GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

MODELLING REBOUNDS AND POLICES AT THE MESO AND MACRO LEVEL

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Christian Lutz, Maximilian Banning

Bundesministerium für Bildung und Forschung

FONA Sozial-ökologische Forschung BMBF

1. **Background and aim of our approach**

2. **Comparison of selected models**

3. **Valuable insights for ReCap modelling**

Starting point

- Broad range of macroeconomic models for various uses
  - ⇨ Single-sector (macro) and multi-sector (meso and macro) models
  - ⇨ Different theoretical approaches
  - ⇨ Various applications
    - Evaluate socio-economic impacts of policies
    - Compare target and reference scenarios
    - Calculate rebound effects
    - Modelling economic growth
  - ⇨ Rebounds are just sometimes considered explicitly
  - ⇨ Rebounds and policies are rarely modelled together

Research question

- How to model rebound-proof policies in PANTA RHEI
  - ⇨ Macroeconometric national economy-energy-environment model
  - ⇨ Incl. input-output tables (63 industries) and energy balances
  - ⇨ Applied among others to evaluate socio-economic impacts of the German energy transition
- Literature review
  - ⇨ How are macroeconomic rebounds modelled in the literature?
  - ⇨ General approach, specification of key scenarios and shocks?
  - ⇨ What are decisive parameters and influencing factors, major results?
  - ⇨ Has anyone modelled rebound-proof policies?

Selection criteria for literature review

- Choice of publications is based on the following criteria:

  ⇨ 1) Analysis of a macro or economy-wide rebound effects, consistent with the definition used in ReCap

  ⇨ 2) Detail of explanation, allowing for sufficient insights regarding assumptions, variables and chain of effects

  ⇨ 3) Relevance for the pursued modelling in PANTA RHEI

  ⇨ 4) Overall selection covers a range of different model types and theoretical approaches

Four models examining the macro-rebound

Model type	Publication of choice
► Macroeconomic (growth) model	► Saunders (2000)
► Computable general equilibrium model (CGE)	► Allan et al. (2007) ► Koesler et al. (2016)
► Macroeconometric model	► Barker et al. (2008)

Model overview

Saunders (2000)

- Analyses general impact of an energy efficiency shock on GDP
- Strong links with neo-classical theory
- No explicit calculation of the rebound effect but implied back-fire

Koesler/Swales/Turner (2016)

- Efficiency shock with German origin influences RoW
- (Changes in) competitiveness of (8) industries important
- Choice of geographical scope influences size of rebound effects

Allan/Hanley/McGregor/Swales/ Turner (2007)

- CGE approach on the UK economy (25 sectors)
- Elasticities of substitution determine rebound size
- Significant differences between short and long run results

Barker/Foxon (2008)

- Evaluation of the impact of UK energy efficiency policies
- Direct rebound effects enter the model exogenously
- Largest indirect effect in energy-intensive sectors

Characteristics overview

	Saunders	Allan et al.	Barker et al.	Koesler et al.
Model-type	Theoretical macroeconomic model	E3-CGE (UKENVI)	National macroeconometric model (MDM-E3)	Multi region CGE world model
Production function	Cobb-Douglas	Multi-level production functions (CES, sector specific)	No explicitly stated production function: factor demand estimated individually	KLEM (CES, sector/country specific)
Number of sectors	Holistic economy	25 (5 of which energy)	50 industries, 4 sectors: 50 fuel users	8 (2 of which energy) per country
Elasticity of substitution	1 (between labour, capital, and Energy)	0.3 (between energy and non-energy components)	0.8%	Various; between 0.15 and 0.72 (between Energy and Capital & Labour, median values over all countries)

Results overview

	Saunders	Allan et al.	Barker et al.	Koesler et al.
Rebound effects	Not quantified	- Electricity production: 62% s. t., 27% l. t. - Remaining energy prod.: 55% s. t., 31% l. t.	- Macro rebound (by their definition): 11% - Direct rebound: 15% (exogenous) Total rebound: 26%	- 47% - 57%, depending on scope and scenario
Causal shock	Rise in energy productivity by 20%	Rise in energy productivity by 5%	Various policy measures	Rise in energy productivity by 10% (depending on sc.)
Effect on GDP	Short term: +1%-2% Long term: 14% higher than short term	Short term: +0.11% Long term: +0.17%	+1.26%	- Sc. 1: Germany: +0.13%; ROW: +0% - Sc. 2: Germany: +0.5%; ROW: -0.002%
Empl.	n.a.	+0.21%	+0.8%	n.a.
Price effect	n.a.	CPI: -0.27%	GDP-deflator (end of the period; 2010): -2.4%	- Sc. 1: aff. sector -0,08% - Sc. 2: rise in energy prices world wide

Conclusions

- Similar comparisons of a scenario with autonomous increase in energy efficiency with a reference case throughout publications
  - ⇨ Direct effect on the production function
  - ⇨ Private households only indirectly affected
- An exception is Barker et al. modelling explicit policies
- Elasticities along the cause-impact chain are responsible for the size of the rebound effects (in particular SE of energy)
  - ⇨ Need for discussion about the relationship between energy and capital (substitutes vs. complements)
- Although causal shocks (increase in energy efficiency) are largely the same, results differ significantly

Implications for modelling in ReCap

- Autonomous increase in energy efficiency and one triggered by investments will be analysed separately
- Important elasticities will build on econometric estimations
- Sensitivity analyses is important
- Synopsis is of limited use for mapping policy measures that reduce the rebound effect
- Literature on policy measures against rebound effects will be reviewed more closely
- Further studies will be considered that explicitly include policy measures, going beyond those concentrating on rebound effects

Outlook for ReCap

- Implementing different policy sets in the model
  - ⇨ Current policy
  - ⇨ Prices (taxes, caps, market-based instruments)
  - ⇨ Policy mixes
  - ⇨ Rebound-proof policies
- Model adjustment
  - ⇨ Elasticities for industry from ex-post estimations
  - ⇨ Sensitivity analyses
  - ⇨ Test different model specifications (e.g. consumption functions, investment, international trade)
- Develop and evaluate rebound-proof policies in close cooperation with the Policy Innovations Lab

Thank you for your attention.

Christian Lutz

T +49 (0) 541 40933 - 120
E lutz@gws-os.com

Head of division Energy & Climate

Maximilian Banning

T +49 (0) 541 40933 - 286
E banning@gws-os.com

Researcher, Division Energy & Climate