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The benefits of using Regional Input Output tables and the importance of region-specific satellite emissions data

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The general project

- Current work is part of the EPSRC-funded project titled “Energy saving innovations and economy wide rebound effects”
- Under Work Package 2 we examine the economy-wide impact of changes in consumer behaviour using Input Output models
  - Re-spending of savings due to increased energy efficiency of households
- Already expressed interest by the Energy Saving Trust
  - IO a preferred tool as it is simple and transparent
  - Can also be used to understand the impact of consumer decisions on both downstream and upstream supply chains

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The objective of this work

- PhD work on structure of CO_2 emissions tied with EPSRC project
- Focus on showing how Single Region IO from disaggregated Regional IO (national and sub-national) tables can add extra details to analysis conducted using Global Inter-Country IO tables
- Also to highlight the importance of region-specific emissions intensities using calculation of multiplier as illustrative example
  - Therefore the need for region-specific satellite emissions account

Why use Global IO?

- Global Inter-Country IO has been used in PhD work to study the structure and drivers of direct CO_2 and CO_2 footprint of different sectors
- There is policy interest in sectors' direct CO_2 emissions but also in CO_2 footprint
- With Global IO we can study the structure of domestic and international downstream and upstream supply chains
- The more trade partners included the more accurate the results (Lenzen et al, 2004)

Then why the need for Regional IO tables?

- Analysis on Global IO usually points at highly aggregated sectors
  - Potential aggregation bias (Ara, 1959; Miller and Blair, 1981)
  - Over-aggregated sectors can include industries with significantly different characteristics (Hawdon and Pearson, 1995)
  - Not possible to distinguish which component(s) is the main source of emissions
- Regional IO tables usually at national or sub-national level
  - When properly implemented can be highly disaggregated
  - Focus on disaggregating sectors of regional interest
  - More suitable to inform local policy makers
  - However lacking details on imports and exports

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What are the gains using Regional IO?

- IO framework used in this study (based on methodology proposed by Turner et al, 2007)

$$Cem_{IRIO} = EL_{IRIO}DY_{IRIO} = \begin{bmatrix} e_i^1 l_{ij}^{11} y_j^1 & \cdots & e_i^1 l_{ij}^{1s} y_j^s & \cdots & e_i^1 l_{iN}^{1T} y_N^T \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_i^r l_{ij}^{r1} y_j^1 & \cdots & e_i^r l_{ij}^{rs} y_j^s & \cdots & e_i^r l_{iN}^{rT} y_N^T \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_N^T l_{Nj}^{T1} y_j^1 & \cdots & e_N^T l_{Nj}^{Ts} y_j^s & \cdots & e_N^T l_{NN}^{TT} y_N^T \end{bmatrix}$$

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What are the gains using Regional IO?

- Table 1 shows top 10 UK sectors with most direct CO_2 emissions, 2009
  - Sum of row elements for r=UK
  - Calculated using OECD "Inter-Country Input Output database" (Global IO)

Table 1. Top 10 UK sectors in terms of direct emissions

Rank	OECD Sector Code	Sector	Total Direct Emissions (Mt of CO2)	%share of Total UK Direct Emissions	CO2 Intensity (Mt of CO2/$m of output)	Total Final Demand ($m)	Total Output ($m)
1	C40T41	Electricity, Gas and Water Supply	342.40	37.47%	0.00299	57,877.36	114,527.34
2	C60T63	Transport and Storage	141.71	15.51%	0.00079	57,679.74	178,982.35
3	C50T52	Wholesale and Retail; Repairs	50.81	5.56%	0.00012	246,461.62	411,641.78
4	C23	Coke, Refined Petroleum and Nuclear Fuel	35.92	3.93%	0.00113	7,198.71	31,812.09
5	C24	Chemicals and Chemical Products	31.62	3.46%	0.00045	27,832.84	70,494.93
6	C85	Health and Social Work	22.79	2.49%	0.00007	278,692.36	345,408.46
7	C74	Other Business Activities	21.11	2.31%	0.00004	69,853.79	487,861.48
8	C27	Basic Metals	17.71	1.94%	0.00028	14,937.90	63,299.86
9	C55	Hotels and Restaurants	15.72	1.72%	0.00012	123,294.18	130,026.50
10	C90T93	Other Community, Social and Personal Services	15.60	1.71%	0.00009	118,498.87	173,974.91
		All Others	218.52	23.91%			
		Total UK Direct Emissions	913.92	100.00%			

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What are the gains using Regional IO?

