The additional contribution of non-CO_2 mitigation in climate policy costs and efforts in Europe

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FONDAZIONE ENI ENRICO MATTEI

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Outline

- Motivation
- ICES model structure
- Modelling non-CO2 GHG emissions and their mitigation potential
- Policy scenarios and results
- Conclusions and further analyses

Motivation

non-co_2 gasses are not included in the European ETS

however, the EU Effort Sharing Decision establishes binding annual greenhouse gas emission targets for Member States for the period 2013–2020.

These targets concern emissions from most sectors not included in the EU Emissions Trading System (EU ETS), such as transport (except aviation), buildings, agriculture and waste.

Motivation

Thus, it is important to answer the following questions:

- What happens in terms of GDP loss if the European Union include non-co2 emissions in the emission trading system (ETS)?
- How a multi-gas ETS might impact the sectoral composition of output?
- Would the GHG emission profile change due to this policy?

Motivation

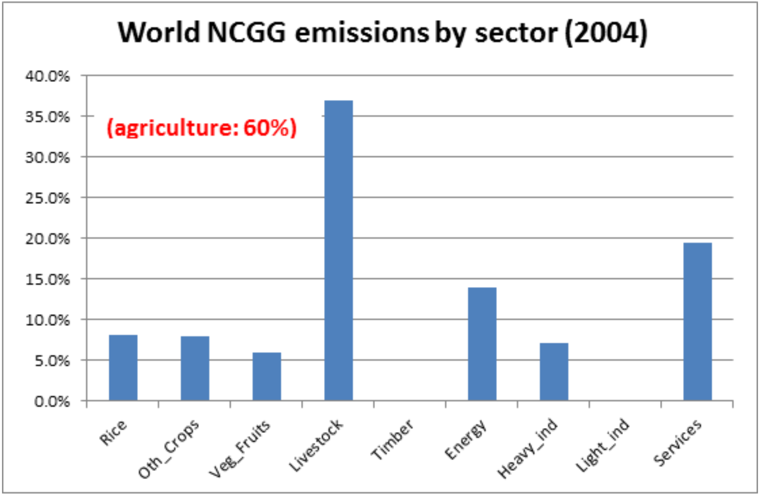
Huge literature exists on non-co_2 greenhouse gases (NCGG) emissions and their mitigation policy policy options.

We used the Gtap database developed by Rose et al 2010, which include nitrous oxide (N_2O), methane (CH_4) and fourteen fluorinated gases ($F - gases$) emissions for all sector and regions of the Gtap model.

This database led to a more comprehensive analysis in terms of change in the distribution of consumption and food security.

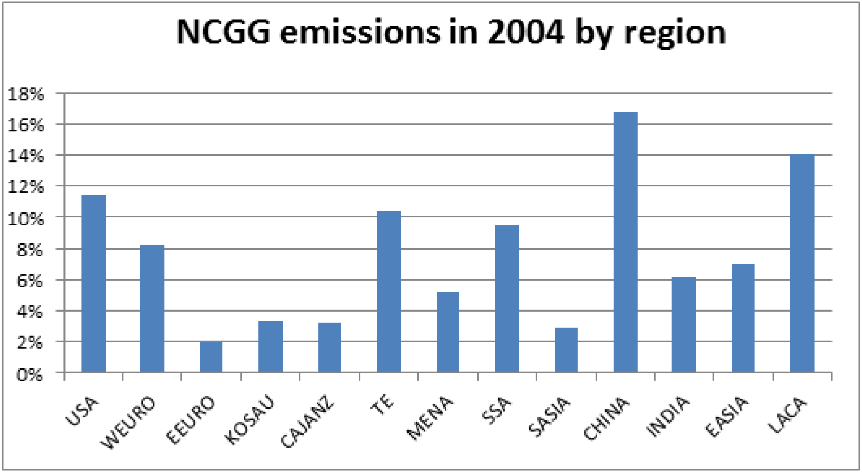
- Golub et al. 2012 (pnas)

