

### *Abstract*

This thesis includes four separate research essays, which all revolve around environmental regulation with applications to Sweden. The three first essays analyze, theoretically and empirically, a charge on emissions of nitrogen oxides from large combustion plants in Sweden. The fourth and last essay investigates the effects on water consumption and tax revenues from a potential tax on household water use in Sweden.

The first essay explores the static and dynamic properties of output-based refunding of emission charges. The findings show that with many small and competitive polluters targeted by a refunded charge, emissions are reduced to approximately the same marginal abatement cost as under an equivalent Pigouvian tax. However, resource allocation is distorted because of a limited output effect. Marginal spending on research and development of abatement technology is likely to be lower for targeted firms and about the same for outside suppliers under a refunded charge compared with an equivalent Pigouvian tax.

The second essay analyses the costs for abatement investments implemented in 1990-96 by 114 large combustion plants, which in 1992 became subject to the Swedish charge on nitrogen oxide emissions. Marginal abatement cost functions are estimated for four industrial sectors using a double-hurdle model specification. Explanatory variables include emission variables as well as plant characteristics. Estimations, together with descriptive findings, show extensive opportunities to reduce emissions at a zero or very low cost. The findings support the hypothesis that "low-hanging fruit" is abundant in abatement activities.

The third essay analyses regulation costs of the Swedish charge on emissions of nitrogen oxides. Based on plant-level data, costs for abatement, monitoring and control, plant and regulator administration, and welfare losses of refunding the charge are calculated, as well as estimates of the environmental costs for increases in other pollutants following from abatement of nitrogen oxides. The sum of the average costs of regulation per unit of nitrogen oxides reduced is found to be close to the level of the unit charge.

The fourth essay estimates empirically the effects of a water tax on water use and on the size and stability of the tax revenues. A tax exceeding VAT can be motivated on efficiency grounds when there are environmental external costs of water use and when water is a scarce resource. Household demand functions for water are estimated using community level data for 282 (out of 286) Swedish communities studied annually over the period 1980-92. Estimations using static and dynamic panel data methods show a long run price elasticity of -0.10 in marginal price models and -0.20 in average price models. The findings imply that a tax of 1 SEK/m<sup>3</sup> of water used (corresponding to a 5% increase in the mean average price) would generate about 600 million SEK in tax revenues per year when levied on all households in Sweden. The water consumption would, however, only be reduced by about 1%.

*Keywords:* nitrogen oxides, abatement cost, transaction cost, emission charge, output-based refunding, low-hanging fruit, double-hurdle, water demand, water tax, price elasticity, panel data, dynamic panel data.

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