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The Economic and Environmental Impact of the Introduction of a Carbon Tax for Scotland: A Computable General Equilibrium Analysis*

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* The presentation reflects joint research with colleagues in Fraser of Allander Institute, Department of Economics: Grant Allan, Patrizio Lecca, Kim Swales, Marie Tamba and Matt Winning
1. Introduction and background

- Successive Scottish Governments have sought to pursue a distinctive energy and climate change policies (relative to UK)

- Reflected in:
  - Emissions [and renewables] targets that are tougher than UK: emissions 42% below 1990 levels by 2020 (UK 34%) [renewables equivalent to 100% electricity consumption by 2020]
  - Use of planning system (no new nuclear), schemes to encourage new renewable technologies (marine) within scope of devolution settlement

- But Climate Change Committee expects Scotland to miss emissions targets, and
  - While Scottish targets ambitious, limited instruments: major elements of policy reserved to Westminster (tax-transfer system; ROCs; electricity market)
  - Many argue carbon tax most efficient way to tackle emissions
  - Not feasible under current constitutional arrangements, but these are under pressure: move to greater fiscal autonomy
2. Pressure for greater fiscal autonomy

- Continuing lively debate shifting in favour of Scottish Parliament having greater fiscal autonomy/ independence:
  - SNP (independence party) formed a minority administration in 2007 and first ever majority Government in 2011
  - Committed to holding referendum on independence in 2014
  - General agreement that greater fiscal autonomy likely, though no unanimity on extent: new status quo – Scotland Act 2012; “devo(lution) plus”, “devo max”, independence

- Given ambitious emissions targets, expectations that current policy will not deliver on these and pressure for greater fiscal autonomy, seems natural to consider impact of a Scottish carbon tax (if EU ETS not expected to deliver appropriate carbon price).

- We consider the implications of meeting the emissions reduction targets through a (currently hypothetical) Scottish-specific carbon tax
3. The likely impact of a Scottish-specific carbon tax

- Carbon tax would be possible under “devo max” or independence (not under status quo)
  - Classic motivation: internalise externality – polluters pay (using market)
  - Relative price changes induce production and consumption changes away from carbon intensive production and consumption

- Carbon tax also raises revenues: and overall impact may vary with assumptions about their recycling (“double dividend”?)
  - No recycling within the Scottish economy (external- Westminster)
  - Used to finance a expansion in Scottish Government expenditure
  - Alternatively, revenues are recycled to cut tax on labour Scotland

- “No recycling” option:
  - Big increase in fuel prices, contractionary demand and supply effects
  - Increases the relative price of carbon-intensive goods
  - Reallocation of consumption and production away from such goods
  - Likely reduction in emissions, but also economic activity
3. The likely impact of a Scottish-specific carbon tax (continued)

- Revenues used to finance increased government expenditures
  - Ambiguous impact on economic activity in general: carbon tax reduces it, government expenditure increases it, and supply side and bargaining
  - However, as before carbon-intensive goods and modes of production discouraged; but if economic activity rises, limits reduction in emissions

- Revenues used to reduce other taxes e.g. on labour:
  - Again ambiguous impact on overall activity: countervailing effects
  - Again, however, has desirable impact on distribution of economic activity across commodities and sectors, and ultimately technical change

- In general ambiguity about even the direction of effects on the macro-economy (except where no recycling of revenues within Scotland). Of course, even where we know direction of impacts, need a numerical model to indicate the scale of any impact.
  - Need modelling: here use AMOSENVI energy-economy-environment CGE model of Scotland to explore the likely impacts of securing emissions targets through a carbon tax
4. AMOSENVI: energy-economy-environment model of the Scottish economy

- **AMOSENVI**
  - Multi-sectoral, energy-economy-environment model of economy
  - 17 industry sectors (13 energy, 9 generation technologies): big variations in energy and emissions intensities across sectors
  - Interdependence of energy, economy, environment subsystems captured

- Firms cost-minimisers, who sell in competitive markets and consumption is dependent on population, average income and consumer prices

- Wage-setting determined by bargaining – with real wage inversely related to unemployment rate.

