EV-model: an integrated top-down - bottom-up-model for Finland

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• Background
• EV-model
• Key elements of Finnish Climate change strategy
• Costs of Finnish Climate change strategy
The costs of Finnish climate change strategy

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• Recent studies on Climate change policies in ETLA, VATT and VTT Energy
  – Development of EV-model with VTT Energy
    • Forsström and Honkatukia (2002)
  – Finnish climate change policies
    • Evaluation of national Climate change strategy with VTT
    • Several studies on Kyoto mechanisms
  – International climate change policies
    • Several studies on energy taxes
    • Regional energy markets and climate change policies
    • Emission trade in the EU

• New initiatives
  – Distributional effects on climate change policies
    • Regional
    • Income groups
  – Further analysis on regional energy markets and climate change policies
    • Electricity markets in CGE-models
    • Finland
    • Northern dimension?
Background: climate policies

• Economic Instruments for Climate Policies
  – Carbon taxes
  – Kyoto mechanisms
  – Command and control policies
  – Voluntary agreements

• A great many questions
  – The effects of domestic economic measures
    • Price effects
      – Direct impact on demand for fossil fuels
      – Indirect effect on other sectors via relative price changes and the use of fuels as intermediate inputs
    • Macroeconomic effects
      – Effects caused by export price competitiveness
      – Income effects
      – Carbon leakage
  • The effects of other economic policies
    – Revenue recycling
  • Technology policies
  • Conflicts between climate and other policies

• The effects of the actions of other countries
  • Kyoto mechanisms
  • Price competitiveness
  • Changes in export demand

• Technology effects
  – Crucial, but often not covered in detail, or:
  – Only technology effects covered
• Implementing Kyoto targets involves both technological and economic measures
  – both need to be addressed

• Cost estimates for implementing Kyoto targets from technological and economic models seemingly stem from two different worlds
  – Two approaches often create confusion and unnecessary debate

• The “conflict” stems from a misperception
  – Technology models usually partial equilibrium
  – Economical models usually general equilibrium
  – Top-down: choice of technology exogenous and emissions endogenous
  – Bottom-up: demand for energy services exogenous and technology choice endogenous

• Approaches can be combined to answer more questions
  – Can answer specific technology questions
  – Can introduce economic measures

• Hybrid also produces more answers
  – Can handle broad cost concepts (GDP, utility, equivalent variations, replacement costs etc.)

• Hybrid has some real advantages
  – “unrealistic” technology assumptions are ruled out
  – Scarcity rents are included
μ = 1, niin vain T1 tuottaa.

 isoquant for technology bundle

 Isoquant for technology bundle

 Technology-bundle isoquant

 Isoquant for a top-down model

 Top-down isoquant
EV-model

• Model takes into account
  – Power production technologies (18 in all)
  – Process technologies (forest, chemical and metal industries)
  – Most fuels
    • motor gasolines
    • diesel fuels
    • light fuel oil
    • heavy fuel oil
    • LPG
    • coal
    • peat
    • natural gas
    • wood
  – Energy taxes
  – Prices and competitiveness
  – Labour markets
  – Capital markets
  – Energy efficiency
  – Kyoto mechanisms (to an extent)

• Model does not account for
  – Endogenous productivity gains
  – Other countries’ policies (only as scenarios)
  – Spillovers from Kyoto mechanisms
Utility in EV model

Utility

Consumption

Consumption goods

Good 1

Domestic

Foreign

Good N

Energy

Electricity and heat

District heat

Electricity

Domestic

Foreign

Fuels

Wood

Peat

Oil products
Table 3.3 Production sectors and parameters

<table>
<thead>
<tr>
<th>ISIC Code</th>
<th>Sector Description</th>
<th>σ_j^M</th>
<th>σ_j</th>
<th>KLE</th>
<th>X^j</th>
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### Table 3.3 Production sectors and parameters (cont.)