Motivation



Source: Rose et al. 2010

Motivation



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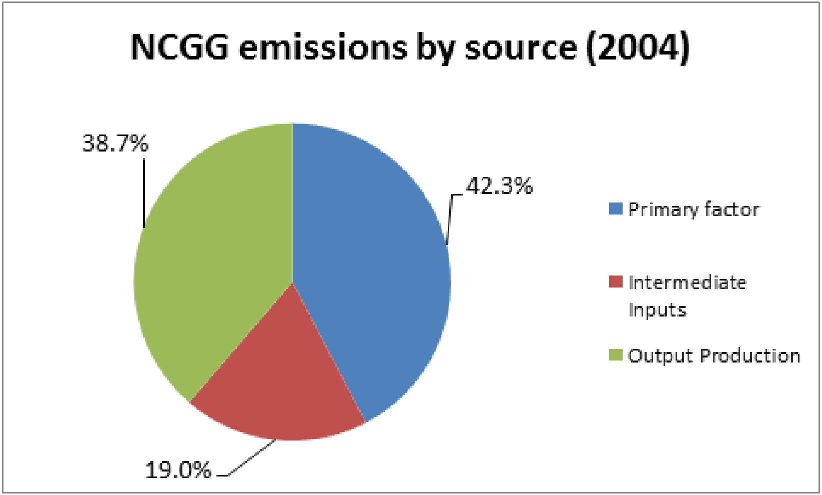
Motivation



Source: Rose et al. 2010

The ICES model

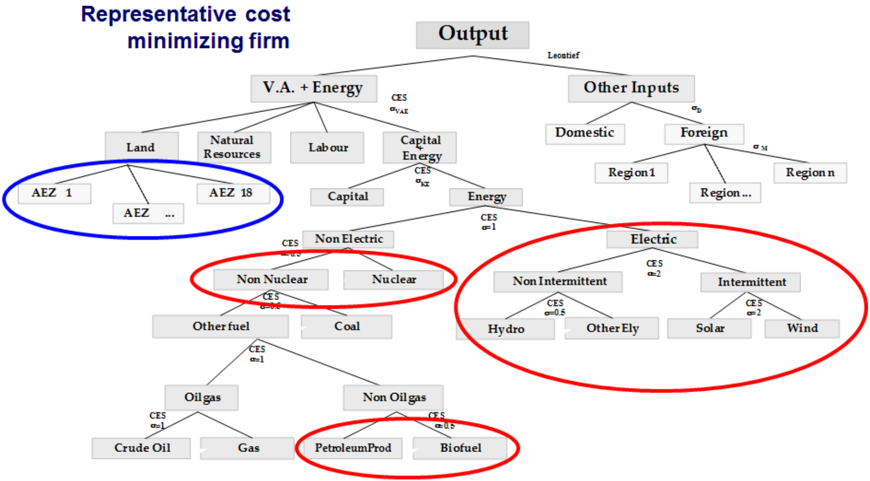
The ICES model structure

ICES is a dynamic recursive CGE model. Basedata from Gtap 7 (57 sectors for 113 countries of the world).

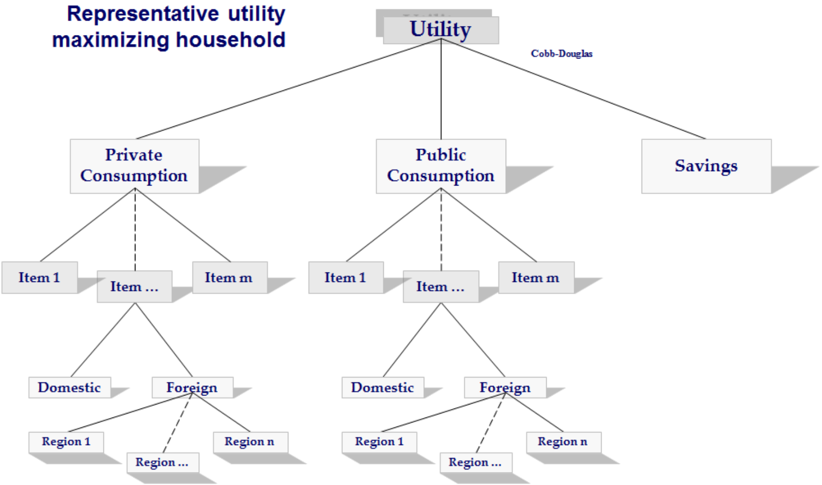
Multicountry-multisector model with international trade.

