

Energy efficiency: international spill over and rebound effects Karen Turner (CEP)

"ENERGY AND THE ECONOMY: PUSHING THE BOUNDARIES" 02 FEBRUARY 2017 CHURCH HOUSE, DEAN'S YARD WESTMINSTER SESSION 1: SHOULD WE ANALYSE IMPACTS OF NATIONAL ENERGY AND ENVIRONMENTAL POLICIES AT A NATIONAL OR GLOBAL ECONOMY LEVEL?









EPSRC EUED project 'Energy saving innovations and economy-wide rebound effects' http://cied.ac.uk/research/impacts/energysavinginnovations

Project partners: EUED CIED centre at Sussex and Fraser of Allander Institute; external collaborators on different WP









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- **Real focus of project:** how does the wider economy respond to improvements in energy efficiency?
- Not just energy use across the economy (rebound question) but activity levels, incomes etc.
- 'Multiple benefits' (International Energy Agency, 2014) argument
- Considering both industrial energy efficiency stimulus to competitiveness
- And household energy efficiency demand-driven stimulus
- Efficiency in the delivery of energy-using services









- Project partners at Strathclyde
- Fraser of Allander Institute: expertise in economy-wide CGE (computable general equilibrium) modelling not limited to energy issues
- For example, fiscal analysis, labour market issues, multi-region modelling for the UK – current example with impacts of Brexit on Scottish and wider UK economy
- Centre for Energy Policy: specific focus on impacts of energy/environmental policy initiatives, and impacts on non-energy policies on energy use/emissions generation
- For example, recent Regional Studies paper of impacts of increased labour productivity on regional activity and emissions, both territorial and traded









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International spillover and rebound effects from increased energy efficiency in Germany



Energy Economics

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ABSTRACT

The pollution/energy leakage literature raises the concern that policies implemented in one country, such as a carbon tax or tight energy restrictions, might simply result in the reallocation of energy use to other countries. This paper addresses these concerns in the context of policies to increase energy efficiency, rather than direct action to reduce energy use. Using a global CGE simulation model, we extend the analyses of 'economy-wide' rebound from the national focus of previous studies to incorporate international spill-over effects from trade in goods and services. Our focus is to investigate whether these effects have the potential to increase or reduce the overall (global) rebound of local energy efficiency improvements. In the case we consider, increased energy efficiency in German production generates changes in comparative advantage that produce negative leakage effects, thereby actually rendering global rebound less than national rebound.

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Motivation for study

- Industrial energy efficiency: lowers marginal cost of energy services, encouraging increased use of energy service and underlying physical energy use – erosion of energy savings
- Decreased cost of production: may reduce output price, boosting economic productivity and competitiveness
- Both in sector where efficiency improves and downstream
- Process of productivity-led or cost-push economic expansion...economy-wide rebound
- Need an *economic system* model (rather than/in addition to energy system work on technology issues)







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A new contribution

- Economy-wide energy efficiency studies, mainly using CGE techniques, have tended to have a national focus
- What if we extend focus to the global economy?
- Important where multi-lateral policies/targets can we assume that energy efficiency changes in one country and energy use in others are independent?
- Pollution leakage and carbon footprint issue: energy use and emissions embedded in trade flows
- Will energy savings rise or fall as we expand boundaries of the economy?







Common expectation?

- Economic expansion increased *demand* on supply chains, and energy use therein
- Our work with international input-output model (WIOD): energy intensity of energy supply chains and net impacts
 - Forthcoming in Energy Policy: Turner and Katris 'A 'Carbon Saving Multiplier'...'
- Energy supply chains may be less international than those of other goods and services?
- Input-output focus on flows of goods and services
- But no consideration of price or supply-side effects
- Work with ZEW Centre for European Economic Research on international CGE (WIOD database)





Problem and approach

- Concerned with international spillover effects
- Don't get clear signals from trade theory 2x2x2 models don't consider intermediate inputs (focus on final goods/services) or changes in efficiency in their use
- Need a numerical model to experiment with
- Here, global CGE Germany, other EU27 (aggregated to one region in results) and 'rest of the world'
- 8 sectors per region, including 2 produced energy supply (electricity and gas; coke, refined petroleum and nuclear)





Problem and approach

- Restrictive assumptions for first step fixed labour and capital (no investment or migration) but mobility across sectors in response to changing returns
- Comparative static all factors fully employed, determining governing wage and capital rental rates (implying Marshallian long run equilibrium interpretation of results)
- Simple 10% increase in energy efficiency introduced as a costless public good in German industry (energy a substitute for valueadded, labour and capital)





Problem and approach

- Get some surprising results to try to explain:
- Key energy use falls outside of target economy even in absence of energy efficiency improvements
- Due to combination of relative competitiveness and energy supply effects
- Negative energy leakage (reverse 'pollution haven'?) with energy use drawn to most efficient location
- However, Germany starts out in relatively energy efficient state





Table 1Changes in output [Billion 2009 USD]

Scenario 1: 10% increase in energy efficiency in all German sectors

Scenario 1						
	GER	REU	ROW	Total across regions		
Total across sectors	10.117	-1.311	-0.065	8.741		
Electricity & gas	-3.331	-1.364	-0.713	-5.408		
Services	9.647	1.364	1.158	12.169		
Transport	1.006	-0.424	-0.469	0.113		
Construction	1.222	0.035	0.006	1.263		
Manufacturing	0.305	1.210	2.286	3.801		
Fuels (CPN)	-0.423	-1.326	-0.648	-2.397		
Food, bev., tob.	0.900	-0.134	-0.099	0.667		
Primary (extract)	0.791	-0.672	-1.587	1.468		





Table 2 Changes in output [Billion 2009 USD]

Scenario 2: 10% increase in energy efficiency in German manufacturing

Scenario 2					
	GER	REU	ROW	Total across regions	
Total across sectors	5.002	-0.860	-1.973	2.169	
Electricity & gas	-1.579	0.054	-0.016	-1.541	
Services	2.186	0.825	0.571	3.582	
Transport	-0.424	0.245	0.255	0.076	
Construction	0.337	0.065	0.010	0.412	
Manufacturing	6.631	-3.124	-3.422	0.085	
Fuels (CPN)	-0.526	-0.063	0.005	-0.584	
Food, bev., tob.	-0.940	0.824	0.424	0.308	
Primary (extract)	-0.683	0.315	0.200	-0.168	





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Conclusions and policy implications

- Concern that policies implemented in one country, such as a carbon tax or tight energy restrictions, might simply result in the reallocation of energy use to other countries
- Here, consider in context of policies to increase energy efficiency, rather than direct action to reduce energy use
- Key finding: increased energy efficiency in German production generates changes in comparative advantage that produce <u>net</u> negative energy leakage effects
- Global economy-wide energy savings greater than at national level





A general result?

- Beginning experiments with a Scotland-Rest of UK model
- Increase energy efficiency in Scotland
- Get similar results: energy production and use falls in RUK i.e. greater energy savings as expand boundaries of economy
- However, where Scottish energy production is more efficient, RUK uses more Scottish-produced energy to extent activity rises in Scottish sector
- Key differences in model specification: (i) capital stock responds to investment, and (ii) labour supply can change via migration







Key: energy use falls in other region but may rise by more in the more efficient region

- Where capital stock responds to investment, Scottish energy production and use across economy (greater GDP boost) rise by more
- Where labour supply changes via migration, the more energy efficient Scotland draws labour, as well as energy use away from RUK – both GDP and industrial energy use in RUK fall by more than where labour supply is fixed
- But further research is required



Thanks for your attention!

Questions?