- In period by period mode, population and capital stocks updated every period.
  - Flow in-migration – positively related to Scottish real wage and inversely related to Scottish unemployment rate
  - Investment essentially driven by profits

- Transactors either myopic or have perfect foresight: in latter case react to anticipated future events
5. Simulation strategy and results

• We introduce a tax on carbon emissions that ensures satisfaction of the Scottish emissions targets (£50 per tonne)
  – Ad valorem tax on the use of the three domestic and imported fossil fuel energy sources – coal, oil and gas – in their use as intermediate inputs in the production of other goods and services
  – Tax rate differentiated according to carbon content of each fuel (price hikes of: 67%, 42% and 31% respectively)
  – Tax introduced in period 1 and maintained throughout

• The tax raises revenues, and we consider three cases identified above:
  – The revenues are not recycled within Scotland
  – They are used to expand general government expenditure in Scotland
  – They are used to reduce other taxes – here income tax
Table 1. Impact of implementing a £50 per tonne carbon tax in Scotland on key macro-variables (percentage change from base year values)

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<thead>
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<th>Externally Recycled</th>
<th>Internally Recycled</th>
<th>Internally Recycled</th>
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<tr>
<td></td>
<td>Public Expenditure</td>
<td>Income Tax</td>
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<td></td>
<td>Short-run</td>
<td>Long-run</td>
<td>Short-run</td>
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<tr>
<td>GDP</td>
<td>-0.30</td>
<td>-2.68</td>
<td>-0.14</td>
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<td>Unemployment Rate</td>
<td>4.08</td>
<td>0.00</td>
<td>1.79</td>
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<tr>
<td>Total Employment</td>
<td>-0.45</td>
<td>-2.60</td>
<td>-0.20</td>
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<tr>
<td>Nominal Gross Wage</td>
<td>-0.60</td>
<td>0.81</td>
<td>0.24</td>
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<tr>
<td>Real Wage After Tax</td>
<td>-0.45</td>
<td>0.00</td>
<td>-0.20</td>
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<tr>
<td>Replacement Cost of Capital</td>
<td>-0.26</td>
<td>0.63</td>
<td>0.50</td>
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<tr>
<td>Labour Supply</td>
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<td>-2.60</td>
<td>0.00</td>
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<tr>
<td>Household Consumption</td>
<td>-0.90</td>
<td>-1.68</td>
<td>-0.56</td>
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<tr>
<td>Govt. Consumption</td>
<td>-</td>
<td>-</td>
<td>4.66</td>
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<tr>
<td>Income Tax Rate</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Capital Stock</td>
<td>0.00</td>
<td>-2.82</td>
<td>0.00</td>
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<tr>
<td>Export</td>
<td>0.14</td>
<td>-1.23</td>
<td>-0.55</td>
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Figure 1. The short and long-run percentage change in sectoral output for a £50 per tonne tax on CO₂ emissions with revenue recycling through a reduction in income tax.
Figure 2. Change in total CO2 emissions for a £50 per tonne tax on carbon emissions for all three forms of revenue recycling.
Figure 3. % reduction in total CO₂ emissions for a £50 per tonne tax with revenue recycling through a reduction in income tax. A comparison between myopic and perfect foresight agents.
Figure 4: The short and long-run % reductions in sectoral CO₂ emissions for a £50 tonne tax with revenue recycling through a reduction in income tax.
Figure 5: Marginal Abatement Cost Curve
6. Conclusions

• Our results suggest that:
  – A Scottish-specific carbon tax could achieve the Government’s emissions targets, but is only likely to generate a double dividend if revenues are used to reduce other taxes
  – The credibility of the policies has a positive impact on their effectiveness

• However, this is a preliminary analysis:
  – Systematic sensitivity analysis required
  – Sector-specific detail on abatement costs
  – Explore interaction with EU ETS (carbon price floor? tax non-traded?)
  – Allow for endogenous technological change in response to CT
  – Impacts on the rest-of-the UK?
  – Equity issues?
  – Investigate the possible targeting of recycled revenues on:
    • The young who have borne the brunt of recession and its aftermath?
    • Renewables development?
    • Energy infrastructure: government capital expenditure has distinctive impacts