- Table 2 shows top 10 Scottish sectors with most direct CO_2 emissions, 2009
  - Calculated using Scottish Input Output tables (Regional IO)
  - Single Region IO framework

Table 2: Top 10 Scottish sectors in terms of direct emissions

Rank	Scottish Sector Number	Sector	Total Direct Emissions (Mt of CO2)	% share of Total Scottish Direct Emissions	CO2 Intensity (Mt of CO2/$m of output)	Total Final Demand ($m)	Total Output ($m)
1	46	Electricity	37.27	35.49%	0.00299	4,975.39	12,466.09
2	26	Coke, Petroleum & Petrochemicals	9.49	9.04%	0.00113	6,723.15	8,407.34
3	49	Waste, Remediation & Management	6.34	6.04%	0.00299	1,562.72	2,122.02
4	48	Water and Sewerage	6.19	5.89%	0.00299	1,342.76	2,070.58
5	47	Gas etc	6.18	5.88%	0.00299	1,163.73	2,066.92
6	58	Support Services for Transport	4.60	4.38%	0.00079	1,537.68	5,815.21
7	55	Other Land Transport	4.12	3.92%	0.00079	2,079.21	5,198.28
8	53	Retail - excl vehicles	1.75	1.67%	0.00012	13,952.37	14,184.41
9	52	Wholesale - excl vehicles	1.50	1.43%	0.00012	8,653.86	12,138.72
10	8	Mining Support	1.43	1.36%	0.00017	7,719.12	8,364.61
		All others	26.14	24.89%			
		Total Scottish Direct Emissions	105.01	100.00%			

What are the gains using Regional IO?

- 'Electricity, Gas and Water Supply' the top sector in Table 1

- 'Electricity', 'Waste, Remediation & Management', 'Water and Sewerage', 'Gas etc' within the top 5 sectors in Table 2
  - Also components of the aggregated 'Electricity, Gas and Water Supply'

- Working with Regional IO tables helps get extra information on highly aggregated sectors
  - 'Electricity' identified as the top polluter amongst the components of what would have been the Scottish 'Electricity, Gas and Water Supply' sector

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Are the findings accurate?

- In Tables 1 & 2 the same emissions intensities have been used
  - UK averages
- We observe counter-intuitive results
  - 'Support Services for Transport' more polluting than 'Other Land Transport'
- Discrepancy between the calculated results of Scottish 'Electricity' and the emissions reported to SEPA
  - 37.3Mt of CO_2 calculated, 13.4Mt of CO_2 reported

How this influences analysis?

- We explore how it affects the calculation of a multiplier

- Carbon Saving Multiplier (CSM)
- $$CSM = \frac{Total\ change\ in\ emissions}{Change\ in\ direct\ household\ emissions}$$

- Illustrative example: Indirect rebound from 10% improved energy efficiency in Scottish households
  - 10% reduced demand in sectors ‘Electricity’ and ‘Gas etc’

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How this influences analysis?

- Change in household demand $360.25m, 2.82Mt of CO_2
- Using UK average intensities the total carbon savings within Scotland from 10% improved Scottish household energy efficiency are 4.64Mt of CO_2
- CSM=1.64

How this influences analysis?

- Substituting SEPA reported emissions (see McGregor et al, 2004) for 'Electricity' then the carbon efficiency savings are 3.65Mt of CO_2
- In that case CSM=1.29
- Already a difference in the size of CSM
- When using UK average intensities we estimate additional 0.35Mt of CO_2 saved economy-wide per Mt of CO_2 saved by Scottish Households

How this influences analysis?

- What if we examine re-spending scenarios?
- Example: All the monetary savings ($360.25m) re-allocated to ‘Food & Beverage Services’
- With UK average carbon intensity for Scottish ‘Electricity’ the CSM is eroded to 1.61
  - An erosion of 1.82%

How this influences analysis?

- With Scotland specific ‘Electricity’ carbon intensity CSM is eroded to 1.27
  - An erosion of 2.06%

- The different intensities generate different results, different magnitudes of change

Conclusions

- Global and Regional IO both useful, for different focus of analysis
- Regional IO can provide additional details to findings from Global IO analysis
- However using the same emissions intensities can lead to errors
  - Especially in sectors with multitude of production technologies
- Region-specific emissions intensities is the key
- Can be rather costly (time, resources) but there are benefits to be made by the generation of better results (Turner, 2006)

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Thank you for your attention

For any enquiries feel free to contact us at:

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Policy briefing: http://cied.ac.uk/documents/3507-cied-policy-briefing-02-6th-aug16-web.pdf

Project website: http://cied.ac.uk/research/impacts/energysavinginnovations

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