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<tr>
<th>ISIC</th>
<th>Description</th>
<th>$\sigma$</th>
<th>$KL$</th>
<th>$KL^X$</th>
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<td>Other private services</td>
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</table>

Public services

- Import elasticity: $\sigma^M$
- Labour-capital elasticity of substitution: $\sigma^{KL}$
- Value added energy – intermediate good elasticity of substitution: $\sigma^{KLE}$, $\sigma^X$

### Table 3.4 Utility function parameters

<p>| $\sigma_C$ | Elasticity of substitution between goods | .5       |
| $\sigma_{CEL}$ | Consumption-leisure elasticity of substitution | .52     |
| $\sigma_{FE}$ | Elasticity of substitution between energy and goods | .25    |
| $\sigma_{HE, SF}$ | Elasticity of substitution between heat, electricity, and between fuels | .25    |
| $\sigma_{FHE}$ | Elasticity of substitution between heat-electricity and fuels | .15    |</p>
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<tr>
<th>X40111</th>
<th>Hydropower, wind</th>
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<td>X40122</td>
<td>Distribution of heat and electricity</td>
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<td>Peat-fired condensing plants</td>
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<tr>
<td>X401292</td>
<td>Coal-fired condensing plants</td>
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<tr>
<td>X401293</td>
<td>Natural gas-fired condensing plants</td>
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<td>Oil-fired condensing plants</td>
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<td>X40212</td>
<td>Wood-fired CHP</td>
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<td>X402291</td>
<td>Peat-fired CHP</td>
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<td>X402292</td>
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<td>X402293</td>
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<td>Fine paper</td>
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<table>
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<th>Basic oxygen furnace steel</th>
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<td>Electric arc furnace steel</td>
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<td>X3713</td>
<td>Stainless steel</td>
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<td>X372</td>
<td>Non-ferrous metals and ferrochromium</td>
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</table>
Evaluating the costs of Finnish Climate Change Strategy

• Based on an “official” BAU
  – Responsible ministries evaluated energy saving potential in their fields
  – FM and MTI considered macroeconomic BAU

• EV-model used for analysis
  – Bottom-up – part calibrated according to EFOM results
  – Top-down – part follows economic BAU
  – Point of reference: BAU in 2010

• Policy alternatives
  – Energy saving programme and programme for renewable energy always included
    • Tax breaks and subsidies for green energy
    • CAC for energy saving
  – Two electricity supply scenarios
    • Natural gas
    • Nuclear
  – Most alternatives include increases in fuel and electricity taxes
• **Evaluating energy saving**
  – Energy saving consists of detailed policies that increase energy efficiency
  – Energy saving may benefit users of energy
  – Costs evaluated on the basis of required investments
    • Heating: CLIMTECH
    • Electricity and fuels: EFOM
    • Administrative costs: mostly n.a.

• **Renewable energy**
  – Goals:
    • Wood-based CHP +15 %
    • Wood-based HP +75 %
    • Wind (and water) +15 %
  – Costs stem from investment on new capacity
    • EV estimate
  – Tax breaks and subsidies for green energy must be financed
    • Budgeted amounts
    • Wood: around 100m € by 2010
    • Wind, water 2-3m€ by 2010
• Energy taxes and subsidies
  – Climate change policies are to be revenue neutral
  – Energy tax scenarios
    • CO2 and electricity taxes both raised
    • Transport fuel taxes not raised
    • CAC: more subsidies
  – Revenue recycling
    • 100% Income taxes/transfers
      – Tax wedge -effect disregarded
    • 50% income taxes/transfers, 50% social security payments
    • 50% income taxes/transfers, 50% social security payments
    • 100% Income taxes
      – Tax wedge –effect present
    • 100% VAT
Some results

• Emissions reduced by 21-27 % from BAU (BAU: 69.5 Mt CO2 in 2010)

• GDP down by 0.2-0.7 % compared to BAU

• GDP loss 0.1-0.3 percentage points lower if electricity generation strategy is nuclear-based than if it is natural gas-based

• Employment down by 0.1-0.5 % from BAU
  – Decline smaller in nuclear option
  – Some scope for a green tax reform

• Private consumption falls by 0.6-1.6 % from BAU
  – Fall 0.6 points smaller in nuclear
  – Fall smaller if transportation fuel taxes are not raised

• Energy intensive industries suffer more than labour intensive

• Revenue-recycling can reduce costs – but not much

• GDP: falls more with gas
• Consumption: falls 0.6 % more with gas
• Employment: falls
• Emissions: both hit the target
• Effects smaller, if transport fuel taxes not raised
  – Transport fuel taxes hit consumers relatively more, inducing labour supply and consumption effects