehicle’s wheel centers), rather than weight. This would be analogous to basing a refrigerator efficiency standard on footprint (i.e., floor area coverage). But a footprint-based standard (or similarly, footprint-based tax refunding) does not have a clear policy basis because there is no fundamental engineering relationship between footprint and fuel consumption. Rather than ignoring the intrinsic relationship between fuel consumption and weight, a more reasonable approach would be to use a weight-based standard (or feebate), but to allow “weight crediting” for the use of lightweight engineering materials. For example, if a vehicle manufacturer replaces 1000 pounds of structural steel with 600 pounds of functionally-equivalent, high-strength composite material, then a 400-pound weight credit would be added to the vehicle weight for the purpose of determining its emission allowance or feebate (Johnson, 2006a).

In conclusion, refunded emission taxes represent a neglected regulatory alternative that could overcome the deficiencies of both caps and taxes. In contrast to cap and trade, a refunded tax would be immune to price volatility, and its incentives for further emission reduction would not disappear when emissions reach some predetermined cap level. Furthermore, the refund would make it feasible to increase marginal incentives for technology-based emission reduction by an order of magnitude relative to an unrefunded tax. Refunded taxes could provide both long-term market incentives (over a multi-decade investment horizon) and a stable investment climate that would be conducive to the rapid and orderly transition to a low-carbon economy.

Footnote

1. The points in this paper are discussed at greater length in Johnson (2006b).

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