MEASURING THE EFFECTS OF AN AUSTRIAN CLIMATE MITIGATION POLICY – AN INPUT OUTPUT APPROACH

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Introduction

- What are the economic effects of an Austrian climate policy?
- And how can the conflicting relationship between economic and environmental targets be illustrated?

- ***Combining** an **Environmental Input Output model (EIO)** (top-down) with information of the **GAINS model** (bottom-up) provided by IIASA*

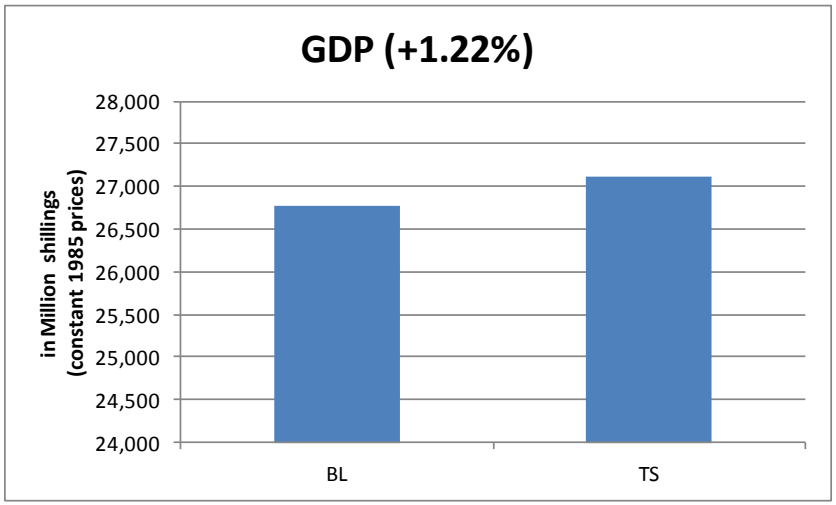
- Depicting
  - Combining political objectives with modelling data
  - Inserting exogenous information about climate mitigation potentials into an IO model

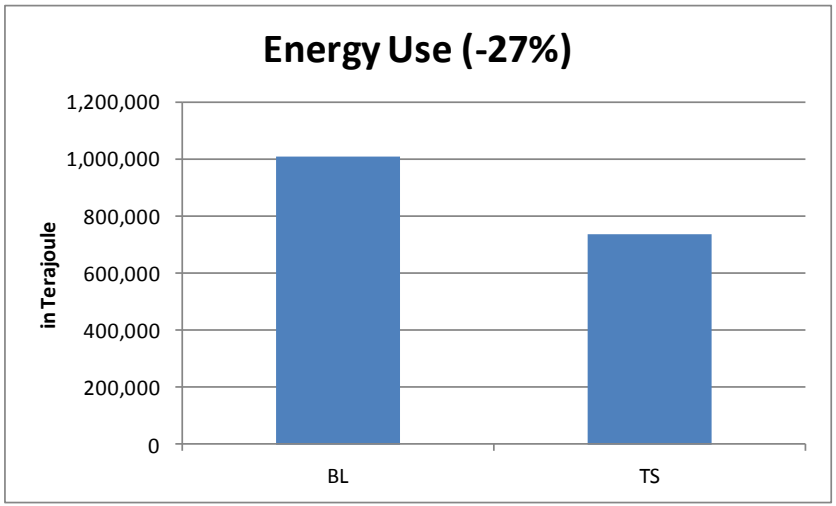
Effects of climate mitigation measures in Austria - previous studies

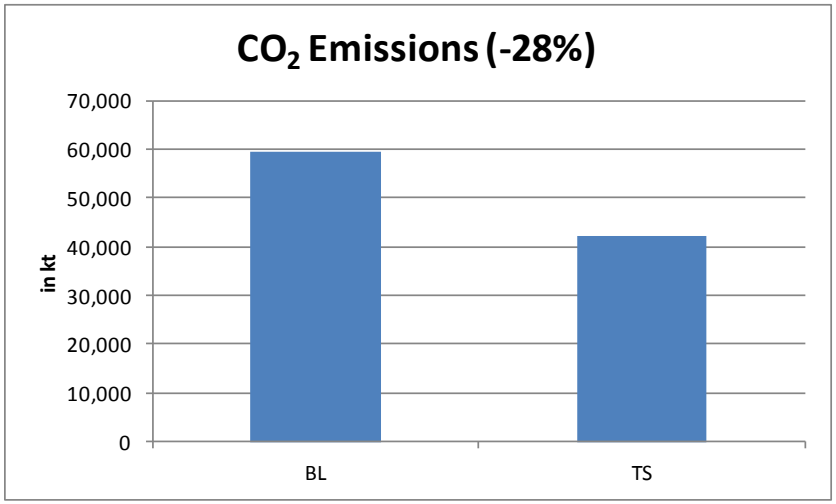
- *Kratena, Schleicher (1999): Impacts of Carbon Dioxide Emissions Reduction on the Austrian Economy*

