Emission distribution and incidence of national mitigation policies among households in Austria

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Overview

Achieving a transition to a low-carbon society requires targeted policies to reduce the carbon content in the economy and potentially bears large implications for different groups in society. Against the background of rising income inequality in many developed countries [1], the distributional implications of greenhouse gas mitigation policies are of utmost importance. This manifested for example in the yellow vest movement in France in which individuals, mainly from low-income households, protested against an announced carbon tax by the French government [2]. This underlined how strong the feasibility of mitigation policies depends on the perceived distributional outcome of the specific policy.

We therefore compare three approaches to estimate the incidence of national mitigation policies for the case of Austria, that vary in terms of data and computational intensity: (i) household fuel expenditure analysis, (ii) household carbon footprints and (iii) macroeconomic general equilibrium modelling with heterogeneous households. As concerns about heterogeneity within low-income groups (horizontal equity) were recently articulated as main objection for effective redistributive revenue recycling in the literature, we compare a pricing instrument of a fuel tax with two non-pricing instruments.

Methods

In our analysis we employ different approaches to investigate direct and indirect incidence effects of climate policy used in different strands of the literature. The first strand investigates household expenditure for energy and fossil fuels, as it has been shown that fuel spending strongly varies between households and regions [3]. Such studies quantifying the direct price effects of policies, using simple mark-ups for energy taxes based on the carbon content of the energy sources or some consumer demand system, as e.g. [4]. A second (more recently developed) strand uses input-output models to account for emissions embodied in consumption and calculate so-called consumption-based emissions or carbon footprints of households [5]. We employ both approaches to analyse vertical and horizontal distributional aspects. The third strand uses macroeconomic models, i.e. econometric Input-Output models or computable general equilibrium (CGE) models [6] to account for indirect effects from (price) adaptations on the firm and household side, thereby including income use and income source effects for households.

For the household expenditure analysis we use the Austrian most recent household budget survey from 2014/15 with a representative sample of 7,162 households. This expenditure data is linked to sectoral consumption-based emission accounts calculed in an Environmental Extended Multi-Regional Input-Output (EE-MRIO) model, based on the GTAP 9 database, to obtain carbon footprints for each observation of the household survey. Finally we extend a multi-sector multi-regional CGE model of global trade from Nabernegg et al. [7] on the private household side to represent different expenditure groups and subsistence consumption. The heterogeniouse household representation is implement via hybrid method of household disaggregation [8] according to total household expenditure, specifying for each household group the use of income (expenditure and savings) as well as the source of income (factor income and transfers). The non-homothetic preferences are modelled via Stone–Geary utility functions.

Results

Looking at the share of household spending on fossil fuels we find a consistent picture for Austrian households with the literature on high-income European countries. First, the expenditure share for heating fuels decreases with income. Contrary, the expenditure share for transport fuels increases from low to middle incomes and is rather stable across middle to high-income groups. Second, the variation of relative fuel expenditures within income groups is much higher for low-income groups than for high-income groups. This holds especially for heating fuel spending.

By using the described EE-MRIO model, we extend this analysis for consumption-based emissions, i.e. we consider not only the direct emissions from fuel use but also the emissions embodied in consumption activities through which a carbon price transmits on the household level. We find that 70% to 80% of total consumption-based emissions are embodied in consumption and do not arise from direct fuel use. Therefore the vertical and horizontal distribution of fossil fuels captures only a small part of the potential effects from a carbon or fuel tax on household groups. Contrary to heating and transport emissions, that are similar distributed as fuel spending, embodied emissions are more equally distributed across and within income groups. For horizontal equity, the larger variance of emissions within low-income

groups is therefore ameliorated when looking at the picture of total consumption-based emissions instead of fuel expenditure or fuel emissions only.

Calculating an emission intensity of expenditure from the ratio of emissions and expenditure in each income group shows that households with high incomes cause on average less emissions per dollar spent, than households with low incomes. Because of this lower emission intensity of expenditure, a carbon or fuel tax can be expected to have a slightly regressive distributional effect from the income use side. Considering horizontal equity concerns for revenue recycling to compensate the regressive income use effect, we find in-group variation of emission intensity of expenditure is higher for low-income households but also much lower than for fuel expenditures.

To account for indirect and income source effects, we use the CGE model with heterogenous households and confirm a slightly regressive distributional effect from a fuel tax increase for Austria (isolating recycling effects by proportionally redistributing tax revenues to income) from the model simulation. The reason for that is that a fuel tax increase affects consumption possibilities of household groups mainly through the income use side.

Preferences for revenue recycling may vary across societies [2,9] as well as various types of recycling bear different advantages and disadvantages. Therefore we investigate in the CGE model also two non-pricing instruments of a building code adaptation allowing a wider use of wood-based building materials and company mobility plans to support environmental friendly commuting (based on an analysis for Austria [10]). We find the policy incidence of these two policies to depend on the interplay of income use and income source side effects. We show that the building code policy can explicitly target income sources of low-income households and this income source channel is dominant, thus the policy effect across income groups is progressive. The effects of the mobility policy work equally strong through the income source and the income use channel, resulting in an invertet U-shape distribution with stronger consumption reduction for high- and low-income households and consumption increases for middle-income groups.

Conclusions

Considering fuel expenditure as indicator for the incidence across income groups of economy-wide fuel or carbon pricing suggests a regressive policy effect. Furthermore, within-group variation is much stronger for low-income households, compromising targeted revenue recycling for these groups. When taking into account the high share of embodied emissions, we showed that fuel expenditures overestimate the regressivity of the income use effect of fuel or carbon pricing. Additionally, the within-group variation of emissions is considerably alleviated when accounting also for embodied emissions in the consumption of households. Distributional effects from this emission analysis also indicate a less strong but regressive income use effect of a fuel tax, as the emission intensity increases with income. This supports the use of a much less data and computationally intensive emission analysis as approximation for the incidence of carbon pricing instruments, when redistributive revenue recycling is ignored.

However, only the application of a macroeconomic closed model allows us to consistently investigate policies with differentiated price effects as well as conclusions on the interplay and dominance of the income use and income source channel that determine the overall distributional effect across households. We show in the macroeconomic policy application that the incidence of climate policies depends on three aspects: (i) the consumption patterns of households and their emission intensities of consumption, (ii) the existing distribution and composition of income, and (iii) the specific policy and policy design considered.

With the target of a transition towards net-zero emissions in Austria and the EU within the next 20 to 30 years broad policy packages are however needed, including pricing instruments for which potential negative distributional implications need to be taken into account . The persistent blanket public perception of regressive climate policies and especially fuel and carbon pricing therefore needs to be addressed by a clear elaboration and communication of both income use as well as (re-distributional) income source effects in a public discourse.

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