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GREEN REFORM

Modelling the EU ETS system in GreenREFORM while respecting national account statistics

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In this note, I will discuss how to model the EU ETS system in GreenREFORM. In the first section, I discuss how the EU ETS system appears in the national accounts, which GreenREFORM is build on and which accounting principles we must respect. In light of this, in the second section, I discuss how to model firm behaviour. The note is expected to be expanded with sections discussing modelling government finances and forecasting the allocation of free allowances.

EU ETS in the danish national accounts

The government revenue of sales of EU ETS allowances are defined as a tax according to the ESA 2010 manual[1]. This implies, that all revenue raised by the government must be levied on domestic economic activities or recidents, even if there is not likely to be a net zero cross border sale. Other than domestic firms seeking to fulfill a direct requirement of production, purchases of allowances could be associated with the need for production by foreign firms, or it could be purchases by foreign or domestic financial investors, the later including net investments (or banking) of domestic firms. The important distinction for the moment is however between net purchases of domestic firms serving a direct need for production and investments for other reasons.

We denote the total Government revenue (or value) of sales of allowances in year t as vGS_t and the quantity of allowances sold as qGS_t. For 2018 we have vGS_{2018} = 1.14bn DKK and qGS_{2018} = 12.27mio tCO2e from which an implicit price of 115 DKK per tCO2e can be deduced. This corresponds well with general statistics on the ETS price.

Based on firm level data on the allocation of free allowances and emissions covered by the EU ETS, Statistics Denmark define the need for allowances for production (købsbehov) of each sector j in year t as $q\widehat{CO2}_{j,t} = qCO2_{j,t} -$

[1] Manual on Government Deficit and Debt IMPLEMENTATION OF ESA 2010 2019 edition

$\overline{qCO2_{j,t}}$, where $qCO2_{j,t}$ is the emissions associated with production, and $\overline{qCO2_{j,t}}$ is the amount of free allowances allocated to firms in the sector.

In accordance with the before mentioned accounting principles, Statistics Denmark use the need for allowances $q\widehat{CO2}_{j,t}$ as key for distribution of the government revenue of allowances vGS_t,hence a so called CO2 emissions tax of $T_{j,t} = vGS_t * \frac{q\widehat{CO2}_{j,t}}{\sum_i q\widehat{CO2}_{i,t}}$ is levied on each sector as part of the total costs of production in the national accounts. Note that this CO2 emissions tax is a ficticious tax which can easily be confused with a real tax with almost the same name (CO2-emmissionsskat versus CO2-afgift).

This would be all good, if it wasn't for the fact, that the quantity of allowances sold by the government greatly exceed the sum of needs for production across sectors in all current years, ie. $qGS_t > \sum_i q\widehat{CO2}_{i,t}$. For 2018 we have $qGS_{2018} = 12.27$mio tCO2e and $\sum_i q\widehat{CO2}_{i,t} = 8.03$mio tCO2e.

This means that the tax levied on production of danish firms is roughly fifty percent too high on average. In principle this is problematic, since it will lead to a distortion of GDP or production values. In monetary value it does however only amount to 0,4 bn DKK in 2018.

Statistics Denmark is currently exploring, how to ensure that the revenue not related to purchases of domestic firms serving a direct need for production ($q\widehat{CO2}_{i,t}$) be not levied as a production tax in future revisions of the national accounts, while still respecting the ESA manual. In addition it should also be noted, that Statistics Denmark calculate $q\widehat{CO2}_{i,t}$ at firm level and discard negative values when adding up to sector level. Statistics Denmark have already decided to refrain from discarding the negative values in future revisions of the national accounts.

Modelling the EU ETS system in firm behaviour

Modelling the EU ETS in firm behaviour in greenREFORM we have three objectives: Firms should internalize the marginal value of allowances (forecast of ETS-prices) in input decisions, the subsidy value of free allowances (and forecasts thereof) should also be reflected in the total costs of production, and lastly we need to respect the national accounts.

In a seperate note[2], we discuss a general methodology on how to model marginal taxes while respecting the national accounts. If the reader is not familiar with this note, now would be the time to read it, before moving on in the current text.

In data year the payment of the CO2-emissions tax $T_{j,t}$ can be divided by the ETS covered emissions $qCO2_{j,t}$ to form the effective tax rate $\tau_j^{eff} = \frac{T_{j,t}}{qCO2_{j,t}}$. The effective tax rate τ_j^{eff} can be expected to be a lot higher than the marginal price of allowances (the ETS price) denoted by τ_j^{marg} for two reasons. Firstly

[2]Modelling marginal tax rates while respecting national accounts statistics in the CGE-model GreenREFORM, Stephensen and Kirk 2022

firms receive free allowances $\overline{qCO2_{j,t}}$ and second, Statistics Denmark in effect allocates a too high total payment on the production of danish firms. Accepting the national accounts as they are, and thus ignoring the later problem, the above mentioned note explains how to insert the correct marginal price in the equations governing firms demand for imputs, and how to subsequently adjust the total costs of production to still reflect $T_{j,t}$:

$$T_{j,t} = \tau_t^{marg} \left(qCO2_{j,t} - \overline{qCO2_{j,t}} \right)$$

Note, that in the data year, the bottom deduction $\overline{qCO2_{j,t}}$ must be calibrated to match. The note also suggest, that in the case of the EU ETS system, one should use the following equation (using the notation of the current note) to forecast the bottom deduction $\overline{qCO2_{j,t}}$, given information on the ETS price τ_t^{marg}, the amount of emissions and the allocation of free allowances $q\widetilde{CO2}_{j,t}$:

$$\overline{qCO2_{j,t}} = q\widetilde{CO2}_{j,t} + \alpha_{j,t}$$

In the data year, the error term $\alpha_{j,t}$ must be calibrated. In forecast years we will adjust the error term to zero ($\alpha_{j,t} = 0$). It will distort production values by a small fraction, and it could distort the Government revenue from sales of allowances by a large fraction. We return to the later issue in a section below. As mentioned above, we hope that Statistics Denmark will adjust there practice in future, such as to avoid the need for the adjustment term in the first place.

In forecast years, we will need information on future ETS prices τ_t^{marg}which is available to us from The Danish Energy Authority, but we also need a forecast of the free allowances at sector level $q\widetilde{CO2}_{j,t}$, which is at present not available to us. We are hoping, that The Danish Energy Authority will also be able to supply information on this.

Government sales of allowances

As explained above, there is no direct link between the need for allowances of domestic firms and government sales of allowances. In simple terms, the Government is allocated a pool of allowances each year, some of which can be distributed as free allowances and some of which are sold on a common EU exchange. In order to forecast the government revenue from sales of allowances, we simply need a forecast of the number of allowances expected to be sold qGS_t, and the revenue will be described by

$$vGS_t = qGS_t * \tau_t^{marg}$$

where $\tau_t^{marg}$of the base year is expected to be calibrated, and to be set exogenously in forecast years.

In the data year the revenue will be equal to the payments by danish firms as by the construction of the national accounts, as explained above. In forecast years we will however not impose a restriction on this. Hence, there will be

no link between the need for allowances of danish firms and the revenue of sales of allowances, and setting the error term $\alpha_{j,t}$ to zero in forecast years will thus not affect government revenue. The question remains though, what agents should we assume pay for the residual revenue? This question at present remains unresolved.