  - Analysed macro-economic impact of CO_2 emission reduction on the Austrian economy for the period (1997 – 2005)
  - Baseline forecast for output and energy until 2005 (baseline scenario, BL)
  - Changing investment figures based on expert judgement necessary to fulfil **Toronto target** →20% reduction compared with the level of 1988 (Toronto scenario, TS)

Effects of climate mitigation measures in Austria - previous studies







Other Effects:

- Negative effects **on total gross outputs** due to less production in the energy secctors (-0.48% in TS compared to BL in 2005)
- Positive effects on **total employment;** positive effects of capital goods production compensate for negative emploment effects of less energy output (+0.30% in TS compared to BL)

Applied Method

- ***Combining** an **Environmental Input Output model (EIO)** (top-down) with information of the **GAINS model** (bottom-up) provided by IIASA*

Advantages of EIO model	Advantages of GAINS model
Depicting structural relations	Internationally accepted data, consulted at climate summits
Considering efficiency gains due to changing coefficients	Includes information concerning mitigation potentials of activities
Determining sectoral emission and energy intensities	Includes a lot of underlying energy information

Environmental IO model

- Basic Idea of the Environmental IO model (Leontief, 1970)

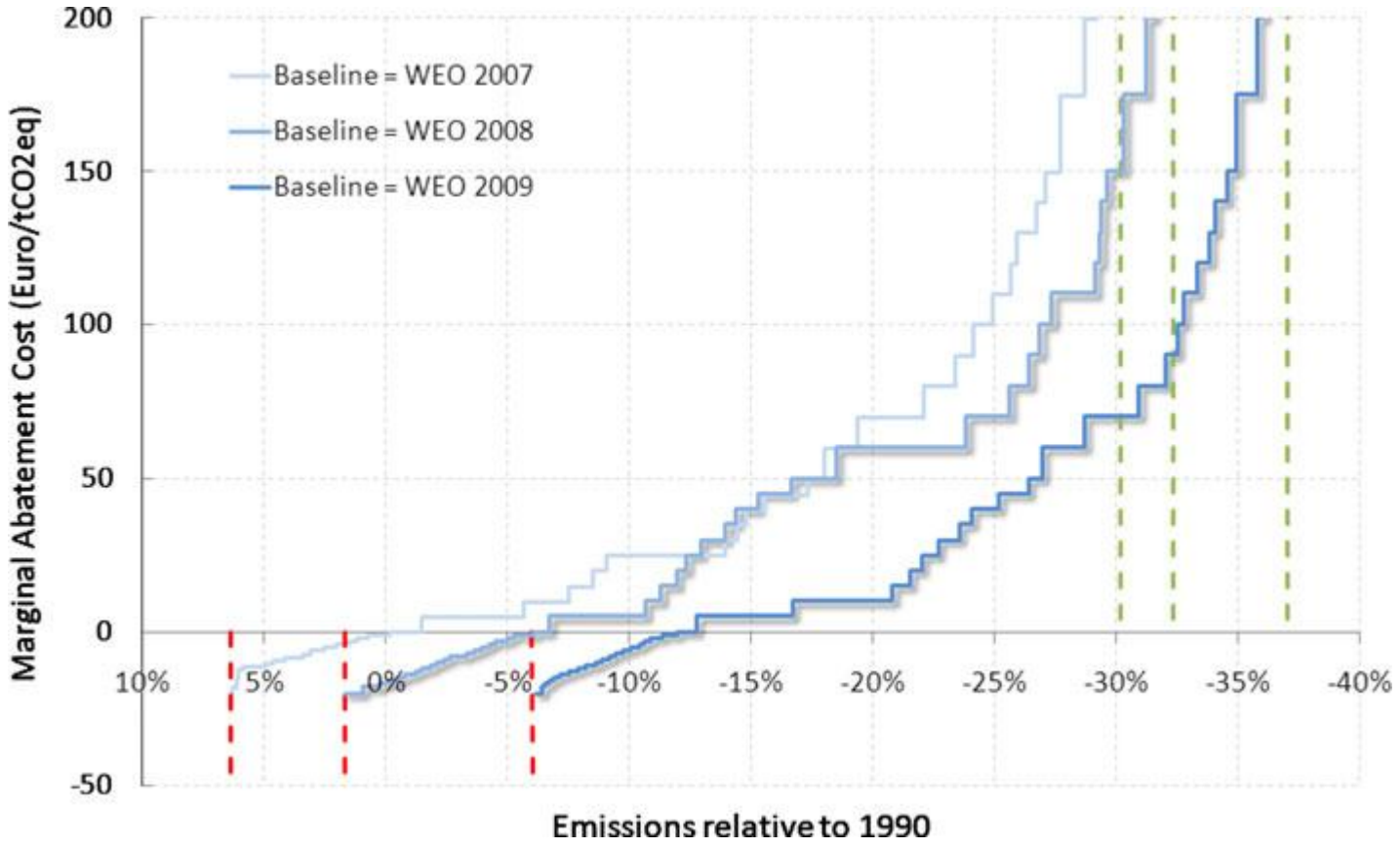
$$\begin{bmatrix} (I-(DB)_{ii}) & -A_{ip} \\ -A_{pi} & 0 \end{bmatrix}^{-1} \begin{bmatrix} (Dy)_i \\ -y_p \end{bmatrix} = \begin{bmatrix} g_i \\ x_p \end{bmatrix}$$