- Multigas emissions are modeled: CO_2, N_2O, CH_4, Fluorinated gases
- Renewable energy production (Solar, Wind and Hydro)
- Nuclear production
- The land endowment in each region split into agro-ecological zones.

The ICES model structure: the production tree



The ICES model structure: the demand tree



Modelling non-CO2 emissions

Modelling non-CO2 emissions

We used the Gtap satellite database derived by Rose et al. (2010).

- This database distinguishes between three sources of non-CO2 emissions: those related to **input consumption** (e.g. fertilizers usage in agriculture), those related to **endowment consumption** (e.g. land in rice cultivation) and those related to **output production** (e.g. wastewater treatment).

Thus, the evolution of

- emissions coming from inputs usage evolve proportionally to the demand for this inputs;
- emissions coming from endowment or primary factor usage are linked to the evolution of consumption of these inputs;
- emissions from output are linked to output production.

Modelling non-CO2 emissions

For a simple two-inputs aggregate, a CES function looks like

$$y = \left(a_1 {x_1}^{\frac{\sigma-1}{\sigma}} + a_2 {x_2}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

thus, the demand functions looks like:

$$x_i = A_i y \left(\frac{p_i}{p_y} \right)^{-\sigma}$$

thus the emissions might depend on the output y

$$W_y = \alpha_y y$$

or might depend on the demand of input/endowment i

$$W_i = \alpha_i x_i$$

where α_y and α_i are emissions conversion factors.

Modelling non-CO2 emissions

To analyze mitigation policies that include non-co2 gases, we introduce the carbon tax through specific ad valorem rates depending on the source of emissions: one for the use of inputs, one for the use of endowments and one for the output emissions.

- Carbon tax rates were calculated for each emitting input/endowment/output as the corresponding ratio between tax revenues and the total tax base.

$$TRC_{ijr} = \left(\frac{W_{ijr} CTAX_r}{p_{jr} q_{jr}} \right)$$

Modelling non-CO2 emissions

- This ad valorem tax was added up to the supply price and determined the market price that households and firms faced in the market.
- The tax revenues accrued to the representative consumer of each region and increased his income.
- The carbon tax formulation was extended to model an alternative ETS, which allows the exchange of emissions permits among countries.

Impact of a GHG tax

Consider a tax on GHG emissions associated with the use of inputs (e.g. fertilizers use).

$$TR = \left(\frac{W_{ijr} CTAX_r}{p_{jr} q_{jr}} \right)$$

or:

$$TR = \phi CTAX$$

where $\phi = \frac{W_{ijr}}{p_{jr} q_{jr}}$

Impact of a GHG tax

With PF being the price paid by producer per unit of input and PM the market price of the input.

$$\frac{PF}{PM} = T$$

With the new carbon tax rate, we have

$$PF = PM \times (T + TR)$$

Thus, the economic impact of an emissions tax will depend not only on the size of the tax CTAX, but also on the emissions intensity per dollar of input.

$$\frac{PF}{PM} = T + \phi \times CTAX$$

Policy scenarios and results

Regional aggregation

OECD	NON-OECD
USA (United States of America)	TE (Transitional Economies)
WEURO (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands Portugal, Spain, Sweden, UK)	MENA (Middle East and North Africa)
EEURO (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Malta, Romania, Slovak Republic, Slovenia)	SSA (Sub-Saharan Africa)
KOSAU (Korea, South Africa, Australia)	SASIA (South Asia)
CAJANZ (Canada, Japan, New Zealand)	INDIA
	CHINA
	EASIA (East Asia)
	LACA (Latin America)

