EU-wide Carbon Pricing – Macroeconomic Effects and Distributional Implications

SoMBI Research Brief

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Research assistance: Katharina Köberl-Schmid, Susanne Markytan

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We analyse the potential of a uniform EU-wide carbon price in the non-ETS sectors under different revenue recycling options in the EU 27, focusing specifically on the following three research question: (1) What are the effects of carbon pricing policies for the non-ETS sectors on CO_2 emissions in the EU 27, Austria, and Poland? (2) What are the macroeconomic impacts of these carbon pricing policies? (3) What are the distributional effects of these carbon pricing policies across household income quintiles and regions? To answer these questions, a model-based analysis with the ADAGIO model is carried out. For two case study countries (Austria and Poland), that differ considerably in terms of the structure of their energy systems and economies, results are discussed along with the EU 27.

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1. Introduction

With the European Climate law adopted in 2021, the European Union has legally determined to become climate-neutral by 2050, thus recognizing the need to ambitiously combat anthropogenic climate change. The law also contains the intermediate target of reducing greenhouse gas emissions by 55% by 2030 compared to 1990 levels. Although EU-wide emissions have been decreasing for the past three decades, declining by 31% between 1990 and 2022, reaching the ambitious long-term decarbonization objective will require further efforts. Significant emission reductions will therefore have to be achieved in all areas of the economy, particularly in the buildings and transport sectors. From 2027 on a separate, EU-wide emission trading system (ETS 2) will become operational for emissions from road transport, buildings, and other sectors (mainly small, non-ETS industry) introducing a uniform EU-wide carbon price.

2. Research questions

We analyze the potential of a uniform EU-wide carbon price in the non-ETS sectors under different revenue recycling options in the EU 27, focusing specifically on the following three research questions:

1. What are the effects of carbon pricing policies for the non-ETS sectors on CO_2 emissions?
2. What are the macroeconomic impacts of these carbon pricing policies?
3. What are the distributional effects of these carbon pricing policies across household income quintiles and regions?

To answer these questions, a model-based analysis with the 'ADAGIO' model (Kratena et al., 2017) is carried out. For the analysis, ADAGIO was extended with features of its sister model DYNK (which is a single region model of Austria, focusing on macroeconomic energy and environmental analyses[1]); these extensions consist of specific modules of energy demand for industry sectors (shares of energy carriers) and private households (energy demand for mobility, heating and appliances). The production module has been augmented to account for inter-fuel substitution.

For two case study countries (Austria and Poland), that differ considerably in terms of the structure of their energy systems and economies (Kletzan-Slamanig and Kettner, 2024), results are discussed along with the EU 27. The main differences between the two case study countries are summarized in Box 1.

Box 1. Background information on the case study countries

Austria and Poland were used as case study countries for the introduction of an EU-wide carbon price since the two countries differ considerably in terms of their energy systems, economic conditions, and related financial capacity for decarbonization.

The main differences between Poland and Austria can be found in their energy systems. Poland has been and still is relying heavily on its coal resources, considering it as a strategic resource to ensure not only an affordable domestic energy supply but also independence from other suppliers, foremost Russia. EU climate and energy policy initiatives are widely regarded as undesired interference with the country's sovereignty. Therefore, opposition to climate policy – from right-wing political parties, religious groups, and the coal industry and unions – continues to be very pronounced. Apart from substituting coal, there is large potential for reducing emissions by renovating buildings, improving public transport, and modernizing the vehicle fleet. However, energy and climate policies face the challenge of avoiding adverse social impacts. Already now, energy poverty is widespread and persistent in Poland. In addition, the energy transition will have a massive impact in those regions where coal mining is concentrated and currently provides a large share of employment. Accompanying measures will be necessary to ensure a just transition and cushion vulnerable households against increasing costs from carbon pricing.

Austria's energy system, on the contrary, is much more based on renewables. The share of hydropower in electricity generation is comparable to the share of coal in Poland. The main ESD emitter is transport, where emissions have been constantly growing since 1990 due to higher domestic mileage and importantly due to refueling by non-domestic trucks as fuel prices are significantly lower than in neighboring countries. In contrast, the building sector has managed to reduce emissions since 1990. There is still potential for further fuel shift and emission mitigation in heating, but it is comparatively low.

3. CO_2 price and revenue recycling scenarios

In the following, the key assumptions for the policy scenarios are described. These scenarios are compared to a baseline where no carbon price for the non-ETS sectors will be introduced.

