REFUNDED EMISSION PAYMENTS SCHEME – A COST-EFFICIENT AND POLITICALLY ACCEPTABLE INSTRUMENT FOR REDUCTION OF NO_X-EMISSIONS?

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Overview

Refunded emission payments (REP) scheme is a policy instrument that has garnered attention to overcome some problematic issues associated with the standard Pigouvian tax. With a REP scheme, a charge is put on emission and the collected revenue is recycled back to the emitting firms. It could increase public support for emission regulations through refunding and make it possible to introduce efficient emission charges. It could also address concerns about competitiveness and emission leakage.

The main objective of a REP scheme, however, is to achieve effective emission mitigation. Hence, this paper analyzes two different designs of a REP scheme in order to assess whether a REP scheme can be used as a cost-efficient instrument for mitigation of nitrogen oxide (NO_x) - emissions over time. The main focus in the literature has been on output-based refunding. We analyze a scheme where refunds are based on emissions cuts and compare it with an output-based scheme due to its prominence in the literature. By assumption, there is a binding path of emission reductions announced by the regulator and the optimal emission tax is not an available instrument, due to lack of political acceptance. We examine the incentives for compliance on the firm level under the two different versions of a REP scheme. Firms emit through their production and emissions can be mitigated either with production adjustments or use of abatement technology. An optimal instrument incentivise firms to choose the cost-minimizing combination of these two measures. Previous contributions to the literature have used static models, this paper expands the literature by using a dynamic model. Comparative statics and an illustrative simulation model are used to gain more insight from the theoretical results.

Methods

The analysis in the paper is conducted, using dynamic optimization. The model focuses on energy producing firms that emit NO_x as part of their production process. The regulator announces a target path of NO_x-emission cuts to be achieved for the regulated firms. There are two ways for the firms to reduce their emissions. They can either reduce production or invest in more abatement technology. The firms in the model are heterogenous. Hence, we examine how different types of firms adapt under the two policy instruments. The model uses optimal control theory to highlight the accumulation of abatement technology required to meet the specific target path. The stock of technology represents the state variable and investments in new technology represents the control variable. Depreciation of existing stock of technology captures maintenance costs for installed capacity.

Results

Results from the paper show that both REP schemes can achieve the target path of NO_x-emission reductions announced by the regulator, but is only cost-efficient when refunds are given for emission reductions. With this scheme, the socially optimal solutions can be achieved with a proper combination of the REP charge and the refund. The REP charge will be lower than the standard emission tax with no refund, and is determined by the emission tax, and the stringency of the emission regulations. With the output-based REP scheme, the target path can still be achieved, but incentives for emission mitigation differ from the socially optimal solutions. The REP charge necessary to achieve the target path will be higher than the optimal emission tax and is equal to the refund given in proportion to output.

We examine four scenarios in the paper where we look at the impact on mitigation measures made by firms and their resulting emissions under the two REP schemes. These four scenarios are 1) the effect of of emission per unit of output, 2) the effect of abatement ability through the use of abatement technology, 3) the effect of abatement technology costs and 4) the effect of profit per unit of production. In scenario 1), higher emission per unit of output unambiguously results in lower output. This is the case under both schemes. In addition, under the output-based scheme, it also matter whether emission per unit of output is above or below the average level of emission per output for all firms. If it is below, a firm can actually increase emitting production. In scenario 2) and 3) it is the case under both REP schemes that a firm that has higher ability to use abatemt technology and faces lower technology costs, invests more. Although a comparable firm has higher investment levels and hence, generally lower emission under the output-based REP scheme, there can be exceptions. Even tohugh a firm invests more under the output-based scheme, it still receives an output subsidy, which could result in higher emission for some firm types, compared to the case under the emission-reductions based REP scheme. Finally, in scenario 4), a firm with higher profit per unit of production always produces more, regardless of REP scheme and the levels are higher for comparable firms under the output-based REP scheme. However, due to the incentives for abatement technology in the output-based scheme, a firm with low profitability could actually emit less than a identical firm under the emission-reductions REP scheme even though it produces more.

We also investigate which type of firms that are winners and losers in terms of net payments under the two REP schemes. The net payment is the difference between the amount they pay for their emissions and the refund they receive. In scenario 1) it is firms with emission per unit of output lower than average that gain the most under the output-based scheme. When refunds are given for actual emission reductions however, it is firms with high emission per unit of output that receive the highest net payments. In both scenario 2) and 3) the firm type that gains the most are those with high abatement ability and low technology costs under both REP schemes. Finally, in the last scenario, firms with highest net payments are those with low profit per unit of production. A firm with high profit per unit of production produces more and hence, emits more, resulting in higher payments.

Conclusions

Both REP schemes can achieve the target path of NOx-emission reductions announced by the regulator. The results show that a REP scheme is only cost-efficient when refunds are given for emission reductions. The design of the two schemes also target different objectives. With the emission-reductions scheme, the focus is on emission reductions and allowing regulated firms a flexible and cost-efficient way to achieve this. In the output-based scheme however, competitive concerns are an integral part of the scheme design. There are also differences concerning distribution of costs in the two REP schemes, which means that different firm types could end up as net-winners under the two REP schemes.

A REP scheme can also remedy some concerns that regulators may have about emission taxes. An advantage with an emission tax, however, is that it generates revenue. Hence, an emission tax, even at an inefficient level, could still be appealing if revenue generation is an important concern. Both REP schemes also violate the polluter-pays-principle. When refunds are given to firms that are responsible for the emissions, these firms do not fully internalize the effect of the damage that they cause. Also, refunding could increase public support, but the refunding could also be perceived as unfair if the refunds are a reward for behavior that includes NOx emissions. Nevertheless, if established policy instruments prove unfeasible, a REP scheme could be an attractive addition to the regulatory toolbox.