- DB_{ii} ... matrix of input coefficients (k x k)
- A_{pi} ... matrix of emission coefficients (s x k)
- A_{ip} ... Matrix of abatement coefficients (k x s)
- $(Dy)_i$ ... final demand of sectoral outputs (k x 1)
- y_p ... tolerated emission level
- g_i ... gross sectoral outputs (k x 1)
- x_p ... abated pollution

The GAINS model

- **Basic Idea of GAINS:**
  - Illustrating marginal abatement cost curves
  - The baseline of the GAINS model is representing the amount of remaining emissions in 2020 (Baseline), when no mitigation measures were taken, including a 10 year implementation period for mitigation technologies
  - With an increasing carbon price, abatement activities are rising and the amount of remaining emissions is decreasing
  - Including 300 mitigation options: distinguishing between add-on measures, efficiency improvements and fuel switches
  - Information on technological costs of mitigation technologies

GAINS cost curves



Source: Wagner et al. (2012)

GAINS Cost Curves (extract)

Carbon Price (in €)	Agriculture	Industry and Fuel Production	Energy Supply	Transport	Waste	Public and Private Services	Sum
BL*	**8,416.10**	**15,665.15**	**25,422.33**	**18,564.00**	**1,024.15**	**10,364.46**	**79,456.19**
5	0.00%	0.00%	0.00%	-2.84%	0.00%	0.00%	-0.66%
10	0.00%	-4.80%	-0.24%	-3.10%	0.00%	-0.35%	-1.79%
20	-2.22%	-16.18%	-2.33%	-3.35%	-5.25%	-77.16%	-15.09%
50	-5.41%	-24.50%	-6.63%	-4.71%	-28.74%	-82.51%	-19.76%
115	-11.98%	-54.17%	-11.55%	-6.63%	-28.74%	-84.34%	-28.57%
155	-11.98%	-54.40%	-11.99%	-6.72%	-28.74%	-84.40%	-28.78%
200	-11.99%	-53.92%	-16.78%	-6.73%	-43.61%	-84.63%	-30.44%
275	-15.60%	-55.78%	-19.69%	-7.42%	-43.61%	-85.12%	-32.35%

* Remaining emissions in kt CO_2 equivalents

** 6,000 kt CO_2 equivalents from fuel exports were removed

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Combining EIO and GAINS data

- **2 ways:**
  - Using the cost information combined with mitigation potentials to derive information on average abatement costs
  - Using the underlying information of energy demand by activities
- **Time perspective:**
  - GAINS implementation period for mitigation measures (2010 – 2020) will be compared with the period 2002 – 2012 (from the presentation of the first climate strategy until the end of Kyoto period)

Combining EIO and GAINS data

	Agriculture	Industry and fuel production	Energy supply	Transport	Waste	Public and Private Services
ACs of abatement (€/kt CO_2 eq.)	31.85	96.23	12.84	100.00	18.76	12.52

Inserting information into the anti-pollution sector

$$\begin{bmatrix} (I-(DB)_{ii}) & -A_{ip} \\ -A_{pi} & 0 \end{bmatrix}^{-1} \begin{bmatrix} (Dy)_i \\ -y_p \end{bmatrix} = \begin{bmatrix} g_i \\ x_p \end{bmatrix}$$

Inserting emission reduction targets of Kyoto Protocol

Effects of introducing abatement activites and emission targets into the EIO model