In the policy scenarios an EU-wide carbon price is implemented from 2027 on for current non-ETS sectors. In our main carbon pricing scenario, the initial price of € 45 per t CO_2 remains constant until

[1] For details see e.g. Kirchner et al. (2019), Sommer and Kratena (2020), or Kettner et al. (2024).

2036, which is the target price for ETS 2 until 2030[2]. For those EU member states that have already implemented a national CO_2 price, the price paths are converted into country specific mark-ups with the respective changes in carbon prices depending on the 2019 carbon price level in the countries. For sectors covered by the EU ETS, we assume that the carbon price increases from € 60 per t CO_2 in 2027 to € 120 per t CO_2 in 2036 in all scenarios[3].

In addition to assumptions regarding the CO_2 price paths, six options for revenue recycling and mitigating adverse macroeconomic and distributional impacts are investigated:

1. **PCI**: In the first case, revenues are used for public consumption. This is the 'default option' in the model, which is closed via endogenous public consumption given a pre-defined budget deficit (see below). Ceteris paribus[4], public consumption will increase.
2. **CDP**: The second case involves the recycling of carbon tax revenues via lump-sum transfers to households, i.e., climate dividend payments. The payments are distributed on a per capita basis, with children up to 14 years obtaining a reduced amount of 40%.
3. **LCR**: In the third case, non-wage labor costs are reduced by lowering employers' social security contributions. This is the only option with positive direct impacts on competitiveness.
4. **SSCw**: Reductions in workers' social security contributions. Contrary to the LCR option, it has no direct (positive) impact on competitiveness.
5. **ITR**: The fifth case entails a reduction in workers' income taxes. This is similar to the SSCw option. Like CDP and SSCw, it implies a c.p. increase in disposable income.
6. **VTR**: The sixth approach for revenue recycling is a reduction of the standard value added tax rate on goods and services, except for energy goods. Indirectly, via reduced inflation, this option influences the wage rate and thus competitiveness.

For all options it is assumed that the introduction of the carbon price is revenue-neutral, i.e., the total volume of the compensation measures corresponds to the revenues generated by the CO_2 pricing mechanism in the respective member state.

4. Simulation results: Macroeconomic Impacts

Figure 1 shows the effects of the € 45 carbon price under various recycling options on real GDP. In addition to the six recycling options, we also include a scenario assuming no recycling. This implausible 'no-recycling' assumption yields notably extreme outcomes, especially in the short run[5].

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[2] When the average allowance price in ETS 2 exceeds € 45 per t CO_2 for two consecutive months, allowances from the market stability reserve shall be released (Directive 2003/87/EC, Art 30h).

[3] The value for 2026 was set at the observed EU ETS price in 2022. To this price, we apply the growth rate of the MIX-CP scenario in the Impact Assessment to the EU's 'Fit for 55'-Package (European Commission, 2021) to obtain the price path until 2030.

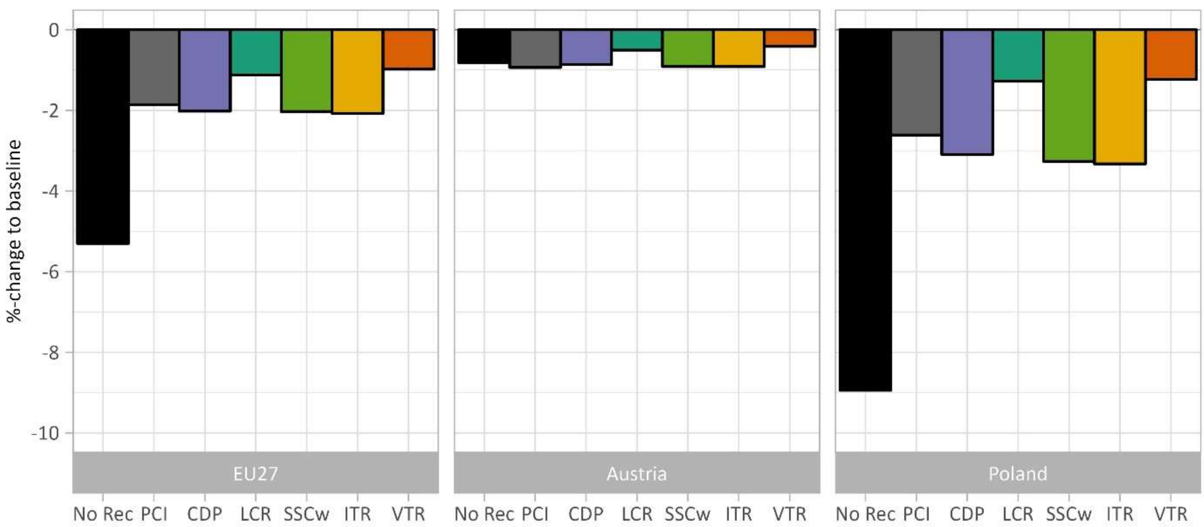
[4] Ceteris paribus, because a strong contracting effect of the carbon price on the economy could lead to an overall net decrease in public consumption. It is exactly this possibility that will be investigated via our model simulations.