Sectors		
Agriculture/Land Use	**Energy**	**Others**
Rice	Coal	Heavy Industry
Other Crops	Crude Oil	Light Industry
Vegetables & Fruits	Natural Gas	Services
Livestock	Petroleum Products	
Timber	Nuclear	
	Hydro	
	Solar	
	Wind	
	Other Electricity	
	Biofuels	

Policy scenarios

Name	**Description**
BL	Baseline GDP and emissions calibrated on historical values until 2010 (new base year). Then, until 2020 we calibrate GDP and FF prices using projections coming from EU project Ampere
$20CO_2$	All GHG emissions reduction of 20% wrt 1990 values $\rightarrow$ Tax only on CO_2 emissions
$20all$	All GHG emissions reduction of 20% wrt 1990 values $\rightarrow$ Tax on all GHG emissions
$30CO_2$	All GHG emissions reduction of 30% wrt 1990 values $\rightarrow$ Tax only on CO_2 emissions
$30all$	All GHG emissions reduction of 30% wrt 1990 values $\rightarrow$ Tax on all GHG emissions

Policy Scenarios: targets

We define a single cap on all greenhouse gases.

Within the same reduction cap (either -20% or -30%), we distinguish two abatement opportunities:

- co2 gases only
- both co2 and non-co2 gases

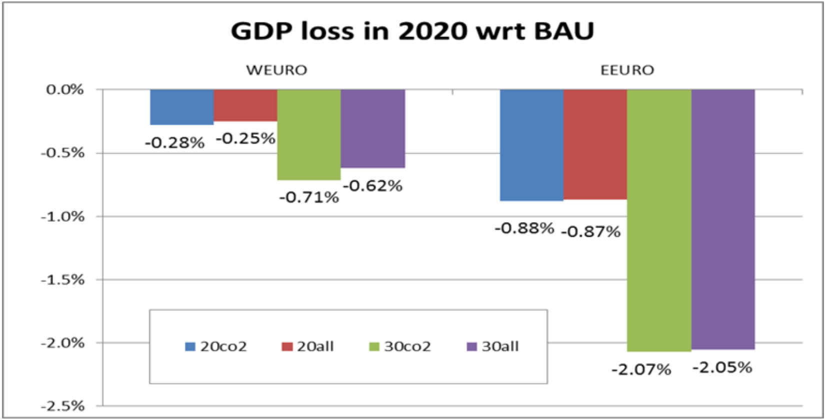
Policy Scenarios: targets

We define an Emission Trading Scheme between the two European regions (Western and Eastern Europe) with the following cap:

- -20% wrt 1990 values of all GHG in 2020:
  WEURO: -11.1% wrt 2010
  EEURO: +1.4% wrt 2010 (BAU assumption)

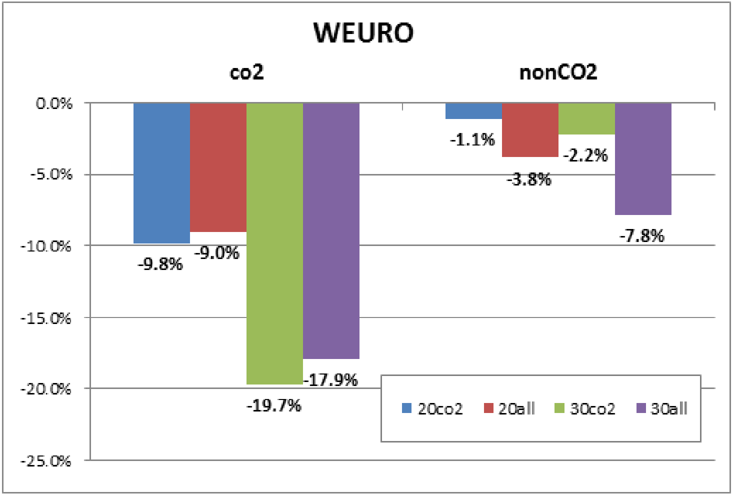
- -30% wrt 1990 values of all GHG in 2020
  WEURO: -22.1% wrt 2010
  EEURO: +1.4% wrt 2010 (BAU assumption)