	Output 2008	Output Kyoto	Employment 2008	Employment
	Million Euros		Persons	
agriculture	8,995.69	+ 0.53	254,719	15
Industry and fuel production	203,156.94	+ 2.05	921,093	9
Energy supply	28,320.74	+ 0.57	27,394	1
Transport	17,797.00	+ 1.36	138,196	11
Waste	5,249.84	+ 0.34	18,142	1
Public and Private Service	285,872.25	+ 1.36	2,870,038	14

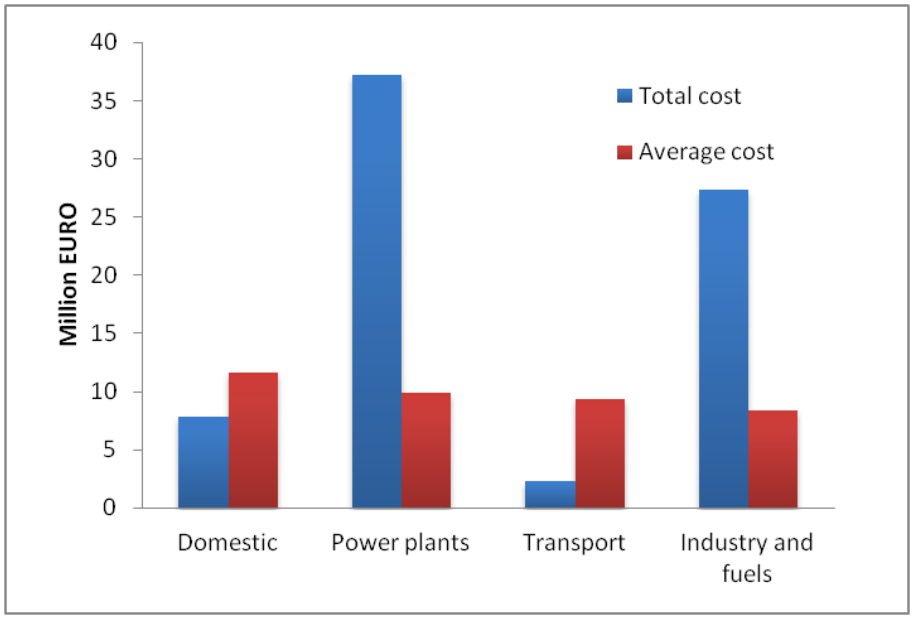
Example for using GAINS data

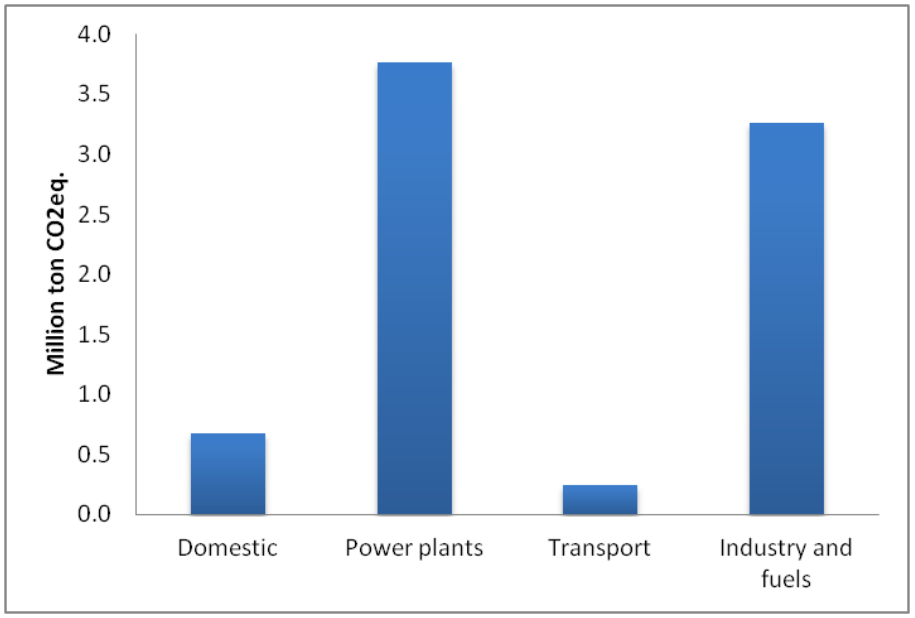
- Austria agreed to reduce by 13% compared to its 1990 emission level
- In 2012 Austria planed to buy certificates for160 million € to reduce 32 million tons CO2 eq. (Die Presse, 2012); the carbon price at this time was around 5€/ton.

- During the period (2008 – 2012) Austria's emissions were around 15 million tons CO2 eq. higher than it's Kyoto target → 75 million Euros not spent in the Austrian economy
- How many emissions would be reduced if 75 million € were invested in Austria?