[5] ADAGIO estimates an 8.9% decline in Poland's real GDP and a 0.8% decrease in Austria's relatively carbon-efficient economy. At the EU 27 level, GDP would decline by more than 5%. Given these drastic results, this scenario is excluded

Revenues from carbon pricing are significant: ten years post-implementation, Austria generates approximately € 1.6 billion in revenue, Poland € 6.7 billion, and the EU 27 around € 77 billion that are used for financing compensation measures. Even with recycling, the carbon price exerts substantial negative macroeconomic effects. At the EU level, real GDP decreases by 1.0% to 2.1%, with Austria experiencing a 0.4% to 0.9% decline and Poland facing a negative effect of 1.2% to 3.3%, depending on the recycling option chosen.

Reductions in non-wage labor costs as well as the reduction in VAT deliver the most favorable outcome in terms of real GDP. A reduction in non-wage labor costs directly dampens output prices, thus counteracting the carbon price-induced price increases. With a VAT reduction, the impact is indirect via the inflation-reducing effect. In contrast to the non-wage labor cost reductions, it has an expansionary effect on consumption. For certain countries, such as Poland, the reduction in employers' social security contributions results in an initial increase in GDP before the negative price effects dominate. This phenomenon stems from model dynamics, as the dampening effect of reduced social security costs is realized more rapidly than the delayed responses of other price variables, particularly wage rates.

Figure 1. Changes in real GDP in the main carbon pricing scenario by recycling option compared to the reference scenario in 2036

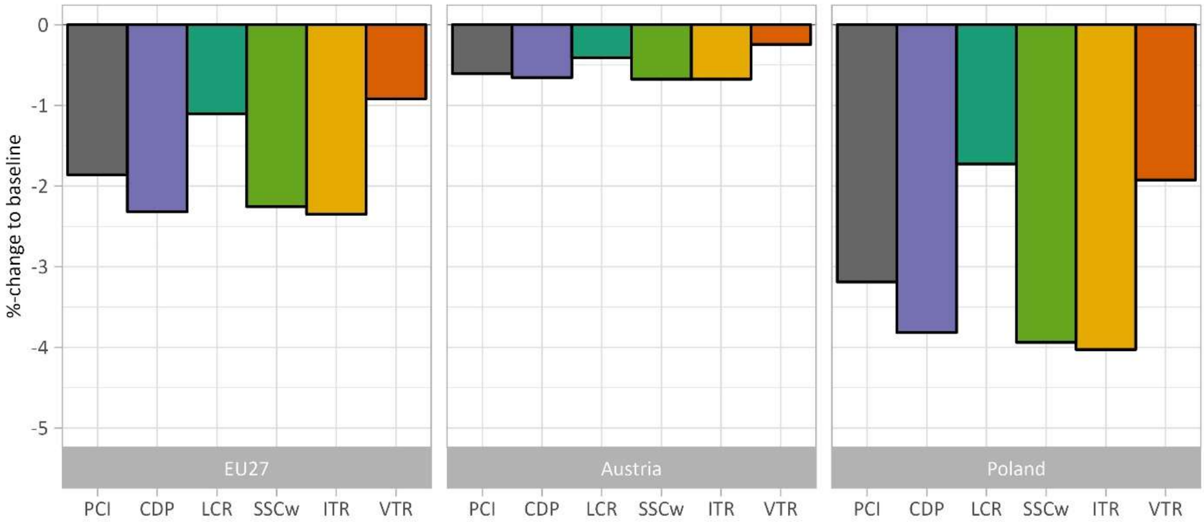


The reductions in value added taxes (VTR) and employers' social security contributions (LCR) deliver the most favorable impact on employment, given their positive effect on prices, exports and,

from further analysis. These extreme results are a consequence of the closure rule, i.e., the assumption of a constant budget deficit: To keep to the pre-defined deficit path, and without the possibility to spend the carbon price revenues, public consumption in Poland must be drastically reduced, exacerbating the regressive impact of the carbon price. This leads to a downward spiral since public consumption as a counter-cyclical stabilizer is completely missing under this closure – in fact, the model must reduce public consumption by more than 80% to keep the budget deficit at the necessary level.

