

# The EU Kyoto target and the choice of policy instruments

## The contribution of a general equilibrium analysis with GEM-E3 compared to a partial equilibrium analysis

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## Outline of the presentation

- Bottom-up Top-down distinction
- The GEM-E3 model
- Contribution of the general equilibrium approach in a simplified model
- Contribution of the general equilibrium model, an analysis with GEM-E3



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## Bottom-up Top-down distinction

What is it?

- Now more a distinction between **Partial** equilibrium and **General** equilibrium in my view
- Different approaches can be found in both modelling strategies
  - for the solution algorithm: simulation or optimisation
  - for the temporal horizon: short to medium term or medium to long term
  - for the definition of the parameters: literature review or econometric estimation
  - assumption for market equilibrium or objective



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## Bottom-up Top-down distinction

What is it?

- They are complementary in nature
- Partial equilibrium:
  - detail analysis of abatement possibilities and their cost
  - technological content and sectoral allocation
  - valuable input for general equilibrium
- General equilibrium
  - total welfare cost, inclusive the feedback
  - choice of policy instruments
  - consistent growth assumption for partial equilibrium



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## GEM-E3 Europe (1)

- **14 EU countries, extension towards Eastern Europe countries and Switzerland**, one model per country, all linked through trade flows and environmental flows
- **4 economic agents:** households, firms, government, rest of the world.
- **18 sectors:** agriculture, 4 energy branches, 8 industrial branches, transport, 4 market and public services.
- **13 household expenditure categories:** 9 non durable consumption categories; 3 durable consumption categories;



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## GEM-E3 Europe (2)

- **9 government revenue/expenditure categories:** direct and indirect taxes, energy and environmental taxes, VAT; subsidies, import duties and foreign sector transfers; social security taxes and transfers, public consumption and government enterprises.
- **5 air pollutants:** CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, VOC, PM and ozone, inclusive damage, abatement possibilities and transfrontier aspects
- **2 primary production factors:** labour; capital.
- **annual/5year time path:** the model is solved annually/by period and follows a time-forward path.



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## Producers' Behaviour

- **Maximising behaviour of producers**
  - in the short run, constrained by the physical capital stock (fixed within a period)
  - in the long run, change of capital stock over time through investment (based on growth and relative price expectations)
- **Production scheme**, based on nested CES function involving capital, labour, energy and materials
  - demand for production factors, based on supply and prices
  - supply of goods and services



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## Consumers' Behaviour

- Maximise intertemporal utility under an intertemporal budget constraint (ELES)
- Derived demand for consumption, leisure and savings, assuming myopic expectation
- Allocation of total consumption between consumption goods (LES)
  - durable goods
  - linked non durable goods
  - non linked non durable goods



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## Public Sector

- Behaviour is largely exogenous
  - public consumption and investment
  - taxation and subsidy rates, permit system
  - social policy
- Possibility of endogenous changes of taxation rates to simulate budget neutral policies
- Taxes, permits and environmental targets, EU wide or national, with level of the tax exogenous or the target



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## Import and Export Demand

- domestic demand allocated between domestic products and imports, following an Armington specification
- export to EU countries for one country derived from the import demand from the other countries
- supply to export market occurs at same price as on domestic markets
- export to the Rest of the World (outside EU) is derived from a demand from the RW depending on relative prices



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## The Environmental Module

- Three important environmental problems
  - global warming
  - problems linked to deposition of acidifying emissions
  - ambient air quality linked to acidifying emissions and ozone concentrations
- Energy related emissions: CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, VOC, particulates (extension to other GHG ongoing)
- Transboundary effect of emission (through transport coefficient or relation between primary (NO<sub>x</sub> and VOC) and secondary pollutant (ozone))
- Damage computation for each country resulting from emissions



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## Contribution of the general equilibrium approach

- Overall effect of a GHG abatement policy depends on the distribution of the burden between economic agents
- Important elements for the welfare cost
  - the presence of tax distortion and impact of revenue recycling
  - openness of the economy and possibility of terms of trade effect
  - substitution between production factors and consumption goods
  - functioning of the labour market and mobility of capital



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## Structure of the simplified one country model

- alternative tax structure
  - lumpsum taxes
  - labour tax combined with lumpsum
  - existing structure: income taxes, capital income taxes, excise taxes and VAT
- openness of the economy
  - perfectly price elastic exports
  - less price elastic demand (between 1 and 3)
- capital stock, fixed or flexible
- share of retained earnings in capital income



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## Welfare impact of an energy tax under alternative economic structures

Capital	flexible	flexible	flexible	flexible	fixed
Export price elasticity	very high	normal	very high	normal	normal
Retained profit	no	no	yes	yes	yes
First Best	-0.1 (13.5)	-0.1 (15.5)	-0.1 (13.5)	+0.1 (15.5)	+0.7 (25)
Labour tax (22%)	-0.2 (15)	-0.2 (17)	-0.2 (15)	-0.0 (17)	+0.4 (25)
Existing tax (52% labour+ 30% capital income tax)	-0.4 (19)	-0.3 (21)	-0.3 (19)	-0.1 (21)	+0.0 (26.5)



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## Policy Strategies for the EU Kyoto target

- National Kyoto target by burden sharing agreement
- Four scenarios are considered
  - EU wide permit system with grandfathering
  - domestic CO2 permit system with grandfathering
  - domestic CO2 tax with two forms of recycling
    - social security contribution
    - lumpsum transfer to household



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## National GHG target and reduction effort