Example for using GAINS data

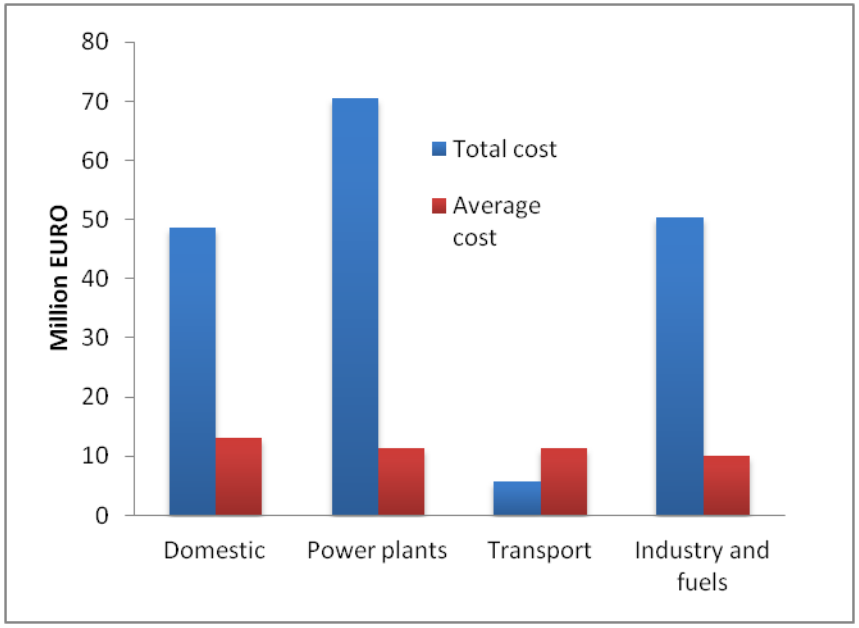
- For € 75 million Austria could have reduced 7 mt CO2 eq.

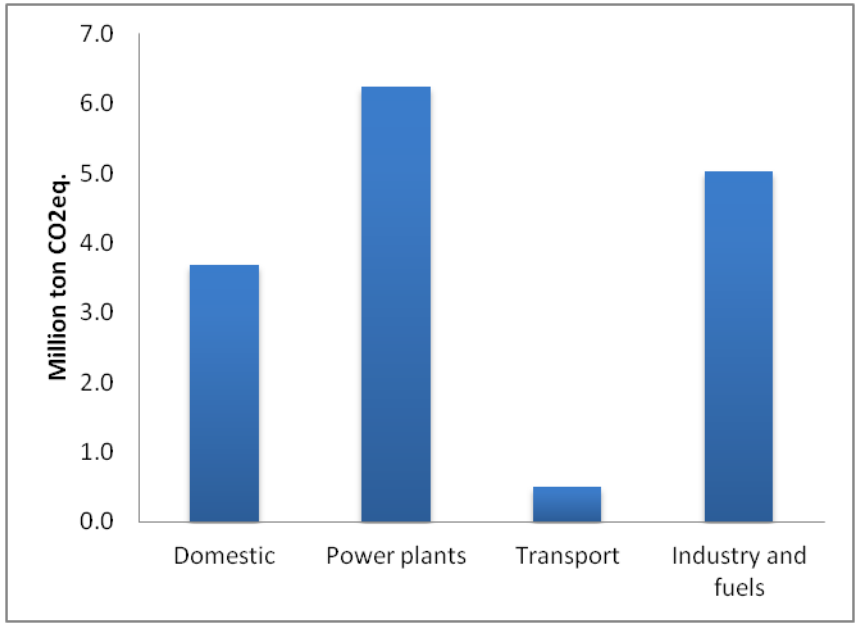




Example for using GAINS data

- It will cost € 175 million to reduce 15 Mt CO2 eq.





Next steps

- Determining cost-effective solutions through optimization techniques (vs. objectives of climate strategy)
- Multi-criteria analysis to account for diverging environmental and economic targets
- Dynamic analysis to account for technological change over time
  → helpful to question the matter of rebound effect
- Using GAINS information on changes in energy demand in respect to raising carbon prices to obtain an insight in the relative changes of sectoral energy demand at certain carbon price steps
- Separating the different mitigation measures entailed in the cost curves: add-on measures, efficiency improvement and fuel switches
- Considering flexible mechanisms in the EIO-GAINS model

Conclusion & Challenges

- Modelling with focus on environmental or climate issues is dependant on external information → challenge/chance to work more interdisciplinary
- Combination of modelling data an political assumptions is not always easy and reasonable