accordingly, GDP. Conversely, the public consumption recycling option exhibits the most adverse outcomes (Figure 2). This disparity is likely attributable to the comparatively higher wage levels prevalent in public sector industries such as administration, education, and healthcare. Only the LCR and VTR recycling options effectively contain unemployment levels. Poland even records a decline in unemployment, while the EU's unemployment rate remains relatively stable. In contrast, other scenarios, such as those involving increased public consumption or income tax reductions, lead to a doubling of unemployment in Poland. This surge cannot be offset by labor force reductions.

Figure 2. Changes in employment in the main carbon pricing scenario by recycling option compared to the reference scenario in 2036



5. Simulation results: Distributional Impacts

The analysis of the distributional impacts of the carbon pricing under the various revenue recycling options is one key aspect of our research. The model distinguishes between five household income quintiles, each exhibiting distinct characteristics, particularly the lowest quintile (Q1).

Except for the recycling via employers' social security contributions, poorer households generally experience smaller declines in disposable income compared to richer households. This is primarily due to the indexation of transfers, which provides a degree of protection against inflationary periods.

Under most recycling options, real disposable income of the two lower-income quintiles remains relatively stable. Climate dividend payments even imply a slight increase for these groups. In Austria, quintiles Q4 and Q5, as well as Q2 and Q3, exhibit comparable changes in real disposable income. Poland deviates from this pattern, as losses escalate with income due to the country's more pronounced economic downturn after the introduction of carbon pricing. Reductions in employers' social security contributions yield the most homogeneous impact across income quintiles and regions.

Table 1. Changes in real disposable income in the main carbon pricing scenario by recycling option and household type compared to the reference scenario in 2036

	Austria						Poland						EU 27					
	Q1	Q2	Q3	Q4	Q5	**Total**	Q1	Q2	Q3	Q4	Q5	**Total**	Q1	Q2	Q3	Q4	Q5	**Total**
PCI	-0.2	-0.8	-1.2	-1.6	-1.5	**-1.3**	-1.0	-2.0	-3.2	-4.2	-4.7	**-3.9**	-0.2	-1.1	-1.8	-2.6	-2.7	**-2.2**
CDP	0.6	0.0	-0.6	-1.0	-1.2	**-0.8**	3.5	1.7	-0.5	-2.4	-4.3	**-2.3**	1.8	0.5	-0.8	-1.9	-2.5	**-1.5**
LCR	-0.2	-0.4	-0.6	-0.8	-0.7	**-0.6**	-0.6	-0.9	-1.2	-1.6	-2.0	**-1.6**	-0.1	-0.6	-0.9	-1.3	-1.5	**-1.2**
SSCw	-0.2	-0.5	-0.7	-1.0	-0.9	**-0.8**	-0.7	-1.2	-1.9	-2.6	-3.3	**-2.6**	-0.1	-0.8	-1.3	-1.9	-2.1	**-1.6**
ITR	-0.2	-0.5	-0.9	-1.2	-0.8	**-0.8**	0.0	-0.6	-1.6	-2.6	-3.2	**-2.4**	-0.1	-0.6	-1.2	-1.9	-1.8	**-1.5**
VTR	-0.1	-0.3	-0.5	-0.6	-0.4	**-0.4**	-0.3	-0.7	-1.3	-1.8	-2.0	**-1.6**	0.0	-0.4	-0.7	-1.1	-1.1	**-0.9**