Results: GDP loss

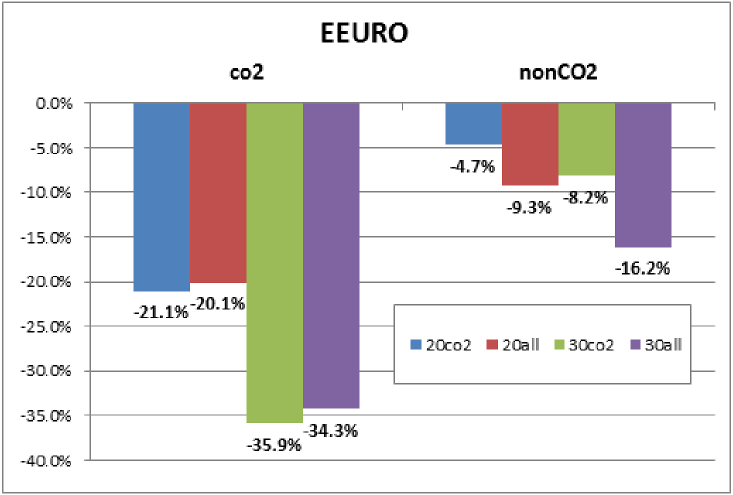


including non-CO2 in the ETS, WEURO can save 0.05% of GDP in 2020 in the -20% scenario and 0.1% in the -30% scenario For the EEURO the gains are negligible.