	National Target	CO2 reduction effort
Austria	-13	-31.2
Belgium	-7.5	-29.7
Germany	-21	-15.5
Denmark	-21	-39.4
Finland	0	-24.8
France	0	-21.8
Greece	25	-2.1
Ireland	13	-28.9
Italy	-6.5	-29.1
Netherlands	-6	-26.7
Portugal	27	-16.2
Spain	15	-29.5
Sweden	4	-14.1
UK	-12.5	-17.3
EU	-8	-21.7



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## Scenario Results

- Reducing CO<sub>2</sub> emissions implies a cost in terms of economic welfare in all scenarios but a gain in environmental welfare
- A coordinated policy at EU level implementing an EU wide permit system is the least negative
- At domestic level, a grandfathered permit system is also less negative
- The distribution of the burden between sectors and economic agents depends on the choice of instrument



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Country: Europe	EU wide CO <sub>2</sub> permit market (with burdensharing)	Domestic grandfathered CO <sub>2</sub> permit market	Domestic CO <sub>2</sub> tax with SS recycling	Domestic CO <sub>2</sub> tax with transfer recycling
<b>Macroeconomic aggregates (% change w.r.t. benchmark)</b>				
<b>GDP</b>	-0.5	-0.6	-0.2	-0.8
<b>Employment</b>	-0.1	-0.1	+0.6	-0.5
<b>Private consumption</b>	-0.2	-0.3	-0.4	-0.7
<b>Investment</b>	-0.3	-0.4	-0.6	-0.9
<b>Energy consumption</b>	-14.6	-15.8	-16.4	-16.8
<b>Exports</b>	-1.9	-2.1	-1.0	-2.5
<b>Imports</b>	-1.2	-1.4	-1.7	-2.2
<b>Real wage rate</b>	-0.6	-0.7	+0.6	-1.7
<b>Relative consumer price</b>	+2.3	+2.3	+0.8	+1.5
<b>Terms of trade</b>	+0.9	+0.9	0.0	+0.9
<b>Public surplus (% of GDP)</b>			0.0	+0.0
<b>Current account (% of GDP)</b>	-0.3	-0.2	+0.3	+0.0





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Europe	EU wide CO2 permit market with burdensharing	Domestic grandfathered CO2 permit market	Domestic CO2 tax with SS recycling	Domestic CO2 tax with transfer recycling
<b>Emissions (% change w.r.t. benchmark)</b>				
CO <sub>2</sub>	-21.5	-21.7	-21.7	-21.7
NO <sub>x</sub>	-23.5	-24.2	-24.3	-24.3
SO <sub>2</sub>	-28.8	-26.4	-27.7	-27.6
VOC	-19.5	-20.4	-19.9	-20.0
PM	-29.2	-27.8	-29.1	-28.9
<b>Policy</b>				
Environmental tax revenue (% of GDP)			+2.1	+2.0
Change of social security rate w.r.t. benchmark			-3.0	
CO <sub>2</sub> marginal abatement costs (EURO/tonne CO <sub>2</sub> )	65.1	74.0	66.7	64.8


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Welfare Cost (economic and total) (% change wrt benchmark)	EU wide CO2 permit market with burdensharing		Domestic grandfathered CO2 permit market		Domestic CO2 tax with SS recycling		Domestic CO2 tax with transfer recycling	
Europe	-0.03	+0.01	-0.04	+0.00	-0.15	-0.10	-0.09	-0.04
Austria	-0.46	-0.32	-0.47	-0.31	-1.25	-1.09	-0.80	-0.63
Belgium	-0.29	+0.05	-0.21	+0.19	-0.64	-0.24	-0.19	+0.60
Germany	-0.06	+0.32	-0.12	+0.24	-0.35	+0.01	-0.34	+0.03
Denmark	-0.20	+0.03	-0.23	-0.01	-0.17	+0.05	0.0	+0.21
Finland	-0.10	-0.05	-0.10	-0.06	-0.21	-0.17	+0.08	+0.12
France	-0.31	-0.21	-0.42	-0.30	-1.22	-1.09	-0.88	-0.75
Greece	+1.97	+2.07	-0.08	-0.05	-0.09	-0.05	-0.18	-0.14
Ireland	-0.43	-0.37	-0.34	-0.30	-0.14	-0.07	+1.09	+1.17
Italy	-0.34	-0.17	-0.36	-0.15	-1.37	-1.16	-1.08	-0.87
Netherlands	-0.28	+0.21	-0.28	+0.23	-1.24	-0.72	-0.49	+0.03
Portugal	+0.58	+0.75	-0.02	+0.13	-0.04	+0.11	+0.10	+0.25
Spain	-0.09	+0.08	-0.04	+0.15	-0.56	-0.37	-0.12	+0.08
Sweden	+0.18	+0.26	-0.05	+0.01	-0.02	+0.05	+0.02	+0.09
UK	-0.01	+0.16	-0.08	+0.08	-0.04	+0.14	+0.29	+0.47


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## Mechanisms behind these results

- the tax/cost shifting
  - to the foreign sectors
  - to the capital owners
- the tax recycling effect
  - SS reduction improves efficiency of production, both foreign and domestic sectors benefit from this
  - transfer recycling is sometimes welfare improving but through a gain in terms of leisure but sharpest decline in activity
- the tax base effect, limiting the recycling impact



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## Conclusion

- General equilibrium effects are important especially with
  - the complexity of the existing tax and transfer system
  - the openness of the economies
- Partial equilibrium models are important for
  - a correct evaluation of the direct abatement cost by sector
  - the technological content of the reduction potential



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