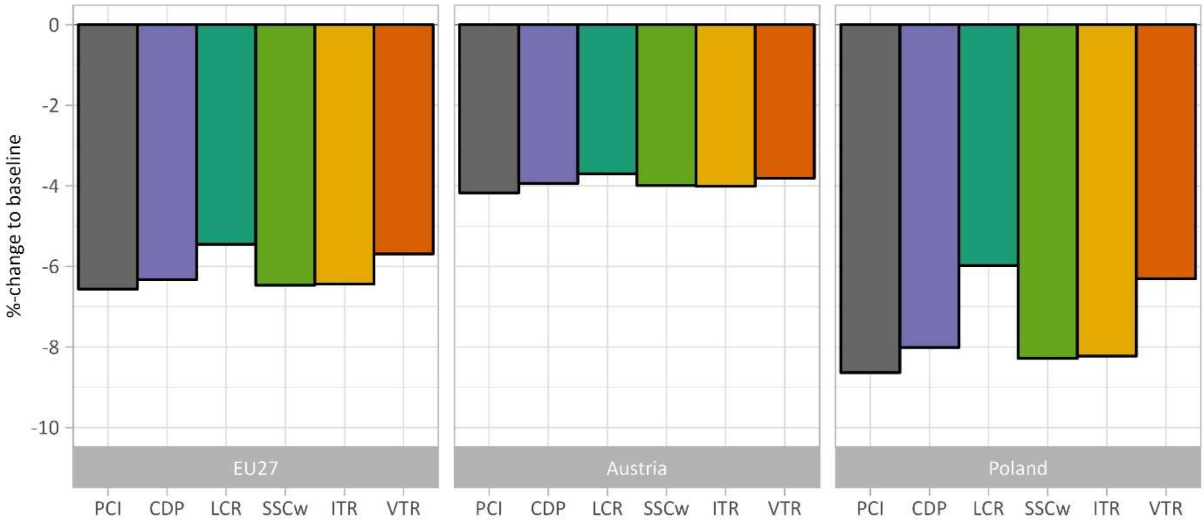
The CDP scenario is unique in that it results in slight income gains for households in the two lowest income quintiles in both Austria and Poland. These gains are primarily attributed to climate dividend payments, which in Q1 are particularly beneficial for urban households. However, an exception is observed in Q2 and Q3, where the positive effects of climate dividend payments in urban areas are overcompensated by significant wage losses, leading to an overall income reduction.

For the other scenarios, the most adverse effects are observed in the lowest income quintile (Q1) in suburban regions. This is indicative of the heightened vulnerability of these areas to economic shifts. In contrast, income quintiles Q2 and Q3 experience the most severe impacts in urban areas, largely due to wage losses that represent a more important income component in urban areas. By contrast, income quintiles Q4 and Q5 in urban regions experience lower income losses than those in suburban and peripheral regions, benefiting substantially from reductions in taxes on various income sources.

6. Simulation results: CO_2 emissions

For the EU total, ten years after the introduction of the carbon price CO_2 emission are reduced by 6% to 7% compared to the baseline. This regards emissions from all sectors, not only the non-ETS sectors. In Austria reductions reach around 4%, in Poland they range from 6% to 9% (Figure 3), depending on the recycling option. ADAGIO exhibits a rapid decline in emissions following the implementation of the carbon price. This behavior is primarily attributed to the abrupt adjustment of final energy consumption by households, contrasting with the more gradual response of intermediate energy consumption.

Figure 3. Changes in total CO_2 emissions in the main carbon pricing scenario by recycling option compared to the reference scenario in 2036



7. Conclusions

Our analyses confirm the efficiency-equity trade-off in the context of carbon pricing with respect to different revenue recycling options. Climate dividend payments are the only option that can avoid income losses for low-income households. However, in terms of macroeconomic effects, climate dividend payments perform much worse than reductions in non-wage labor costs or VAT rates. Probably a mix of various policies – for example, means-testing the climate dividend for households (or subjecting it to personal income tax) – would allow to devote part of the revenues from carbon pricing to other policy options, e.g., reducing non-wage labor costs as the most efficient recycling option from a macro-economic perspective, without completely foregoing the redistributive benefits of the climate dividend.

Moreover, the results for Austria and Poland highlight that countries facing more severe socio-economic challenges related to decarbonization will need higher support. This is due to an above-average carbon intensity aggravated by weaker economic performance and a lag in industrial structural change. The EU's Just Transition Fund can contribute to mitigating adverse socio-economic impacts of the low-carbon transformation and preventing an intensification of inequalities within and between countries.

A last key aspect is that carbon pricing must be embedded in a broader policy mix to achieve greenhouse gas emission reduction targets: Though it is not directly evident from the modelling results, technological innovation (energy efficiency, low-carbon technologies, green industry transformation) must be supported to ensure both ecological effectiveness as well as economic competitiveness.

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