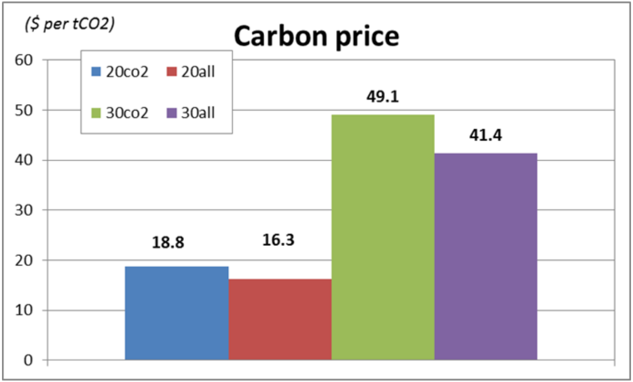
Results: WEURO emissions



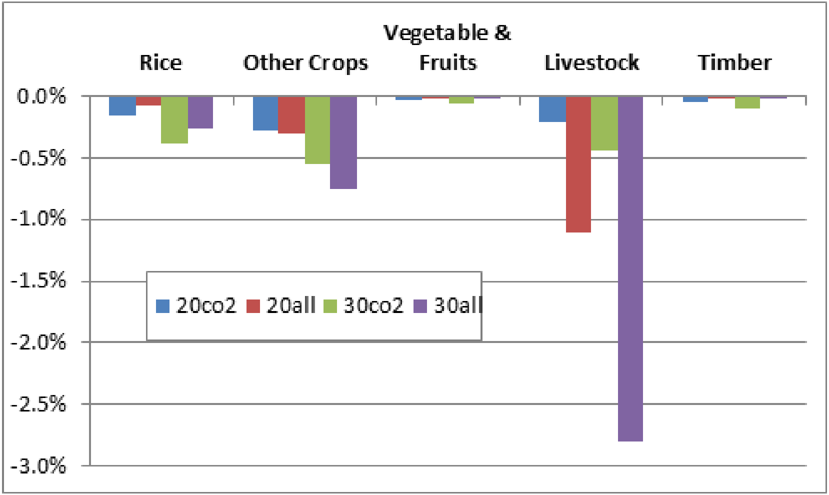
Results: EEURO emissions



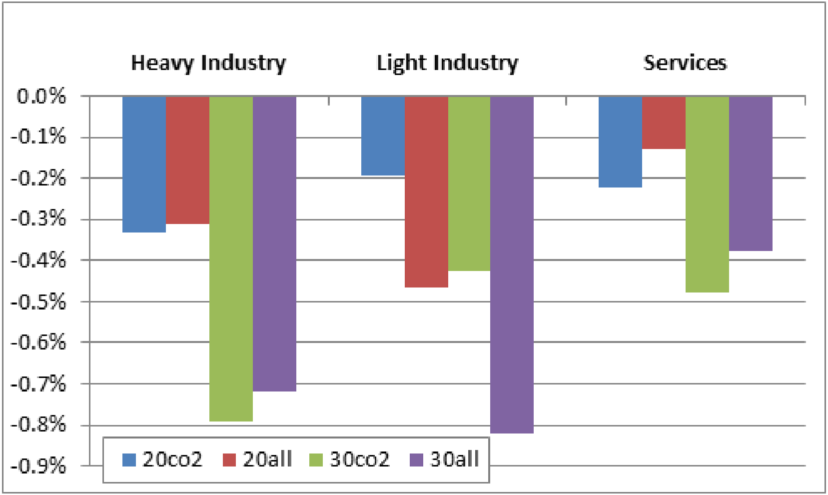
Results: Carbon price in 2020



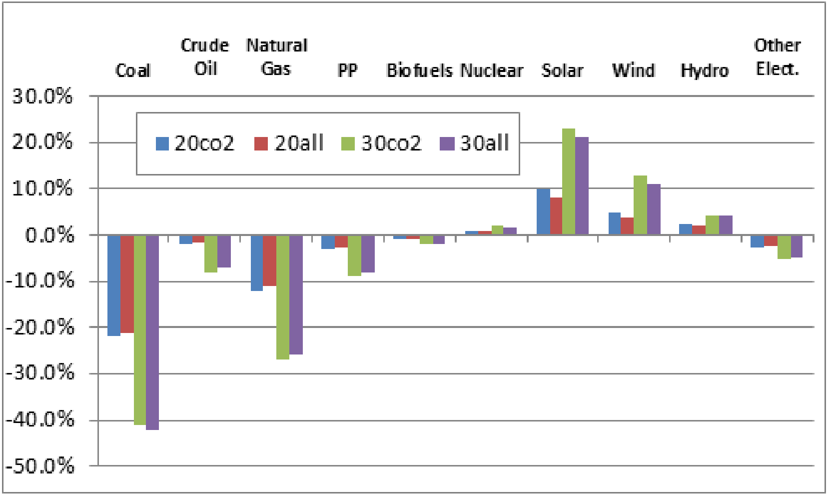
WEURO sectoral output: agriculture



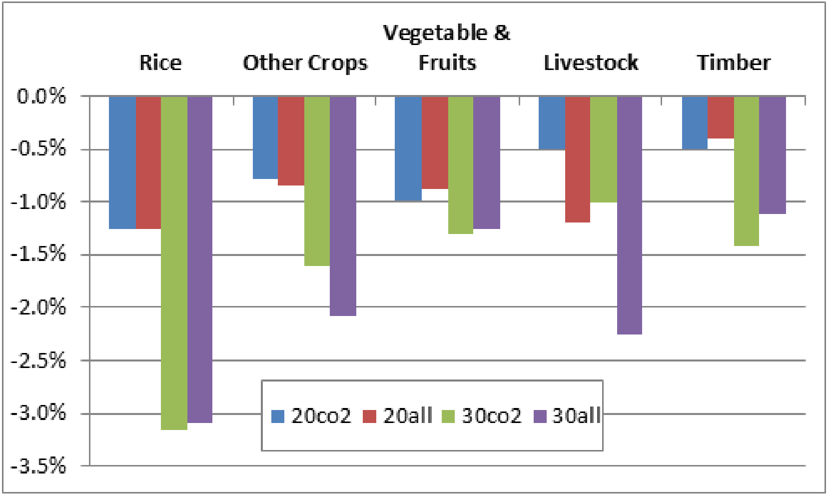
WEURO sectoral output: industry and services



