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How robust is the uniform emissions pricing rule to social equity concerns?

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ABSTRACT

This paper examines pollution tax differentiation across industries in light of social equity concerns using theoretical and numerical general equilibrium analyses in an optimal tax framework. We characterize the drivers for non-uniform optimal taxes stemming from the interaction of household heterogeneity with social preferences. Quantitatively assessing the case of price-based CO_2 emissions control in the U.S. economy, we find that uniform emissions pricing is approximately optimal when social concerns are defined over inequity induced by the environmental tax. The deviation from uniform emissions pricing, however, becomes non-negligible when pollution tax rebates deviate much from optimal transfer schemes or when social concerns are defined over both policy-induced impacts and inequity unrelated to environmental policy. Our results are robust to a number of model extensions including the stringency of the environmental target, downstream vs. upstream taxation, pre-existing distortionary taxes, and parametric uncertainty in firms' and households' equilibrium tax responses.

Introduction

Controlling pollution or carbon dioxide (CO_2) emissions with market-based regulatory instruments such as taxes or tradable permit systems has been shown to be cost-effective and efficient (Goulder and Parry, 2008; Metcalf, 2009). At the same time, the public acceptance of such policies depends crucially on their distributional consequences (Atkinson and Stiglitz, 1980; Fullerton and Metcalf, 2002). While efficiency and equity are fundamentally linked, the issue of addressing unintended distributional outcomes of market-based environmental policy—among, for example, heterogeneous groups of industries, households, or countries—is often analyzed in isolation from efficiency. A large literature in environmental and public economics elucidates important trade-offs between efficiency and equity (for example, Poterba, 1989; Bovenberg et al., 2005; Bento et al., 2009; Rausch et al., 2010a; Sterner, 2012; Fullerton and Monti, 2013) but largely focuses on the issue of how the revenues from efficient market-based regulation, that is based on *uniform* pollution pricing and the principle of equalizing marginal abatement cost in production, can be used to alter incidence outcomes. In an economy with heterogeneous households and social equity concerns, however, efficiency and equity can generally not be separated. This raises

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two fundamental questions which are of importance for environmental policy. First, is uniform pollution pricing optimal in light of social equity concerns? Second, how is the optimal differentiation of pollution taxes linked to social and private preferences?

We examine these questions using both theoretical and numerical general equilibrium analyses in the context of an optimal taxation framework. Our analysis rests on three premises that reflect fundamental constraints for real-world environmental tax policy in most countries. We focus on the design of environmental policy that—in seeking to address the distributional consequences from achieving a given environmental target through pollution taxes—is constrained to using the revenues raised through these taxes.[1] Second, we focus on analyzing revenue-neutral tax policies which do not affect the government budget, i.e. pollution tax revenues are returned back to the economy. Third, we consider pollution tax differentiation among industry sectors and we abstract from direct pollution taxes on private consumption.[2] This is motivated by the observation that pollution is typically taxed at the source which generally lies at the industry level. Taxing pollution downstream at the level of private consumption would raise the issue of accurately determining indirect (embodied) pollution in multiple consumption goods. Moreover, while for some pollutants, such as CO_2 emissions, household emissions constitute a large fraction of economy-wide emissions (e.g., related to private transportation), taxing these sources is politically highly contentious.

We first theoretically study the optimality conditions for industry-differentiated pollution taxes and revenue redistribution to households.[3] Household heterogeneity in preferences and endowments interacts with social equity concerns implying that marginal abatement costs in the absence of social equity concerns are in general not equalized at the social optimum. We identify the motives that affect the sectoral marginal social cost of abatement. Heterogeneity in households' preferences implies a higher marginal social abatement cost for sectors which produce output that is consumed more intensively by households with higher social weights. Marginal social cost of abatement are instead lowered if factor income losses for households with high social weights are relatively small. In addition, the marginal social cost of abatement in a given sector depends on the social value of the pollution tax revenue raised per united of abated pollution. To the extent that these effects vary across sectors, the equalization of sectoral marginal social abatement cost implies that marginal abatement cost in the absence social equity concerns are not equalized, thus requiring differentiated pollution pricing at the social optimum. We use analytical examples to further examine the conditions under which uniform taxes are not optimal and to study how taxes should be differentiated to improve social welfare. If households have different tastes, then taxes, in light of social equity concerns, should be differentiated according to households' consumption characteristics, in order to shift the burden of taxation towards households with lower social weights.

While our theoretical analysis suggests that non-uniform pollution pricing may be optimal when social equity considerations are taken into account, the key question from an applied policy perspective is how large the deviation from uniform emissions pricing is. In other words: how robust is the standard rule of (optimal) uniform emissions pricing, widely embraced in the environmental economics literature and by policy advisors, in the presence of social equity concerns? To investigate this question from an empirical and quantitative perspective requires going beyond pure theory. To this end, we develop a numerical framework that casts the problem of optimal sectoral pollution pricing under social equity concerns in the context of a numerical general equilibrium framework that embodies firms' and households' behavioral equilibrium responses to pollution taxes, while at the same time satisfying cross-market and aggregate economy restrictions. More specifically, we focus on the issue of climate policy aimed at reducing CO_2 emissions through price-based market regulation. The numerical model is calibrated to observed production, consumption, and aggregate (national) as well as household-level income data for the U.S. economy.

When examining the robustness of optimally uniform pollution prices with heterogeneous households and social equity concerns, it is important to define how equity concerns are formulated. The most plausible case for the design of environmental regulation is that equity concerns are defined over differential household impacts that are caused by environmental policy. We refer to this case as "*policy-induced inequity*". Alternatively, one could consider the case in which social equity concerns are also defined over existing inequality already present before the environmental policy is enacted. We refer to this case as "*existing & policy-induced inequity*". Obviously, there exist non-environmental fiscal instruments such as progressive income taxation and social security programs that are better suited than a "narrow" environmental policy to address broader equity concerns that go beyond the impacts brought about by environmental policy. When thinking about the optimality of differentiated vs. uniform pollution pricing, we thus regard the case with "*policy-induced inequity*" as the most relevant one for environmental policy. We also examine the case with "*existing & policy-induced inequity*" but stress that it embeds the extreme view that pollution pricing should be designed in a way that also takes into account social concerns over existing inequalities that are unrelated to environmental policy.

Despite the possibility suggested by theory that differentiated pollution taxes may be optimal, the key finding which emerges from our quantitative analysis is that for the policy-relevant case of "*policy-induced inequity*" uniform emissions

[1] We thus abstract from broader income redistribution through transfers or income taxes to address social equity concerns. While such broader mechanisms are of course conceivable, they are, in our view, beyond the question of environmental policy design—which is the focus of this paper.

[2] We use "industry" and "sector" interchangeably throughout this paper.

[3] Our analysis focuses on the problem of taxing a uniformly mixed pollutant. If pollution is "non-uniformly mixed" (i.e., health and environmental damages from pollution depend on the location of the source), efficiency requires that the marginal costs of pollution abatement should vary across sources according to the marginal damage (Montgomery, 1972; Tietenberg, 2006; Fowlie and Muller, 2017).

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