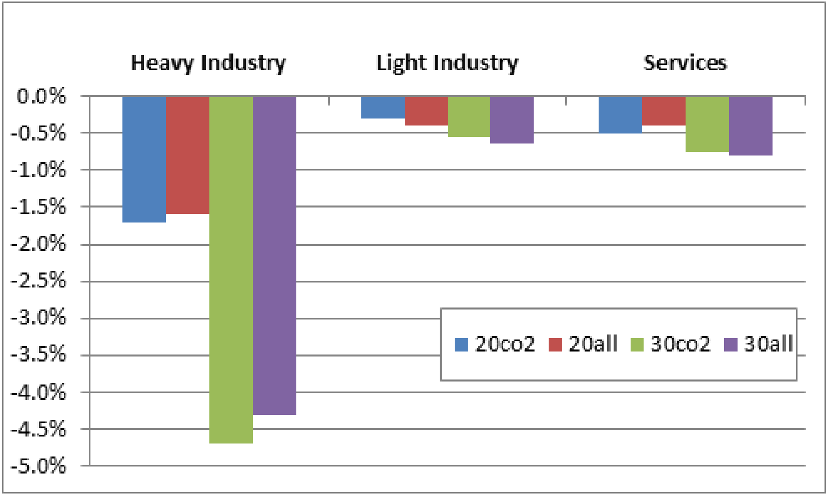
WEURO sectoral output: energy



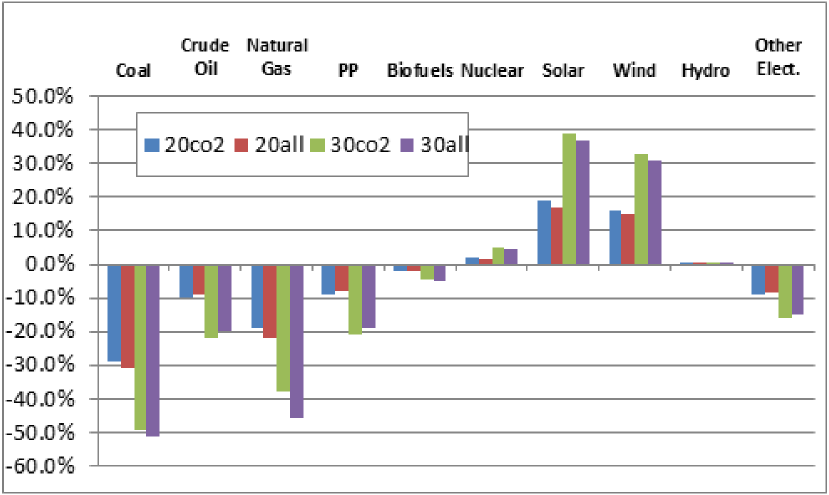
EEURO sectoral output: agriculture



EEURO sectoral output: industry and services



EEURO sectoral output: energy



Conclusions

- Policies targeting CO2 also lead to a reduction in the other GHG included in the model.
- However, with a multi-gas policy it is possible to reduce the GDP loss and therefore achieve emission targets in a less costly manner.
- EEURO prefers to reduce its GDP wrt BAU and sell permits to WEURO.
- Livestock sector is the most penalized one in both WEURO and EEURO

Further analysis

- Extend the analysis to 2050.
- Consider a more detailed regional aggregation to include European Union countries separately.
- Consider a more detailed sectoral aggregation to better identify the poluting sectors/factors
- Extend the ETS to a post-Durban policy set-up to explore possible ancillary benefits of this kind of double taxation (CO2 and/or non-CO2 gases)
- Since large differences that exist in GHG emission intensities and mitigation potentials between regions, better analyse implications of NCCG taxation in developing countries (changes in food consumption, food security).

• Thank you! •